UNIVERSITÄT SIEGEN

Department Chemie und Biologie

HANDBOOK OF MODULES

Chemistry (Master of Science)

Siegen,

General preliminary remarks

Brief description of the course of studies
The consecutive Master study programme is designed to enable students to directly change over to a chemistry-oriented occupational field or to begin the doctorate programme in chemistry on the basis of an in-depth scientific education. In particular, students are to acquaint themselves with modern theoretical and experimental developments in the field of study in its entire breadth and moreover be enabled to develop strategies for solving complex issues individually and in teams and to act with scientific and social responsibility. Variable specialization and prioritization in this Degree programme is to allow students to put together an individual educational profile for themselves in the course of the Master study programme.

The Master study programme provides in-depth natural scientific education with specific regard to main research topics in chemistry and adjacent areas of Universität Siegen. During the first semester, advanced theoretical and methodical skills in the core subjects and in two application-oriented minor fields of study (applied chemistry) are imparted. In these courses, perspectives for specialization in the respective subject are highlighted and the basis for academic development is created. From the second semester onward, deepening of knowledge in elective modules takes place. In the fourth semester, the Master's dissertation/thesis is written in the subject of specialization. Deepening of knowledge can take place in more research-oriented subjects and is then geared to current research topics. As a rule, this deepening of knowledge is aimed at the Master's degree as the qualification for subsequent doctorate. Then again, there is the possibility of deepening one's knowledge in the more application-oriented subjects in order to directly enter into work life upon having obtained the Master's degree.

Prioritization in the elective field and specialization laboratory courses comprise the following areas of research and education:

– Chemistry: Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Analytical Chemistry, Building Chemistry, Macromolecular Chemistry.
– Non-chemical disciplines: Biology, Computer Science, Didactics, esp. Didactics of Chemistry, Economic Disciplines, Electrical Engineering, Foreign Language and Communication, Mathematics, Mechanical Engineering, Physics.

The spectrum of the elective course I is consistent with the classical topics of inorganic chemistry, organic chemistry and physical chemistry. In addition to these subjects, one of the application-oriented subjects of analytical chemistry, construction and materials chemistry or macromolecular chemistry can be chosen as elective course II. Elective courses I and II must not have the same topic to prevent focusing too much on one subject. After all, the elective course III comprises the entire range of the above mentioned chemical and non-chemical subjects. The modules "Research project" must be consistent with the elective course I and/or II from 2nd or 3rd term.

The language of instruction in all chemical subjects is English unless otherwise stated in the module descriptions.

Table 1 shows the course schedule of the Master study programme for chemistry. This module overview lists the titles/short titles of modules, the distribution of hours to the type of knowledge transfer (lecture, tutorial, seminar, lab course) as well as the credit points (CP) associated with them followed by the module descriptions in the individual chemistry courses (order: 1. all courses during the first semester; 2. elective courses sorted by subjects; 3. Master's dissertation/thesis).

In elective course III, all modules can be chosen, which are offered in the study programmes of the faculties of electrical engineering, informatics, mechanical engineering, mathematics, physics, economics or in the "Kompetenzzentrum der Universität Siegen" (KoSi). Module descriptions for courses recommended for students of chemistry as elective course III are outlined separately in annex 1. The elective lab course (table 1, position 8.4) is related to the courses chosen as module elective course I (table 1, position 8.1) and II (table 1, position 8.2).

Basically, a module is passed by obtaining the required study credits (German “Studienleistung”) and exam credits (German “Prüfungsleistung”) of the respective module. Credit points (German “Leistungspunkte”) will be granted by the conditions described in the individual module descriptions upon passing the specified exam and study credits. Exam credits are individualized marked achievements specified in the module description, study credits are non-graded individualized achievements specified in the module description, where the number of reexaminations in case of a failed examination is not directly limited. Study and exam credits can be assessed with the following methods: a) oral examination, b) written examination including distribution onto several smaller written examinations with the same total duration, c) presentation, d) written assignment, e) laboratory course, f) exercise or seminar or tutorial or g) master thesis. Alternatively credits can also be assessed with a combination of the latter methods. In that case the weight of each method in total result must be specified in per cent in the module description. Designated assessment methods are specified in the relevant module descriptions. Students must expressly be notified of any deviations from the details contained in the module descriptions by the responsible lecturer at the beginning of the course, i.e. during the first lecture week. Generally, laboratory courses require presence in the laboratory for obtaining the study and exam credits, because the intended competence can otherwise not be obtained. Unexcused absence of a student from the courses is a sufficient criterion for not passing the respective module.
The final mark of the master course is calculated from the arithmetic average of marks of the individual modules weighted with the credits of the respective modules.

Computation of the workload is based on attendance time (1 HPW = 60 minutes over 15 weeks per semester), preparation and revision times as well as preparations for examinations. Total hours of work of 30 h per semester equals 1 credit point (CP). For granting ECTS points, the conversion factor recommended by the GDCh (German Chemical Society’s) commission of experts was used (rounded to 0.5 CP in each case):
Lectures, tutorials, seminars: 1.5 x HPW = CP
Lab courses: 0.6 x HPW = CP

The compulsory modules are offered either in winter or in summer semester depending whether the semester number in the module description is odd or even, respectively. All elective modules are offered after announcement.

Specialization
A specialization in “materials and interfaces”, “light and matter” or “molecular sciences” will be granted together with the master diploma, which depends on the credit points of the chosen modules for the elective courses in the semesters 2 and 3 (see table 2). If a module is tagged with different specializations its credit points will be shared. It is recommended to choose the subject of the master thesis according to the specialization. If at the time of admission to the module “master thesis” a student has an equal weight for two specializations, then the supervisor of the master thesis will decide on specialization.

Prerequisites for participation

Participation in examinations in a chosen module is not linked with any special prerequisites unless explicitly stated in the module description. Participation can require the attendance or the passing of a module from a previous semester.

Export of teaching
The modules of the Master study programme for chemistry are suited as compulsory subject or elective course in the following courses: course for a teaching degree in chemistry (GHR (primary school, secondary general school, intermediate secondary school) and GYM (grammar school)), Master study programme in physics, mechanical engineering, engineering sciences.
Integration of the chemistry modules into the curriculum of the respective courses can be taken from the relevant examination regulations. For additional information, please refer to:
http://www.uni-siegen.de/start/studium/?lang=de
https://lsf.zv.uni-siegen.de/qisserver/rds?state=user&type=0&application=QISLSF.

Responsibility for the modules
Due to foreseeable fluctuations in the personnel structure of the Department of Chemistry and Biology of the Universität Siegen, several responsible instructors have been listed for some modules. In addition, the Board of Examiners appointed by the school of natural sciences and technology (“Fakultät IV”) is responsible for the correct implementation of the module descriptions.

Table 1. **Module Structure of the Master Studies in Chemistry**

	Module/Courses	**L / HPW[a]**	**T,S / HPW[a]**	**LC / HPW[a]**	**Σ HPW**	**CP**
1st Sem.						
7.1	Inorganic chemistry	2	2		4	6
7.2	Organic chemistry	2	2		4	6
7.3	Physical chemistry	2	2		4	6
7.4	Applied chemistry I[b]	2		5	7	6
7.5	Applied chemistry II[b]	2		5	7	6
Sum		**10**	**6**	**10**	**26**	**30**
2nd Sem.						
8.1	Elective course I[c]	2	2		4	6
8.2	Elective course II[d]	2	2		4	6
8.3	Elective course III[e]	2	2		4	6
8.4	Elective lab course I,II[f]			10	10	6
8.5	Foreign language	1	1		2	3
8.6	Scientific writing	1	1		2	3
Sum		**8**	**8**	**10**	**26**	**30**
3rd Sem.						
9.1	Elective course I	2	2		4	6
9.2	Elective course II	2	2		4	6
9.3	Elective course III	2	2		4	6
9.4	Research project I[g]		1	8	9	6
9.5	Research project II[g]		1	8	9	6
Sum		**6**	**8**	**16**	**30**	**30**
4th Sem.						
10.1	Master thesis (6 months)					**30**

[a] L = lecture; T,S = tutorial or seminar; LC = lab course, HPW = Hours per week of confrontation time in one semester. Factors for the determination of credit points (CP): L/E/S 1.5 x HPW (except for Foreign language); P 0.6 x HPW; rounded to 1 CP, resp. [b] Applied Chemistry I and II:, Analytical Chemistry, Building Chemistry, Macromolecular Chemistry (Applied Chemistry I and Applied Chemistry II need to cover different topics). [c] Elective course I: Inorganic Chemistry, Organic Chemistry, Physical Chemistry. [d] Elective course II (cannot be identical with elective course I and must have a different topic): Inorganic Chemistry, Analytical Chemistry, Building Chemistry, Macromolecular Chemistry, Organic Chemistry, Physical Chemistry. [e] Elective course III: Biology, Computer Science, Didactics, esp. Didactics of Chemistry, Economic Disciplines, Electrical Engineering, Foreign Language and Communication, Mathematics, Mechanical Engineering, Physics, Inorganic Chemistry, Analytical Chemistry, Building Chemistry, Didactics, Macromolecular Chemistry, Organic Chemistry, Physical Chemistry. [f] The subjects of the elective lab course have to correspond to the elective courses I and II in the same semester and must have a different topic. [g] Research project I and II need to be consistent with elective courses I and/or II in the second or third semester.

Table 2. **Elective modules in the 2nd and 3rd semester; abbreviations used: LM = light and matter, MI = materials and interfaces, MS = molecular sciences, AC = analytical chemistry, MC = macromolecular chemistry, BC = building chemistry, IC = inorganic chemistry, OC = organic chemistry, PC = physical chemistry; note that not every course will be offered every semester, thus study the course announcements at the beginning of each semester**

Module-ID	Module title	Topic	Elective course 2nd semester			Elective course 3rd semester			Dependencies (a = attended, p = passed), for details see module description	Specialization	Page
			I	II	III	I	II	III			
InorgChem-2	Solid State Chemistry	IC	x	x					a: InorgChem-1	LM, MI	15
InorgChem-3	Special Inorganic Chemistry I	IC			x					LM, MI	16
InorgChem-4	Materials for Energy Storage and Conversion	IC			x	x	x	x	a: InorgChem-1	MI	17
InorgChem-5	Advanced Magnetic Resonance Spectroscopy	IC			x	x	x	x	a: InorgChem-1	LM, MI	18
InorgChem-6	Nano structured materials	IC			x	x	x	x		LM, MI	19
InorgChem-7	Applied Optical Spectroscopy	IC			x	x	x	x		LM	20
InorgChem-8	Special Inorganic Chemistry II	IC						x		LM, MI	21
OrgChem-2	Aromatic and Heteroaromatic Chemistry	OC	x	x						MS	22
OrgChem-3	Stereochemistry and Synthesis	OC				x	x		a: OrgChem-1	MS	23
OrgChem-4	Physical Organic Chemistry	OC				x	x		a: OrgChem-1	MS	24
OrgChem-5	Radicals and Radical Ions in Organic Synthesis	OC			x			x	p: OrgChem-1 or -2 or -3 or -4	MS	25
OrgChem-6	Advanced Physical Organic Chemistry	OC			x			x	p: OrgChem-1 or -2 or -3 or -4	MS	26
OrgChem-7	Electrochem. Methods in Organic and Bioanal. Chem.	OC			x			x	p: OrgChem-1 or -2 or -3 or -4	MS	27
OrgChem-8	Applied NMR Spectroscopy	OC			x			x	p: OrgChem-1 or -2 or -3 or -4	MS	28
OrgChem-9	Introduction to Bioorganic Chemistry	OC			x			x	p: OrgChem-1 or -2 or -3 or -4	MS	29
OrgChem-10	Organic Photochemistry	OC			x			x	p: OrgChem-1 or -2 or -3 or -4	MS, LM	30
PhysChem-2	Physics and Chemistry of Interfaces	PC	x	x						MI	31
PhysChem-3	Atomic Force Microscopy for materials & interface science	PC			x					MI	32
PhysChem-4	Physical chemistry of nanostructured materials	PC				x	x			MI	33
PhysChem-5	Methods and Techniques of Surface Analysis	PC,AC						x	p: PhysChem-2 and AnalChem-2	MI	34
PhysChem-6	Spectroscopy of Cold Molecules	PC	x	x	x					LM, MS	35
PhysChem-7	Multiscale Simulation of Macromolecular Systems and Cells	PC	x	x	x					MS	36
PhysChem-8	Modeling and Simulation in Chemical and Pharmaceutical Industry	PC				x	x	x		MS	37
AnalChem-2	Modern Analytical Chemistry II	AC		x	x				p: AnalChem-1	MI, MS, LM	38
AnalChem-3	Special Topics in Analytical Chemistry	AC					x	x	p: AnalChem-1	MI, MS, LM	39
BuildChem-2	Advanced Chemistry of Building Materials	BC		x					p: BuildChem-1	MI	40
BuildChem-3	Special Materials Chemistry	BC					x			MI	41
BuildChem-4	Biochemistry of Surfaces	BC		x	x					MI	42
BuildChem-5	Metal Oxides - Corrosion and Application in Renewable Energies	BC					x	x		MI	43
PolyChem-2	Synthesis of Polymers	MC		x	x				p: Polychem-1 and OrgChem-1	MI, MS, LM	44
PolyChem-3	Advanced topics in Polymer Chemistry	MC					x	x	p: Polychem-2	MI, MS, LM	45

Degree programme	**Master *Chemistry***
Course title, Topic	**Inorganic Chemistry**
Subtitle (optional)	Advanced Inorganic Chemistry
Module ID	InorgChem-1
Responsible lecturer	Prof. Dr. Schmedt auf der Günne, Prof. Dr. Wickleder
Teaching type	Lecture, tutorial
Relation to curriculum	7.1, Chemistry, mandatory
Semester	1
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to name and describe syntheses of inorganic compounds, to classify and to characterize inorganic compounds with respect to physical and chemical criteria, to evaluate properties of inorganic compounds and to suggest appropriate physical methods to measure these properties. The students are able to summarize important aspects of a broader topic orally and in written form.
Course description	Chemical and physical crystal growth- and preparation- methods, solid state-, molecular-, cluster- and coordination- compounds, thermodynamic and kinetic aspects of solid state reactions and of stabilities of compounds, advanced models of chemical bonding, structures of molecules and crystal structures of important classes of solids, modern physical methods to investigate and to characterize solids.
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (75%), tutorial (25%)
Literature	Lecture, Tutorial, Seminar**:** Shriver, Atkins, *Inorganic Chemistry*; Riedel: *Modern Inorganic Chemistry*, special textbooks and selected publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Organic Chemistry**
Subtitle (optional)	Advanced Organic Chemistry I
Module ID	OrgChem-1
Responsible lecturer	Prof. Dr. Schmittel, Prof. Dr. Ihmels
Teaching type	Lecture and tutorial
Relation to curriculum	7.2, Chemistry, mandatory
Semester	1
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students master advanced concepts of Organic Chemistry and are able to analyze and interpret reaction mechanisms of complex organic reactions. They master advanced synthetic methods, either stoichiometric or catalytic in nature, and understand and evaluate the physical organic, stereochemical and retrosynthetic aspects. The students are able to analyze and interpret current literature. The students have comprehensive competences in a scientific perspective.
Course description	Advanced stoichiometric and catalytic synthetic methods; general synthetic strategies with examples from current literature, stereochemistry, reaction mechanisms, modern name reactions. Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	Textbooks on advanced Organic Chemistry: e.g. R. Brückner, *Reaction mechanisms, 3rd edition.*

Degree programme	**Master *Chemistry***
Course title, Topic	**Physical Chemistry**
Subtitle (optional)	Advanced Physical Chemistry
Module ID	PhysChem-1
Responsible lecturer	Prof. Dr. Lenzer
Teaching type	Lecture, tutorial
Relation to curriculum	7.3, Chemistry, mandatory
Semester	1
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, Additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students understand the fundamental concepts of Physical Chemistry regarding the atomic and molecular basis of matter and its investigation by various state-of-the-art spectroscopic methods covering a broad wavelength range. They are also able to calculate thermodynamic properties of chemical systems from molecular quantities using a statistical approach.
Course description	Movement of charges in electric and magnetic fields, Black-body radiation, Photoelectric effect, Compton effect, Particle-Wave Dualism, Structure of atoms and molecules, Elementary quantum mechanics: Operators, Eigenvalues, Expectation values, Heisenberg's uncertainty principle, Particle in a box, Tunneling, Rigid rotor, Harmonic and anharmonic oscillators, Hydrogen atom, Spin, Term symbols, Molecular orbitals, LCAO approximation, Rotational, vibrational and electronic spectroscopy, Raman effect, Photoelectron spectroscopy, Statistical thermodynamics (Partition function, Internal energy, Entropy, Heat capacity)
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (90%), presentation (10 %)
Literature	Atkins / Friedman, *Molecular Quantum Mechanics*; Atkins / de Paula, *Physical Chemistry*, and additional literature to be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Applied Chemistry I / II, Analytical Chemistry**
Subtitle (optional)	Modern Analytical Chemistry I
Module ID	AnalChem-1
Responsible lecturer	Prof. Dr. Engelhard
Teaching type	Lecture, laboratory course
Relation to curriculum	7.4 or 7.5, Chemistry, elective
Semester	1
Credit points (CP)	6
Workload	Lecture: 30 h, laboratory course: 75 h, additional individual work of the student / homework time: 75 h
Prerequisites for participation	None
Learning outcomes / Competences	Students master fundamental concepts of instrumental analytical chemistry in theory and practice. Students master basic concepts of analytical quality assurance and are able to use selected analytical instrumentation.
Course description	Lecture: Modern instrumental analysis methods in analytical chemistry including, e.g., atomic absorption/fluorescence/ emission spectroscopy (AAS, AFS, AES), x-ray fluorescence spectroscopy, plasma spectrochemistry (ICP-OES, ICP-MS, GD, LIBS), chromatography (HPLC, GC, CE, IC), molecular mass spectrometry (ESI/APCI-MS); instrumentation, theory and selected applications of modern analytical chemistry. Lab: Theory and practice of modern instrumental analytical chemistry. Data acquisition and analysis, statistics, quality assurance, lab reports, critical evaluation of results.
Interdisciplinary qualifications	Application of advanced knowledge and skills in interdisciplinary discussions; debating and discussing in English. Organization and management of a scientific project; ability to work in an international team; writing scientific reports.
Assessment method (Contribution)	Exam credits: Written examination (60%); laboratory course (40%). Both parts must be independently passed successfully.
Literature	Harris: *Quantitative Chemical Analysis*; additional literature to be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Applied Chemistry I / II: Building Chemistry**
Subtitle (optional)	Advanced Materials Chemistry
Module ID	BuildChem-1
Responsible lecturer	Prof. Dr. Killian
Teaching type	Lecture, lab course
Relation to curriculum	7.4 or 7.5, Chemistry, elective
Semester	1
Credit points (CP)	6
Workload	Lecture: 30 h, lab course: 75 h, additional individual work of the student / homework time 75 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to to recognize and evaluate the chemistry of industrially important material on a high level; priorities are new non metallic inorganic materials and composites.
Course description	Extended description of the characteristic chemical and physical properties of the man types of materials and especially new materials, structure property relations, detailed description of new inorganic materials and composites, nano / micro structured materials, biomineralisation, biomaterials, corrosion und durability, sustainability, new direction in development. Lab course for synthesis and characterization as well as for reactivity of new inorganic binding systems and the physical and chemical properties of the reaction products.
Interdisciplinary qualifications	Interdisciplinary assessment and evaluation, organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (60%); laboratory course (40%). Both parts must be passed independently and successfully.
Literature	Askeland, *Material Sciences*; Callister, *Material Science and Engineering*; Carter, *Ceramic Materials- Science and Materials*, selected publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Applied Chemistry I/II, Macromolecular Chemistry**
Subtitle (optional)	Polymer Chemistry I
Module ID	PolyChem-1
Responsible lecturer	Prof. Dr. Jonas
Teaching type	Lecture, lab course
Relation to curriculum	7.4 or 7.5, Chemistry, elective
Semester	1
Credit points (CP)	6
Workload	Lecture: 30 h, lab course: 75 h, additional individual work of the student / homework time 75 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to to recognize and evaluate molecular, structural and mechanical properties of macromolecules and polymers in the solid, fluid and solution state.
Course description	Structure of macromolecules, physical and mechanical properties, basics of processing, physical characterization methods.
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English, application of physical and engineering principles to the understanding of polymer properties.
Assessment method (Contribution)	Exam credits: Written examination (60%); laboratory course (40%). Both parts must be independently passed successfully.
Literature	Hand-outs for lecture and lab course

Degree programme	**Master *Chemistry***
Course title	**Elective lab course I / II**
Subtitle (optional)	
Module ID	ElectLabCourse
Specialization	Determined by the elective courses I or II from the same topic from the same semester
Responsible lecturer	All lecturers of the elective courses I / II
Teaching type	Laboratory course 1 and laboratory course 2
Relation to curriculum	8.4, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lab course: 90 h (I), 60 h (II), additional individual work of the student / homework time: 30 h
Prerequisites for participation	Passed modules: 1st or 2nd term modules for laboratory courses in the topics analytical, macromolecular and organic chemistry[1]; none (for the other topics).
Learning outcomes / Competences	The students have the ability to work with selected experimental and/or theoretical methods, which depend on the choice of the two elective courses I and II chosen in the same term.
Course description	Different experimental and/or theoretical methods depending on the elective courses I and II chosen in the same term. This module contains two complementary parts.
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English
Assessment method (Contribution)	Exam credits: Laboratory course (I: 60%, II: 40%) Both parts must be independently passed successfully
Literature	Lecture, tutorial, Selected special publications and textbooks.

[1] Lab courses in macromolecular and organic chemistry have special safety requirements for the handling of hazardous substances.

Degree programme	**Master *Chemistry***
Course title	**Scientific writing**
Subtitle (optional)	
Module ID	SciWri
Responsible lecturer	Lecturers of the chemical sciences
Teaching type	Lecture, seminar
Relation to curriculum	8.6, Chemistry, mandatory
Semester	2
Credit points (CP)	3
Workload	Lecture: 15 h, seminar: 15 h, additional individual work of the student / homework time: 60 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to present effectively scientific results to the scientific community in a clear and informative research paper and they know the main aspects of reviewing and publishing peer review papers as well as the different steps in the publication process. They develop skills that demonstrate the ability to a) categorize scientific publications and evaluate scientific journals; b) analyze, interpret and accurately cite current literature; c) organize and write the different parts of a manuscript; d) apply good style and language; e) consider ethical guidelines in science; f) submit a research manuscript to an appropriate journal and handle the revision and final proof reading process.
Course description	Contents: General aspects of research manuscripts, types of manuscripts, journals in Science and Chemistry; action plan for manuscript preparation; structure of a research manuscript; Modus Operandi for organization of a research manuscript; ethics in scientific publishing; instructions and suggestions how to plan/organize/write/assemble/submit a manuscript.
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written assignment (100%)
Literature	Text books and monographs on Scientific Writing; e.g. R. A. Day, B. Gastel, *How to Write and Publish a Scientific Paper*, 6th ed; Greenwood Press: Westport, Connecticut, USA, 2006. J.-L. Lebrun, *Scientific Writing: A Reader and Writer's Guide*; World Scientific Publishing: Ort, 2007. H. F. Ebel, C. Bliefert, W. E. Russey, *The Art of Scientific Writing*, 2nd ed.; Wiley-VCH Verlag GmbH & Co., Weinheim, Germany, 2004. A. M. Coghill, L. R. Garson, *The ACS Style Guide; Effective Communication of Scientific Information*, 3rd ed.; Oxford University Press: New York, 2006. Schoenfeld, R. *The Chemist's English*, 3rd ed.; Wiley-VCH: Weinheim, 1999.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II, Inorganic Chemistry**
Subtitle (optional)	Solid State Chemistry
Module ID	InorgChem-2
Specialization	Light and Matter, Materials and Interfaces
Responsible lecturer	Prof. Dr. Schmedt auf der Günne, Prof. Dr. Wickleder
Teaching type	Lecture, tutorial
Relation to curriculum	8.1 or 8.2, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts of the chemistry of solid compounds. They are able to judge and discuss in oral and written form the most important classes of materials and types of crystal structures, the bonding in solids, the importance of crystallography for the understanding of solids, important physical investigation methods and crystal growth processes.
Course description	Structure types and methods of chemical synthesis and crystal growth, chemical and physical properties of solids, classes of materials: insulators, semiconductors and metals; superconductors, ionic conductors, dielectric, magnetic and optic materials, advanced aspects of crystallography, models of chemical bonding in the solid, structure analysis based on single crystals and powders, electron microscopy.
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (75%), tutorial (25%)
Literature	Lecture, tutorial, seminar**:** Shriver, Atkins, *Inorganic Chemistry*; West, *Basic Solid State Chemistry*, U. Mueller, *Inorganic Structural Chemistry*

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Inorganic Chemistry**
Subtitle (optional)	Special Inorganic Chemistry I
Module ID	InorgChem-3
Specialization	Light and Matter, Materials and Interfaces
Responsible lecturer	Prof. Dr. Schmedt auf der Günne, Prof. Dr. Wickleder
Teaching type	Lecture, tutorial
Relation to curriculum	8.3, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts and research results of current inorganic chemistry. They are able to judge and discuss modern research subjects presented by internal and external speakers.
Course description	In the framework of group specific seminars with internal and external speakers, PhD and master students new results of current research projects and new scientific methods are presented and discussed. The use of scientific data files, literature search and evaluation of scientific publications; scientific reports and computer assisted presentation of current research subjects of inorganic chemistry.
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Presentation (50%), tutorial (50%)
Literature	Lecture, tutorial, seminar**:** selected scientific publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II / III, Inorganic Chemistry**
Subtitle (optional)	Materials for Energy Storage and Conversion
Module ID	InorgChem-4
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Schmedt auf der Günne
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.1 or 9.2 or 9.3, Chemistry, elective
Semester	2 or 3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: InorgChem-1
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts and research results related to materials for energy storage. They now about current scientific developments.
Course description	Classical synthesis routes applied to materials for energy storage and conversion; synthesis of nano-materials using top-down and bottom-up strategies; materials and devices for energy storage and conversion; characterization of relevant properties including impedance spectroscopy, cyclic voltammetry, band-structures, calculation of band-structures; texture and its influence on materials properties; models for ionic conduction; phase-change materials
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (100%)
Literature	Lecture, tutorial, seminar**:** selected scientific publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II / III, Inorganic Chemistry**
Subtitle (optional)	Advanced Magnetic Resonance Spectroscopy
Module ID	InorgChem-5
Specialization	Light and Matter
Responsible lecturer	Prof. Dr. Schmedt auf der Günne
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.1 or 9.2 or 9.3, Chemistry, elective
Semester	2 or 3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Attended: InorgChem-1
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts of magnetic resonance solid-state spectroscopy. They are able to apply methods and concepts to questions in materials chemistry. They know different pulsed experiments and understand how these can elucidate structure and dynamics of solids. They now about current scientific developments.
Course description	Characterization (porosity, structure, ion conductivity) of materials by advanced NMR methods; computer simulation of pulse sequences; multidimensional spectroscopy; product operator formalism; data analysis of pulse sequences (REDOR, MQMAS, ...)
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (100%)
Literature	Lecture, tutorial, seminar**:** selected scientific publications.

Degree programme	**Master *Chemistry***
Course title	**Elective course I / II / III, Inorganic Chemistry**
Subtitle (optional)	Nanostructured Materials
Module ID	InorgChem-6
Specialization	Light and Matter, Materials and Interfaces
Responsible lecturer	Prof. Dr. Claudia Wickleder
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.1 or 9.2 or 9.3, Chemistry, elective
Semester	2 or 3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts and research results related to nanostructured materials. They now about current scientific developments.
Course description	Synthesis routes applied to nanostructured materials; physical properties of nanostructured materials; nanoparticles and thin films; quantum dots; form and structure; coated materials; metallic, semiconductor, dielectrics and oxide materials; applications of nanostructure materials: labels of biological structures, biochemical sensors, energy conversion like solar cells, displays and LEDs, data storage, photo catalysts
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in a foreign language
Assessment method (Contribution)	Exam credits: Oral presentation (50%), written assignment (50%)
Literature	Lecture, tutorial, seminar**:** selected scientific publications.

Degree programme	**Master *Chemistry***
Course title	**Elective course I / II / III, Inorganic Chemistry**
Subtitle (optional)	Applied Optical Spectroscopy
Module ID	InorgChem-7
Specialization	Light and Matter
Responsible lecturer	Prof. Dr. Claudia Wickleder
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.1 or 9.2 or 9.3, Chemistry, elective
Semester	2 or 3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts and research results related to optical spectroscopy. They now about current scientific developments.
Course description	Basic principles of optical spectroscopy; methods for the determination of optical properties; inorganic optical materials: metal organic and solid state compounds, transition metal, lanthanides and s2 ions; synthesis routes, applications of optical materials: sensors, displays, solar cells, scintillators and security phosphors
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in a foreign language
Assessment method (Contribution)	Exam credits: Oral or written examination (50%), Presentation (50%)
Literature	Lecture, tutorial, seminar**:** selected scientific publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Inorganic Chemistry**
Subtitle (optional)	Special Inorganic Chemistry II
Module ID	InorgChem-8
Specialization	Light and Matter, Materials and Interfaces
Responsible lecturer	Prof. Dr. Schmedt auf der Günne, Prof. Dr. Wickleder
Teaching type	Lecture, tutorial
Relation to curriculum	9.3, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts and research results of current inorganic chemistry. They are able to judge and discuss modern research subjects presented by internal and external speakers.
Course description	In the framework of group specific seminars with internal and external speakers and PhD students new results of current research projects and new scientific methods are presented and discussed. The use of scientific data files, literature search and evaluation of scientific publications; scientific reports and computer assisted presentation of current research subjects of inorganic chemistry
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral presentation (50%), written assignment (50%)
Literature	Lecture, tutorial, seminar**:** selected scientific publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II, Organic Chemistry**
Subtitle (optional)	Aromatic and Heteroaromatic Chemistry
Module ID	OrgChem-2
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Ihmels, Prof. Dr. Schmittel
Teaching type	Lecture, tutorial
Relation to curriculum	8.1 or 8.2, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h.
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts of the chemistry of aromatic and heteroaromatic compounds. They are able to develop and apply strategies to solve theoretical and practical problems from this area. They master advanced strategies for the synthesis of aromatic compounds. The students are able to analyze and interpret current literature. The students have comprehensive competences in a scientific perspective.
Course description	Structure and properties of benzene, valence isomers, annulenes, Hückel MO theory, criteria for aromaticity, aromatic and heteroaromatic classes of compounds, heterocyclic compounds in biology and medicine, substitution reactions of aromatic compounds, synthesis of heterocyclic compounds. Attendance at relevant seminars with external speakers ("MC-OC-" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	An updated list of literature is announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II, Organic Chemistry**
Subtitle (optional)	Stereochemistry and Synthesis
Module ID	OrgChem-3
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Schmittel, Prof. Dr. Ihmels
Teaching type	Lecture, tutorial
Relation to curriculum	9.1 or 9.2, Chemistry, elective
Semester	3 (offered every 2nd year)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Attended: Module Organic Chemistry 1 with complementary specialization
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts of static and dynamic stereochemistry and have the competence to apply this knowlege to develop strategies for the stereoselective synthesis of complex target molecules. They master advanced synthetic methods, either stoichiometric or catalytic in nature. The students are able to analyze and interpret current literature. The students have comprehensive competences in a scientific perspective.
Course description	Static and dynamic stereochemistry, stereochemical analysis, diastereoselective and enantioselective synthesis, stereodifferentiation according to Izumi-Tai, general synthetic strategies from the current literature. Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	Textbooks on static and dynamic stereochemistry, e.g. E. L. Eliel, S. H. Wilen, *Stereochemistry of Organic Compounds*, G. Procter, *Asymmetric Synthesis.*

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II, Organic Chemistry**
Subtitle (optional)	Physical Organic Chemistry
Module ID	OrgChem-4
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Schmittel, Prof. Dr. Ihmels
Teaching type	Lecture, tutorial
Relation to curriculum	9.1 or 9.2, Chemistry, elective
Semester	3 (offered every 2nd year)
Credit points (KP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Attended: Module Organic Chemistry 1 with complementary specialization
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts of Physical Organic Chemistry. The are able to analyze and interpret complex reaction mechanisms and how to chose and employ the tools for the determination and assessment of reaction mechanisms. The students are able to analyze and interpret current literature. They have comprehensive competences in a scientific perspective.
Course description	Thermodynamics, kinetics, Marcus theory, VB and MO theory, pericyclic reactions, correlation diagrams, FMO methods, models according to Dewar/Zimmerman/Evans and Möbius-Heilbronner, VBCM, isotope effects, linear free energy relationships, tools for the determination of reaction mechanisms (matrix isolation technique, laser-flash spectroscopy, isotope labeling, traping reactions). Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Export[a]	
Literature	Textbooks on Physical Organic Chemistry: e.g. E. Anslyn, D. Dougherty, *Modern Physical Organic Chemistry.*

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Organic Chemistry**
Subtitle (optional)	Radicals and Radical Ions in Organic Synthesis
Module ID	OrgChem-5
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Schmittel
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.3, Chemistry, elective
Semester	2 or 3 (optional offer, offered in coordination with the other compulsory optional subjects in Organic Chemistry)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: OrgChem-1 or -2 or -3 or -4
Learning outcomes / Competences	The students are able to recognize and evaluate advanced reactions of radicals and radical ions and have the competence to apply this knowlege to develop strategies for the synthesis of complex target molecules. The students are able to analyze and interpret current literature. They have comprehensive competences in a scientific perspective.
Course description	Formation of radical and radical ions, radical addition reactions, rearrangement and fragmentation reactions of radicals, stereoselective reactions of radicals, transition metal-mediated radical reactions, reactions of radical anions and radical cations, biradicals. Attendance at relevant seminars with external speakers (''Kolloquium MC-OC'' or ''GDCh-Kollquium'').
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (100%)
Literature	Linker, Schmittel, *Radikale und Radikalionen in der Organischen Synthese* and actual literature.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Organic Chemistry**
Subtitle (optional)	Advanced Physical Organic Chemistry
Module ID	OrgChem-6
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Schmittel
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.3, Chemistry, elective
Semester	2 or 3 (optional offer, offered in coordination with the other compulsory optional subjects in Organic Chemistry)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: OrgChem-1 or -2 or -3 or -4
Learning outcomes / Competences	The students are able to recognize and evaluate the chemistry of reactive intermediates, they are able to classify and discuss the reactivity thereof. They understand advanced methods to identify and characterize reactive intermediates. The students are able to analyze and interpret current literature. The students have comprehensive competences in a scientific perspective.
Course description	Carbocations, carbanions, non-Kekulé molecules, singlet and triplet carbenes, methods: matrix isolation technique, nanosecond laser-flash spectroscopy, non-statistical reaction dynamics, theoretical calculations as complementary method for the investigation of reactive intermediates. Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (100%)
Literature	Moss, Platz, Jones Jr., *Reactive Intermediate Chemistry* and actual literature.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Organic Chemistry**
Subtitle (optional)	Electrochemical Methods in Organic and Bioanalytical Chemistry
Module ID	OrgChem-7
Specialization	Molecular Sciences
Responsible lecturer	N.N.
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.3, Chemistry, elective
Semester	2 or 3 (optional offer, offered in coordination with the other compulsory optional subjects in Organic Chemistry)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: OrgChem-1 or -2 or -3 or -4
Learning outcomes / Competences	The students are able to understand and describe basic electrochemical measurements performend in aqueous and non aqueous solutions, they understand the set up and operation mode of electrochemical devices containing organic or biological components such as organic solar cells, organic light emitting devices, amperometric biosensors based on redox enzymes, and (bio)fuel cells
Course description	Cyclic voltammetry, amperometry, sqaure wave voltammetry, impedance spectroscopy, different electrode materials, reference electrodes, electrochemical cells, chemical and electrochemical synthesis of (semi)conducting polymers, charge transfer in organic materials and in biological systems, electrochemiluminescence, spectroscopy, energy transfer, oxidoreductases, protein or DNA modified surfaces, redox polymer hydrogels, equivalent circuits, thiol chemistry, liquid crystals Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	Bard, Faulkner: Electrochemical Methods; Orazem, Tribollet: Electrochemical impedance spectroscopy; Gileadi: Physical Electrochemistry; and actual literature.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Organic Chemistry**
Subtitle (optional)	Applied NMR Spectroscopy
Module ID	OrgChem-8
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Ihmels
Teaching type	Lecture, tutorial/seminar
Relation to curriculum	8.3 or 9.3, Chemistry, elective
Semester	2 or 3 (offered in coordination with the other compulsory optional subjects in Organic Chemistry)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial/seminar: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: OrgChem-1 or -2 or -3 or -4
Learning outcomes / Competences	The students are able to apply advanced concepts of 2D-NMR spectroscopy to evaluate and interpret NMR spetcra. They are able to develop and apply strategies to deduce the structure of complex organic molecules from their spectroscopic properties. The students are able to analyze and interpret current literature.
Course description	Components, functions and application of NMR spectrometers, practical aspects of homonuclear 2D-NMR techniques, heteronuclear shift-correlation experiments, Overhauser effect, interpretation of 2D-NMR spectra of selected organic compounds, strategies for unambiguous structure assignment. Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, teamwork, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	Textbooks on modern 2D-NMR spectroscopy.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Organic Chemistry**
Subtitle (optional)	Introduction to Bioorganic Chemistry
Module ID	OrgChem-9
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Ihmels
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.3, Chemistry, elective
Semester	2 or 3 (offered in coordination with the other compulsory optional subjects in Organic Chemistry)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: OrgChem-1 or -2 or -3 or -4
Learning outcomes / Competences	The students are able to recognize and evaluate advanced concepts and interdisciplinary aspects of Bioorganic Chemistry. The students are able to identify and discuss chemical aspects of biochemical transformations and physiologically relevant processes. The students are able to analyze and interpret current literature. The students have comprehensive competences in a scientific perspective.
Course description	Amino acids, peptides, proteins (synthesis, biosynthesis, structure and properties, biological function), nucleotides and nucleic acids, structure and biosynthesis of nucleotides, different DNA forms (duplex, triplex, quadruplex, hairpins etc), RNA, DNA and RNA in cells, transcription, replication, protein synthesis, DNA as target in antitumor therapy, reversible interactions of organic ligands with DNA, DNA lesions. Attendance at relevant seminars with external speakers (''Kolloquium MC-OC'' or ''GDCh-Kollquium'').
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written or oral examination (100%)
Literature	Textbooks on Bioorganic Chemistry or Biochemistry: e.g. van Vranken, Weiss, *Introduction to Bioorganic Chemistry and Chemical Biology*; Voet, Voet, *Biochemistry*; Berg, Tymoczko, Stryer, *Biochemistry*

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Organic Chemistry**
Subtitle (optional)	Organic Photochemistry
Module ID	OrgChem-10
Specialization	Molecular Sciences, Light and Matter
Responsible lecturer	Prof. Dr. Ihmels
Teaching type	Lecture, tutorial
Relation to curriculum	8.3 or 9.3 Chemistry, elective
Semester	2 or 3 (offered in coordination with the other compulsory optional subjects in Organic Chemistry)
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: OrgChem-1 or -2 or -3 or -4
Learning outcomes / Competences	The students are able to recognize and evaluate the concepts of Photochemistry. They are able to develop and apply strategies to solve theoretical and practical problems from this area. They master advanced strategies for the application of photochemical key steps in the synthesis of organic compounds. The students are able to analyze and interpret current literature. The students have comprehensive competences in a scientific perspective.
Course description	Photochemical equipment and general methods, photophysics of excited states, photochemical reactions: photochemistry of carbonyl compounds, photochemistry of azoalkanes, cycloaddition reactions, rearrangements, photochromism, electron-transfer reactions; supramolecular photochemistry, photobiology: photochemistry of nucleic acids, photoaffinity labelling. Attendance at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, scientific writing and presentation, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Written or oral examination (100%)
Literature	Textbooks on Organic Photochemistry, e.g. Turro, *Modern Molecular Photochemistry*, Gilbert, Baggot, *Essentials of molecular Photochemistry*; Horspol, Armesto, *Organic Photochemistry;* Klan, Wirz, *Photochemistry of Organic Compounds.*

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II, Physical Chemistry**
Subtitle (optional)	Physics and Chemistry of Interfaces
Module ID	PhysChem-2
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Schönherr
Teaching type	Lecture, tutorial
Relation to curriculum	8.1 or 8.2, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students know the fundamental concepts and methods of physical chemistry of surfaces and interfaces and can apply these to recent research topics of interfacial science.
Course description	Liquid surfaces, thermodynamics of interfaces, charged surfaces, surface forces, contact angle phenomena and wetting, solid surfaces, adsorption, surfactants, micelles, emulsions, foams, and thin films.
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Written examination (100%),
Study credits	tutorial
Literature	Butt, Graf, Kappl, *Physics and Chemistry of Interfaces,* Butt, Kappl, *Surface and Interfacial Forces* and additional literature to be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Physical Chemistry**
Subtitle (optional)	Atomic Force Microscopy for materials and interface science
Module ID	PhysChem-3
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Schönherr
Teaching type	Lecture, tutorial
Relation to curriculum	8.3, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students know the fundamental concepts and methods of atomic force microscopy, the basics of intermolecular and surfaces forces and can apply these to recent research topics of interfacial science.
Course description	Atomic Force Microscopy principles, instrumentation, imaging, force measurements, data acquisition, data processing, artefacts; AFM measurement modi and underlying physics: contact, intermittent contact, non-contact, resonating force and resonance modes, electric and magnetic force mode; selected examples for AFM on soft matter, solid surfaces, thin films and measurements of molecular scale interaction forces.
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Written or oral examination (100%),
Study credits	tutorial
Literature	Butt, Kappl, *Surface and Interfacial Forces,* Schönherr, Vancso *Scanning Force Microscopy of Polymers (Springer Laboratory)* and additional literature to be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II, Physical Chemistry**
Subtitle (optional)	Physical chemistry of nanostructured and soft materials
Module ID	PhysChem-4
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Schönherr
Teaching type	Lecture, tutorial
Relation to curriculum	9.1 or 9.2, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students know the fundamental concepts and methods of physical chemistry of nanostructured materials and can apply these to recent research topics in this area.
Course description	Basics of nanostructured materials: Nanoscopic dimension, synthesis of nanostructures, approaches to characterize the structure of nanoscopic materials, metrology, approaches to investigate electronic properties of nanoscopic materials. Metal nanostructures: Synthesis, optical properties, magnetic properties, electronic properties. Semiconductors: Band structures, quantization, structure, spectroscopy. Carbon: Carbon nanostructures, electronic transport, phonons, vibrational spectroscopy. Self-assembly and self-organized soft matter nanostructures: particles, capsules, tubes, functional nanomaterials.
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Study credits	tutorial
Literature	Ozin, *Nanochemistry: A Chemical Approach to Nanomaterials,* Cademartiri, Ozin, *Concepts of Nanochemistry,* and additional literature to be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course III, Physical and Analytical Chemistry**
Subtitle (optional)	Methods and Techniques of Surface Analysis
Module ID	PhysChem-5
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Schönherr, Prof. Dr. Engelhard
Teaching type	Lecture, tutorial
Relation to curriculum	9.3, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: PhysChem-2 or AnalChem-2
Learning outcomes / Competences	The students know the fundamental concepts, methods and techniques of surface analysis and can apply these to recent research topics of interfacial and analytical chemical science.
Course description	Surface spectroscopy, including X-ray photoelectron spectroscopy, infrared spectroscopy, electron microscopy, atomic force microscopy, surface plasmon resonance, ellipsometry, quartz crystal microbalance, time-of-flight secondary ion mass spectrometry, laser ablation inductively coupled plasma mass spectrometry, glow discharge spectroscopy, laser induced breakdown spectroscopy, newly developed microscopic and spectroscopic techniques
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Study credits	tutorial
Literature	Vickerman, Gilmore, Surface Analysis: *The Principal Techniques* Butt, Graf, Kappl, *Physics and Chemistry of Interfaces* and additional literature to be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II / III, Physical Chemistry**
Subtitle (optional)	Spectroscopy of Cold Molecules
Module ID	PhysChem-6
Specializations	Light and Matter, Molecular Sciences
Responsible lecturers	Prof. Dr. Lenzer, Prof. Dr. Oum
Teaching type	Lecture, tutorial
Relation to curriculum	8.1, 8.2 or 8.3
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students obtain a comprehensive overview of molecular spectroscopy and reactions dynamics from the experimental and theoretical side, with an emphasis on processes at low temperatures where very detailed information can be obtained. They understand the basis of different types of state-of-the-art experiments and their interpretation by theoretical approaches and calculations.
Course description	Advanced electronic spectroscopy, Temperature-dependent spectra, Radiative and nonradiative processes and their timescales, Perrin-Jablonski diagram, Laser techniques, Molecular beams, State-resolved emission spectroscopy, REMPI spectroscopy, Helium droplets, Laval nozzle spectroscopy, Anion photoelectron and ZEKE spectroscopy, Molecular reactions dynamics, State-resolved and thermally averaged rate constants, Energy and angular momentum conservation, Elastic and inelastic scattering processes, Total and differential cross-sections, Harpoon mechanism, Centrifugal barrier, Langevin model, Potential energy surfaces, Early and late barriers, Polanyi's rules, Quantum mechanical and statistical product state distributions
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	To be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II / III, Physical Chemistry**
Subtitle (optional)	Multiscale Simulation of Macromelecular Systems and Cells
Module ID	PhysChem-7
Specializations	Molecular Sciences
Responsible lecturer	PD Dr. Bäurle
Teaching type	Lecture, Tutorial
Relation to curriculum	8.1, 8.2 or 8.3, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes	The students become familiar with multiscale simulation approaches, to explore multiscale phenomena occurring in macromolecular systems and cells, and can apply them to recent research topics of physical and biological chemistry.
Course description	Multiscale phenomena in chemistry and biology, simulation and analysis methods on the quantum, atomistic, mesoscopic and macroscopic scale, sequential, concurrent and adaptive resolution schemes, applications to macromolecular systems and cells.
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Study credit	Tutorial
Literature	„A review of multiscale computational methods in polymeric materials“, Gooneie, A., Schuschnigg, S. and Holzer, C., Polymers (2017) 9: 16 (https://doi.org/10.3390/polym9010016); „Integrating multiscale modeling with drug effects for cancer treatment“, Li, X. L., Oduola, W. O., Qian, L. and Dougherty, E. R., Cancer Informatics (2015) 14 (Suppl 5): 21 (https://doi.org/10.4137/ CIN.S30797). An updated list of literature is announced at the beginning of the module

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course I / II / III, Physical Chemistry**
Subtitle (optional)	Modeling and Simulation in Chemical and Pharmaceutical Industry
Module ID	PhysChem-8
Specialization	Molecular Sciences
Responsible lecturer	PD Dr. Bäurle
Teaching type	Lecture, Tutorial
Relation to curriculum	9.1, 9.2 or 9.3, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes	The students become familiar with the theoretical concepts of (a) chemical elementary reactions, (b) classical and quantum-mechanical molecular dynamics of many-body systems, and (c) rotational-vibrational-electronic spectroscopy of molecules including non-adiabatic effects
Course description	Potential energy surfaces, classical trajectories, time-dependent and time-independent Schrödinger equation, molecular dynamics/ Monte Carlo approaches, ab initio rovibronic spectroscopy (beyond harmonic oscillator approaches)
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Study credit	Tutorial
Literature	Atkins, Friedman, *Molecular Quantum Mechanics*; Ratner, Schatz, *Quantum Mechanics in Chemistry*; Jensen, *Introduction to Computational Chemistry*; Simons, Nichols, *Quantum Mechanics in Chemistry*; Levine, *Quantum Chemistry*.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II / III: Analytical Chemistry**
Subtitle (optional)	Modern Analytical Chemistry II
Module ID	AnalChem-2
Specialization	Materials and Interfaces, Molecular Sciences, Light and Matter
Responsible lecturer	Prof. Dr. Engelhard
Teaching type	Lecture, tutorial/seminar
Relation to curriculum	8.2 or 8.3, Chemistry, elective subject
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial/seminar: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: AnalChem-1
Learning outcomes	Students master advanced concepts in analytical chemistry, are able to review the scientific literature, and can apply their knowledge to solve analytical problem sets and to select appropriate analytical methods.
Course description	Lecture: Advanced instrumentation, theory, and applications in modern analytical chemistry including, for example, ultra trace and nano analysis, bioanalysis, surface analysis, imaging, speciation analysis, isotope dilution, isotope analysis, and ambient mass spectrometry. Tutorial/seminar: searching and reviewing of scientific publications; scientific databases; oral presentations on modern analytical chemistry topics.
Interdisciplinary qualifications	Ability to think in abstract concepts. Ability to review scientific papers, and to present the content to a group of students. Ability to give feedback to colleagues. Understanding of the fundamentals in scientific writing. Debating and discussing in English.
Assessment method (Contribution)	Exam credits: Written Examination (75%); presentation (25%)
Literature	To be announced at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II / III: Analytical Chemistry**
Subtitle (optional)	Special Topics in Analytical Chemistry
Module ID	AnalChem-3
Specialization	Materials and Interfaces, Molecular Sciences, Light and Matter
Responsible lecturer	Prof. Dr. Engelhard
Teaching type	Lecture, seminar/tutorial
Relation to curriculum	9.2 or 9.3, Chemistry, elective subject
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, seminar/tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: AnalChem-1
Learning outcomes	Students master special topics in analytical chemistry, are able to review the scientific literature, and can apply their knowledge to solve analytical problem sets and to select appropriate analytical methods.
Course description	Advanced instrumentation, theory, and applications in analytical chemistry including, e.g., elemental/molecular mass spectrometry and ambient mass spectrometry. Short courses and group seminars with internal/external speakers and graduate students. Scientific tools for research in analytical instrumentation, e.g., online databases, data acquisition, data processing tools.
Interdisciplinary qualifications	Literature survey, review of scientific publications, application of advanced knowledge and skills in interdisciplinary discussions; debating and discussing in English; organization and management of a scientific project, ability to work in an international team, communication and presentation skills.
Assessment method (Contribution)	Exam credits: Oral or written examination (100%).
Study credits	Tutorial
Literature	Selected literature will be provided at the beginning of the module.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II, Building Chemistry**
Subtitle (optional)	Advanced Chemistry of Building Materials
Module ID	BuildChem-2
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Killian
Teaching type	8.2, Lecture, tutorial
Relation to curriculum	Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: BuildChem-1
Learning outcomes	The students are able to recognize and discuss main principles of reaction mechanism of modern building materials on the basic of actually research results.
Course description	Reaction mechanisms of inorganic binder agents, micro / nano structures, influences on kinetics of reactions and phase formation, effect principles of organic additives, new nano structured building materials, durability, mechanisms of corrosion and corrosion protection. Tutorial including presentations of chosen themes.
Interdisciplinary qualifications	Interdisciplinary assessment and evaluation, literature survey, and techniques of presentation, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (75%), presentation (25%)
Literature	Hand-outs for the lecture, Leas *Chemistry of Cement and Concrete*, Bensted *Structure and Performance of Cements*, selected special literature.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II, Building and Inorganic Chemistry**
Subtitle (optional)	Special Materials Chemistry
Module ID	BuildChem-3
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Killian
Teaching type	Lecture, tutorial
Relation to curriculum	9.2, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial/seminar: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None.
Learning outcomes	The students are able to recognize and discuss new research directions in the field of chemistry of inorganic building materials, with a focus on building and nanostructured composite materials.
Course description	Structure property relation, micro / nano structures and structure arrangement, novel nano structured materials, building materials, biomaterials, composite materials, functionalized surfaces, self-cleaning, energy conversion, sustainability. Tutorial including presentations of selected topics.
Interdisciplinary qualifications	Interdisciplinary assessment and evaluation, literature survey, und techniques of presentation, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (75%), tutorial (25%)
Literature	Hand-outs for the Lecture, Odler, *Special Inorganic Cements*, Carter, *Ceramic Materials- Science and Materials,* selected literature.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II / III, Building Chemistry**
Subtitle (optional)	Biochemistry of Surfaces
Module ID	BuildChem-4
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Killian
Teaching type	8.3, Lecture, tutorial
Relation to curriculum	Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial/seminar: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and discuss new research directions in the field of chemistry of surfaces in contact with biological environment, with a focus on metallic and oxidic surfaces.
Course description	Implant materials, biomineralisation, structure-acceptance-relationships, protein adsorption, drug loading and release, bioactive surfaces, biofouling, biocorrosion, antifouling materials
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (100%)
Literature	Hand-out, Ratner *Biomaterials Science,* selected literature.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II / III, Building Chemistry**
Subtitle (optional)	Metal Oxides – Corrosion and Application in Renewable Energies
Module ID	BuildChem-5
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Killian
Teaching type	Lecture, tutorial
Relation to curriculum	9.3, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial/seminar: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to recognize and discuss new research directions in the field of oxide materials and their application.
Course description	Oxidic semiconductors, corrosion, passivation, anodization, doping and modification, photoconversion, solar cells (active electrode, ETL, HTM), water splitting, photocatalysis, intercalation – batteries & electrochromic effects, chemistry of oxides – self-assembeled monolayers.
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Oral or written examination (100%)
Literature	Askeland, *Material Sciences*; Callister, *Material Science and Engineering*; selected publications.

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II / III, Macromolecular Chemistry**
Subtitle (optional)	Synthesis of Polymers
Module ID	PolyChem-2
Specialization	Materials and Interfaces, Molecular Sciences, Light and Matter
Responsible lecturer	Prof. Dr. Jonas
Teaching type	Lecture, tutorial/seminar
Relation to curriculum	8.2 or 8.3, Chemistry, elective
Semester	2
Credit points (CP)	6
Workload	Lecture: 30 h, tutorial/seminar: 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: PolyChem-1 and OrgChem-1
Learning outcomes / Competences	The students are able to recognize and discuss main principles of polymer synthesis, and differences to low molar mass organic reactions.
Course description	Basic definitions of polymer chemistry, conditions and mechanisms of polymerisation reactions for various types of polymerizations, synthesis and purification strategies, molecular characterization of polymers.
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Written examination (100%)
Literature	Hand-outs

Degree programme	**Master *Chemistry***
Course title, Topic	**Elective course II / III, Macromolecular Chemistry**
Subtitle (optional)	Advanced topics in Polymer Chemistry
Module ID	PolyChem-3
Specialization	Materials and Interfaces, Molecular Sciences, Light and Matter
Responsible lecturer	Prof. Dr. Jonas
Teaching type	Lecture, tutorial / seminar
Relation to curriculum	9.2 or 9.3, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Lecture 30 h, tutorial 30 h, additional individual work of the student / homework time: 120 h
Prerequisites for participation	Passed: Polychem-2
Learning outcomes / Competences	The students have knowledge in special topics of polymer chemistry and master the transfer of these principles to other topics.
Course description	Special topics in the field of Polymer Chemistry, discussion of novel developments in the literature.
Interdisciplinary qualifications	Application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English, Literature search, text analysis, presentation techniques
Assessment method (Contribution)	Written examination or presentation (100%).
Literature	Hand-out, journal articles, monographs.

Degree programme	**Master *Chemistry***
Course title, Topic	**Research Project I / II, Inorganic Chemistry**
Subtitle (optional)	
Module ID	InorgChem-9/InorgChem-10
Specialization	Light and Matter, Materials and Interfaces
Responsible lecturer	Prof. Dr. Schmedt auf der Günne, Prof. Dr. Wickleder
Teaching type	Lab course, seminar
Relation to curriculum	9.4 and/or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	None
Learning outcomes / Competences	The students have the ability to work independently on an extended special research topic including preparation techniques and characterization methods. The students have an overview on the research activities of the workgroup. They are able to summarize a extended research topic in written form according to scientific standards
Course description	Independent preparation and characterization of compounds in an actual field of solid state chemistry. Sophisticated use of program systems and data bases in inorganic solid state chemistry.
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Literature	Original literature, special literature, special data bases.

Degree programme	**Master *Chemistry***
Course title, Topic	**Research project I / II, Organic Chemistry**
Subtitle (optional)	
Module ID	OrgChem-11/OrgChem-12
Specialization	Molecular Sciences
Responsible lecturer	Prof. Dr. Schmittel, Prof. Dr. Ihmels
Teaching type	Lab course, seminar
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	Passed: ElectLabCourse with min. 50% in organic chemistry with a grade ≤ 2.3.
Learning outcomes / Competences	The students are able to perform sophisticated multistep synthesis of complex organic molecules and master the isolation, identification and characterization of new reaction products. They apply modern physical organic, supramolecular, bioorganic or photochemical concepts and methods for the evaluation of experiments. The students are able to organize, perform, document and present a scientific research project. The students are able to analyze and interpret current literature.
Course description	Selected project from current research activities of the organic-chemistry groups. Attendance at group seminars and at relevant seminars with external speakers ("Kolloquium MC-OC" or "GDCh-Kollquium").
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Literature	Recent publications from Organic Chemistry and related disciplines.

Degree programme	**Master *Chemistry***
Course title, Topic	**Research project I / II, Physical Chemistry**
Subtitle (optional)	
Module ID	PhysChem-9
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Schönherr
Teaching type	Seminar, Lab course
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	None
Learning outcomes / Competences	The students are able to plan and carry out research-oriented experiments in physical chemistry
Course description	Projects in current topics in physical chemistry
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Literature	Recent publications in physical chemistry.

Degree programme	**Master *Chemistry***
Course title, Topic	**Research project I / II, Physical Chemistry**
Subtitle (optional)	Computational Chemistry
Module ID	PhysChem-10
Specialization	Molecular Sciences
Responsible lecturer	PD Dr. Bäurle
Teaching type	Lab course, seminar
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	None
Learning outcomes	The students are able to plan and carry out research-oriented projects, using sophisticated computational chemistry program packages.
Course description	Selected projects from current research activities of the theoretical chemistry group.
Interdisciplinary qualifications	Ability to think in terms of abstract concepts, recognition of complex problems, application of advanced knowledge and skills in inter- and trans-disciplinary discussion of complex issues, debating and discussing in English
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Literature	Recent publications from theoretical chemistry and related disciplines.

Degree programme	**Master *Chemistry***
Course title, Topic	**Research Project I / II, Physical Chemistry**
Subtitle (optional)	Special Laboratory Course “Laser Spectroscopy”
Module ID	PhysChem-11
Specialization	Light and Matter
Responsible lecturer	Prof. Dr. Lenzer, Priv.-Doz. Dr. Oum
Teaching type	Lab course, seminar
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	None
Learning outcomes / Competences	The students have the ability to work independently on an extended special research topic in Physical Chemistry including sample preparation techniques and spectroscopic investigations employing state-of-the-art steady-state or time-resolved methods. The students obtain an overview of the research activities of the workgroup. They are able to summarize and present a current research topic according to scientific standards.
Course description	Experiments on selected molecular systems using state-of-the-art optical methods for steady-state and time-resolved spectroscopy, employing e.g. nanosecond or femtosecond lasers. Evaluation of the data by modern software packages, e.g. for graphical representation and kinetic analysis.
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, communication and presentation skills, debating and discussing in English
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Literature	Original literature, special literature, special data bases

Degree programme	**Master *Chemistry***
Course title, Topic	**Research project I / II, Building Chemistry**
Subtitle (optional)	
Module ID	BuildChem-6
Specialization	Materials and Interfaces
Responsible lecturer	Prof. Dr. Killian
Teaching type	Lab course, seminar
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	Passed: BuildChem-1
Learning outcomes / Competences	The students are able to work successfully on special chemical questions in the area of modern inorganic materials.
Course description	Subprojects of current main research fields of from the working group. Independent synthesis or preparation of materials and suitable model systems. Characterization of the materials or the reaction products. Determination of the reaction process and the properties. Application of new and extended characterization methods, in particular in the micro / nano range.
Interdisciplinary qualifications	Interdisciplinary assessment and evaluation, literature survey, und techniques of presentation, organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, debating and discussing in English
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Literature	Current publications from materials chemistry and related disciplines.

Degree programme	**Master Chemistry**
Course title, Topic	**Research project I / II, Macromolecular Chemistry**
Subtitle (optional)	Advanced Lab course in Polymer Chemistry
Module ID	PolyChem-4
Specialization	Materials and Interfaces, Light and Matter, Molecular Sciences
Responsible lecturer	Prof. Dr. Jonas
Teaching type	Lab course, seminar
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	None
Learning outcomes / Competences	Students apply strategies of polymer synthesis and advanced techniques of polymerisation; students are able to design and perform experiments based on literature search on their own.
Course description	Literature search, elaboration of synthesis strategies, involvement in current research topics, lab reports and critical evaluation of results.
Interdisciplinary qualifications	Interdisciplinary assessment and evaluation, literature survey, und techniques of presentation, organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results of a scientific investigation to an expert audience, debating and discussing in English, database literature search, analysis of scientific papers, presentation techniques.
Assessment method (Contribution)	Exam credits: Laboratory course (67%), presentation (33%)
Literature	Journal articles, monographs

Degree programme	**Master *Chemistry***
Course title, Topic	**Research project I / II, Analytical Chemistry**
Subtitle (optional)	Research Project in Analytical Chemistry
Module ID	AnalChem-4
Specialization	Materials and Interfaces, Molecular Sciences, Light and Matter
Responsible lecturer	Prof. Dr. Engelhard
Teaching type	Laboratory course, seminar
Relation to curriculum	9.4 or 9.5, Chemistry, elective
Semester	3
Credit points (CP)	6
Workload	Seminar: 15 h, Lab course: 120 h, additional individual work of the student / homework time: 45 h.
Prerequisites for participation	Passed: AnalChem-1 with grade ≤ 2.7
Learning outcomes	Students have the ability to work independently on a research topic and are able to operate specific analytical instrumentation. Students are able to review the related literature and can summarize their work in a written report according to scientific standards. Data evaluation is performed according to standards of the discipline including quality assurance.
Course description	Students individually perform experimental work on an advanced analytical chemistry research topic (in preparation for a master thesis project). Advanced experimental design and evaluation of analytical data will be carried out. Students will present the results in a group seminar.
Interdisciplinary qualifications	Organization and management of a scientific project, ability to work in an international (and intercultural) team, presentation of the results to an expert audience, communication and presentation skills, debating and discussing in English.
Assessment method (Contribution)	Exam credits: Laboratory course (100%)
Study credits	Presentation
Literature	Introductory material will be provided at the beginning of the research project. In addition, students shall review the most recent publications on the topic.

Degree programme	Master Chemistry
Course title	**Master Thesis**
Subtitle (optional)	
Specialization	Determined by the supervisor of the thesis
Responsible lecturer	Board of Examiners
Module ID	masterthesis
Teaching type	Lab course
Relation to curriculum	10.1, Chemistry, elective
Semester	4
Credit points (CP)	30
Workload	Lab course, additional individual work of the student / homework time: 6 months
Prerequisites for participation	Passing of all modules of the preceding semesters
Learning outcomes / Competences	The students are able to choose a current research topic from a selected area of chemistry. They are able to manage and document their own research project and to present their results in front of an expert audience. The students know and are able to use adequate working methods and instruments for scientific research and application and have comprehensive competences in a scientific perspective.
Course description	Elaboration and organization of a topical research project in theory and practice.
Interdisciplinary qualifications	Interdisciplinary assessment and evaluation, literature survey, organization and management of a scientific project, ability to work in international (and intercultural) research groups, presentation of the results of a scientific investigation to an expert audience, debating and discussing in English.
Assessment method (Contribution)	Evaluation of the thesis by two experts, i.e. University Professors (100%)
Literature	To be announced by the respective professional supervisor.