LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Module Handbook / Program Catalog

Master's Degree: Chemistry

(Master of Science, M.Sc.)

(120 ECTS points)

Based on the Examination Regulations from 18. March 2016

88/032/---/H1/H/2015

Version: 01/11/2018

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Abbreviations and Explanations

ECTS	European Credit Transfer and Accumulation System
h	hours
SoSe	summer semester
SWS	contact hours per week per semester
WiSe	winter semester
WP	optional module (a choice of compulsory modules - Wahlpflichtmodul)
P	compulsory module (Pflichtmodul)

1. In the course catalog assigned ECTS points are designated as follows: ECTS points that are not listed in parentheses are awarded upon successful completion of the respective graded exam. ECTS points listed in parentheses are for calculation purposes only

2. The semester for choosing the course can be either binding or can be considered as a recommendation, according to the stipulations stated in Appendix 2 in the examination regulations, and are indicated in the catalog either by "designated semester" or "recommended semester", respectively.

3. The course catalog is intended to serve as an orientation for the master's program, both in structure and content. For detailed regulations, please see the official examination regulations under www.lmu.de/studienangebot

4. Detailed information concerning the study program and everything around is available under http://www.cup.uni-muenchen.de/study/index.php and http://www.cup.uni-muenchen.de/guide/index.php.

Contacts

Application: http://www.cup.uni-muenchen.de/study/ch/master/ - Application

Examinations Office:

Butenandtstr. 5-13, 81377 Munich, Germany
Bldg F, Room F 5.020
Office hours: Mo - Tue 9:30 - 12:00 a.m. and by appointment

Further Contact Points:

http://www.cup.uni-muenchen.de/guide/ansprechstellen_ch.php

Introduction Session:

Every semester – usually on the first day (Monday) or some time during the first week of the semester – we offer a short introduction to the master's program in chemistry. Detailed information as to the location and time of the event can be found in the online course catalog LSF.

Description and goals of the master's program in chemistry

The **master's program in chemistry** is designed to follow the bachelor's program in chemistry and biochemistry and to afford a future-oriented education in chemistry, or a related subject, with stress upon the fundamentals of natural science and a more profound academic training. The goal of the program is to deepen and expand the knowledge and skills acquired in previous work. Combined with a broad choice of subjects in chemistry and interdisciplinary areas, the program's concept guarantees a flexible combination of subjects which answer to students' individual interests.

Courses are modular where students earn, by passing exams in lecture and lab courses, a total of 120 credits according to the European Credit Transfer system (ECTS). The final grade of the master's program is calculated as the average of all module grades. The module's continual assessment grades are calculated as their average together with a single weighted valuation (see Appendix A23, PSto § 21 and §10 clauses 3 and 4). Courses will be offered in either English or German.

The master's degree facilitates the transition to working life and is preparation for doctoral studies.

The program's description

The LMU's master's program, with its prescribed period of study of four semesters, can be entered in the fall or spring semester. It is research oriented and allows for great freedom in the choice of subjects.

The program's basic concept offers students two options (see Fig. 1):

a) The choice of three major subjects (required electives, WB) in chemistry with 30 ECTS credits each (WB-A, WB-B, WB-C).

In **option a),** students specialize and focus on three core areas and complete a master's thesis exclusively on the basic areas of chemistry: inorganic, organic, physical and theoretical chemistry. The required electives (major) in chemistry comprise two required electives, with 15 ECTS credits each, a lab module (WP 1, WP 3, WP 6 or WP 7) with a specialized research lab course with seminar and a theoretical module (WP 2, WP 4, WP 41 or WP 42), which encompasses a compulsory colloquium and a large number of lecture courses (between four and ten) from which three must be chosen.

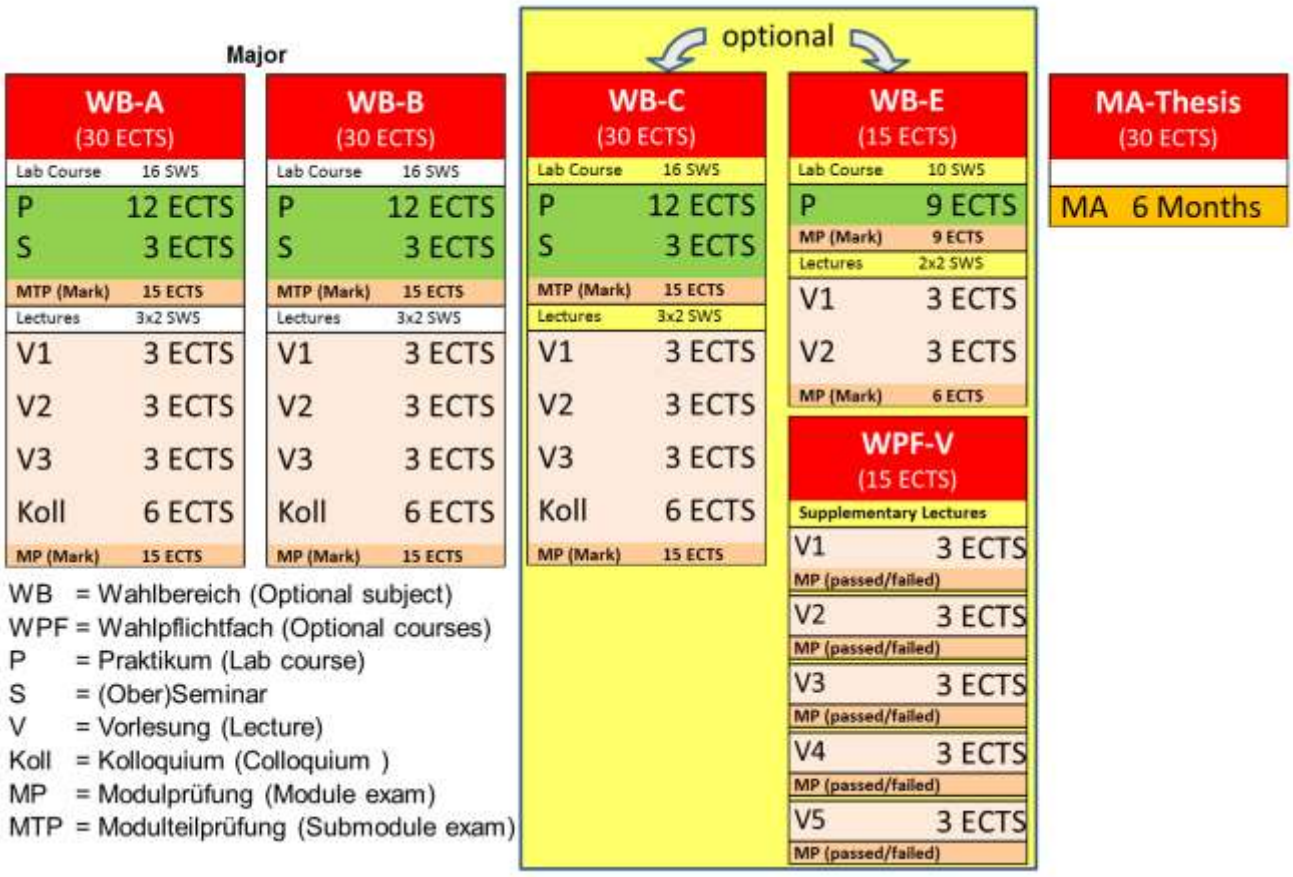


Fig. 1: An overview of the concept and the two master's program options.

b) Students choose two major subjects in chemistry with 30 ECTS credits each (WB-A, WB-B) plus a minor subject (WB-E) and supplementary lectures (WPF-V) with 15 ECTS credits each which must be in chemistry or chemistry-related subjects.

In **option b)**, students may choose two major subjects from the basic areas of chemistry, with a total of 30 ECTS credits each (see option a). A minor subject and further "supplementary" lecture courses must be taken.

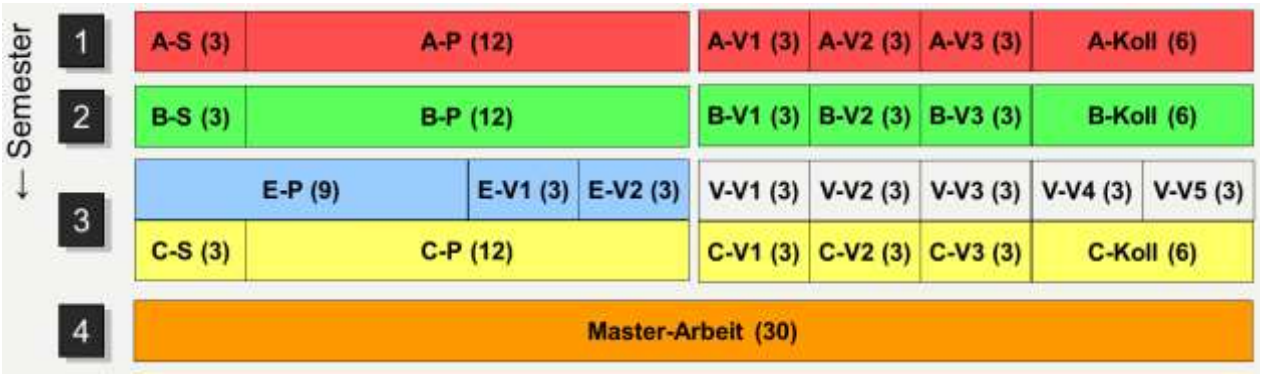
The minor subject (WB-E) consists of two compulsory-elective modules: a lab course module (WP 8 through WP 14 or WP 43) with 9 ECTS credits and a lecture course module (WP 5 or WP 44 through WP 50) with 6 ECTS credits. Two lecture courses must be chosen from the lecture course module. Subjects which had been chosen as a major may not be taken as minor courses. Additionally, minor courses in both physics (WP 17, WP 52 through WP55) and informatics (WP 18 through WP 21 and WP 56 through WP 57) with a total of 15 ECTS credits may be chosen along with courses such as patent law, pharmacology, toxicology (WP 15 and WP 51) and chemistry-related courses taken abroad.

The required five specialized supplementary lecture courses, with 3 ECTS each, may be selected from among the major and minor courses but may not be counted twice if the courses were taken earlier.

The program will have been completed after the submission of a master's thesis for which six months are earmarked. During the six months, a current topic of modern research is worked on in a research group of choice. In most cases the master's thesis is experimental in nature. Upon successful completion of the program the LMU bestows the academic title "Master of Science" (M.Sc.) and issues a certificate with grades. A master's degree is equivalent to that of a "Diplom" degree.

Two examples of a curriculum in the master's program in chemistry:

1)



2)

Fig. 2: Possible curricula: (1) above: in the third semester both options a) and b) are listed in parallel; A, B, C = major subject courses; E = minor subject courses; V = supplementary courses; S = seminar; P = research lab course; V = lecture course; K = colloquium; ECTS credits in parentheses;
(2) below: possible curricula with option b); lectures in major, minor as well as in supplementary course modules e.g. may hang over two semesters.

Module WP 1: Major Inorganic Chemistry (Lab Course)

Degree programme	Master's degree: Chemistry (Master of Science, M.Sc.)

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 1.1 Advanced Research Lab Course in Inorganic Chemistry (T1IA)	WiSe/ SoSe	240h (16 SWS)	120 h	(12)
Seminar	WP 1.2 Seminar in Inorganic Chemistry (T1IC)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 18 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 2 (lectures) if selected as a major subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students work in a research group from the field of Inorganic Chemistry. Supervised by a professional scientist students get involved in a current research project. During the **practical course** they apply modern techniques and complement and deepen their methodical skills and theoretical knowledge. Students learn to plan and execute scientific experiments independently. At the **accompanying seminar** students extend their expertise of the research topic and present and discuss their own research results.
Qualification goals	Students acquire expertise for work in research: • independent, target-oriented literature search • transfer of theoretical knowledge to practical applications • planning and execution of complex experimental

	set-ups • recognition and estimation of security questions while handling hazardous material • decision making and critical interpretation and evaluation of experimental data • appraisal, presentation and discussion of research data and results
Module assessments	Lab report or lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Klapötke
Language	German/English
Additional information	

Module WP 2: Major Inorganic Chemistry (Lectures)

Degree programme	Master's degree: Chemistry (Master of Science, M.Sc.)

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Colloquium	WP 2.1 Expert colloquium in Inorganic Chemistry (T1ZI)	WiSe/ SoSe	45h (3 SWS)	135 h	(6)
Lecture	WP 2.2.1 (= WP 21) Modern Inorganic Main-group Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 2.2.2 (= WP 22) Solid State Chemistry II	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 2.2.3 (= WP 23) Coordination Chemistry II	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 2.2.4 (= WP 24) Spectroscopic Methods	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 2.2.5 (= WP 25) Special Lecture in Inorganic Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 9 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with optional and compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 1 (lab course) if selected as a major subject. In this module three of the courses WP 2.2.1 to WP 2.2.5 must be elected.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 or 2 semesters.
Content	The module broadens and deepens special professional knowledge from the field of Inorganic Chemistry. Three advanced lectures covering current topics of Inorganic Chemistry are chosen.
Qualification goals	Students are introduced to up-to-date topics of current research in Inorganic Chemistry. They broaden their already acquired knowledge with

	current and special topics from Inorganic Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Klapötke
Language	German/English
Additional information	

WP 2.1: Expert colloquium in Inorganic Chemistry (T1ZI)

Type of the submodule	Required course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	Non
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The part of the Module spans 1 semester.
Content	Experts (internal and external) present current results of their research in the Inorganic Chemistry Colloquium. The students have to post-process the scientific talks including literature search.
Qualification goals	Students are introduced to up-to-date topics of current research in Inorganic Chemistry. They broaden their already acquired knowledge with current and special topics from Inorganic Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	s. WP 2
Grading	-
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Klapötke
Language	German/English
Additional information	

Module WP 3: Major Organic Chemistry (Lab Course)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 3.1 Advanced Research Lab Course in Organic Chemistry (T1OA)	WiSe/ SoSe	240h (16 SWS)	120 h	(12)
Seminar	WP 3.2 Seminar in Organic Chemistry (T1OC)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 18 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 4 (lectures) if selected as a major subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students work in a research group from the field of Organic Chemistry. Supervised by a professional scientist students get involved in a current research project. During the **practical course** they apply modern techniques and complement and deepen their methodical skills and theoretical knowledge. Students learn to plan and execute scientific experiments independently. At the **accompanying seminar** students extend their expertise of the research topic and present and discuss their own research results.
Qualification goals	Students acquire expertise for work in research: • independent, target-oriented literature search • transfer of theoretical knowledge to practical applications • planning and execution of complex experimental set-ups • recognition and estimation of security questions

	while handling hazardous material • decision making and critical interpretation and evaluation of experimental data • appraisal, presentation and discussion of research data and results
Module assessments	Lab report or lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hendrik Zipse
Language	German/English
Additional information	

Module WP 4: Major Organic Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Colloquium	WP 4.1 Expert colloquium in Organic Chemistry(T1ZO)	WiSe/ SoSe	45h (3 SWS)	135 h	(6)
Lecture	WP 4.2.1 (=WP 26) Physical-Organic Chemistry	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.2 (=WP 27) The Chemistry of Heterocycles	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.3 (=WP28) Modern Synthetic Methods	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.4 (=WP 29) Synthesis Planning	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.5 (=WP 30) Glycochemistry	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.6 (=WP 31) Radicals in Chemistry and Biology	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.7 (=WP 32) Lecture in Chemical Biology	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.8 (=WP 33) Advanced Topics in Chemical Biology	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.9 (=WP 34) Special Lecture in Organic Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.10 (=WP 34a) Multi-Dimensional NMR Spectroscopy for Structure Elucidation of Big Molecules	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.11 (=WP 34b) Supramolecular Chemistry	WiSe/	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 9 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with optional and compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 3 (lab course) if selected as a major subject. In this module three of the courses WP 4.2.1 to WP 4.2.9 must be elected.
Entry requirements	none

Study pathway level	Between semester 1 and 3
Duration	The module spans 1 or 2 semesters.
Content	The module broadens and deepens special professional knowledge from the field of Organic Chemistry. Three advanced lectures covering current topics of Organic Chemistry are chosen.
Qualification goals	Students are introduced to up-to-date topics of current research in Organic Chemistry. They broaden their already acquired knowledge with current and special topics from Organic Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hendrik Zipse
Language	German/English
Additional information	

WP 4.1: Expert colloquium in Organic Chemistry (T1ZO)

Type of the submodule	Required course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	none
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Experts (internal and external) present current results of their research in the Organic Chemistry Colloquium. The students have to post-process the scientific talks including literature search.
Qualification goals	Students are introduced to up-to-date topics of current research in Organic Chemistry. They broaden their already acquired knowledge with current and special topics from Organic Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	s. WP 4
Grading	-
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hendrik Zipse
Language	German/English
Additional information	

Module WP 5: Minor Lecture in Structural Biology (T1S1)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 5.1 Lecture in Structural Biology (T1S1)	WiSe	30h (2 SWS)	30 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with the modules WP 16 and WP 43, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This lecture covers modern structural biology at an advanced level. The focus is on methods to reveal the three-dimensional structure of proteins and multiprotein complexes, including X-ray crystallography and electron microscopy.
Qualification goals	Students learn the theoretical and methodical basics to analyse the three-dimensional structure of proteins. The lecture prepares students to apply these methods during the laboratory course in Structural Biology and enables them to read and critical evaluate publications in Structural Biology.
Module assessment	Exam or oral examinbation
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Hopfner
Language	English

Additional information

Module WP 6: Major Physical Chemistry (Lab Course)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 6.1 Advanced Research Lab Course in Physical Chemistry (T1PA)	WiSe/ SoSe	240h (16 SWS)	120 h	(12)
Seminar	WP 6.2 Seminar in Physical Chemistry (T1PC)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 18 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 41 (lectures) if selected as a major subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students are introduced to current topics in physical chemistry by working on a selected scientific project integrated into a research group. Development of the required knowledge on the level of a scientifically oriented masters program, problem solving and testing of solutions to open scientific questions.
Qualification goals	Independent application of the expertise established within the study program of physical chemistry by working on scientific problems.Supervised discussion and evaluation of the achieved results with respect to the scientific literature. Writing a report onthe results and their discussion taking into account current knowledge.Qualified presentation of the results.
Module assessments	Lab report or lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. Bein
Language	German/English
Additional information	

Module WP 7: Major Theoretical Chemistry (Lab Course)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 7.1 Advanced Research Lab Course inTheoretical Chemistry (T1TA)	WiSe/ SoSe	240h (16 SWS)	120 h	(12)
Seminar	WP 7.2 Seminar in Theoretical Chemistry (T1TC)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 18 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 42 (lectures) if selected as a major subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students are introduced to current topics in theoretical chemistry by working on a selected scientific project integrated into a research group. Development of the required knowledge on the level of a scientifically oriented masters program, problem solving and testing of solutions to open scientific questions.
Qualification goals	Independent application of the expertise established within the study program of theoretical chemistry by working on scientific problems.Supervised discussion and evaluation of the achieved results with respect to the scientific literature. Writing a report onthe results and their discussion taking into account current knowledge.Qualified presentation of the results.
Module assessments	Lab report or lab assessment
Grading	The module is graded.
Requirements for granting ECTS-	ECTS-points are awarded for passing the exam, which is

Points	allocated to the module.
Responsible person	Prof. Dr. Ochsenfeld, Prof. Dr. R. de Vivie-Riedle
Language	German/English
Additional information	

Module WP 8: Minor Inorganic Chemistry (Lab Course) (T1IB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 8.1 Research Lab Course in Inorganic Chemistry (T1IB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 44 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students work in a research group from the field of Inorganic Chemistry. Supervised by a professional scientist students get involved in a current research project. During the practical course they apply modern techniques and acquire methodical skills and theoretical knowledge in Inorganic Chemistry. Students learn to plan and execute scientific experiments independently.
Qualification goals	Students acquire expertise for work in research: • Independent, target-oriented literature search • Transfer of theoretical knowledge to practical applications • Planning and execution of complex experimental set-ups • Recognition and estimation of security questions while handling hazardous material • Decision making and critical interpretation and evaluation of experimental data • Appraisal, presentation and discussion of research data and results

Module assessment	Lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Klapötke
Language	German/English

Additional information

Module WP 9: Minor Organic Chemistry (Lab Course) (T1OB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 9.1 Research Lab Course in Organic Chemistry (T1OB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 45 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students work in a research group from the field of Organic Chemistry. Supervised by a professional scientist students get involved in a current research project. During the practical course they apply modern techniques and acquire methodical skills and theoretical knowledge in Organic Chemistry. Students learn to plan and execute scientific experiments independently.
Qualification goals	Students acquire expertise for work in research: • Independent, target-oriented literature search • Transfer of theoretical knowledge to practical applications • Planning and execution of complex experimental set-ups • Recognition and estimation of security questions while handling hazardous material • Decision making and critical interpretation and evaluation of experimental data • Appraisal, presentation and discussion of research data and results

Module assessment	Lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hendrik Zipse
Language	German/English
Additional information	

Module WP 10 Minor Physical Chemistry (Lab Course) (T1PB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 10.1 Research Lab Course in Physical Chemistry (T1PB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 46 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students work in a research group from the field of Physical Chemistry. Supervised by a professional scientist students get involved in a current research project. During the practical course they apply modern techniques and acquire methodical skills and theoretical knowledge in Physical Chemistry. Students learn to plan and execute scientific experiments independently.
Qualification goals	Students acquire expertise for work in research: • Independent, target-oriented literature search • Transfer of theoretical knowledge to practical applications • Planning and execution of complex experimental set-ups • Recognition and estimation of security questions while handling hazardous material • Decision making and critical interpretation and evaluation of experimental data • Appraisal, presentation and discussion of research data and results

Module assessment	Lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Bein
Language	German/English
Additional information	

Module WP 11: Minor Theoretical Chemistry (Lab Course) (T1TB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 11.1 Research Lab Course in Theoretical Chemistry (T1TB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 47 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students are introduced to current topics in theoretical chemistry by working on a selected scientific project integrated into a research group. Development of the required knowledge on the level of a scientifically oriented masters program, problem solving and testing of solutions to open scientific questions.
Qualification goals	Independent application of the expertise established within the study program of theoretical chemistry by working on scientific problems.Supervised discussion and evaluation of the achieved results with respect to the scientific literature. Writing a report onthe results and their discussion taking into account current knowledge.Qualified presentation of the results.
Module assessment	Lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. Ochsenfeld, Prof. Dr. R. de Vivie-Riedle
Language	German/English
Additional information	

Module WP 12: Minor Chemical Biology (Lab Course) (T1OX)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 12.1 Research Lab Course in Chemical Biology (T1OX)	WiSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 48 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students are introduced to current topics in chemical biology by working on a selected scientific project integrated into a research group. Development of the required knowledge on the level of a scientifically oriented masters program, problem solving and testing of solutions to open scientific questions.
Qualification goals	Independent application of the expertise established within the study program of chemical biology by working on scientific problems. Supervised discussion and evaluation of the achieved results with respect to the scientific literature. Writing a report on the results and their discussion taking into account current knowledge. Qualified presentation of the results.
Module assessment	Lab assessment
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas Carell

Language	German/English

Additional information

Module WP 13: Minor Biochemistry (Lab Course) (T1YB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 13.1 Research Lab Course in Biochemistry (T1YB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 49 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces students to current, Biochemistry-related research topics. Students work on a selected scientific project and are integrated in a research group. Students acquire the fundamentals of the selected research topic on the level of a scientific orientated Master's programme and develop possible solutions to open scientific problems.
Qualification goals	• Independet application of acquired skills and competences on a scientific problem • Evaluation of the own research results • Written presentation of results in reference to the scientific environment • Professional presentation of results
Module assessment	Written report on or assessment of the practical laboratory course or written report on and assessment of the practical laboratory course
Grading	The module is graded.
Requirements for granting ECTS-	ECTS credits will be granted when the module

Points	examination (or the examination of pertinent mandatory and potential elective compulsory module parts) has/have been completed successfully.
Responsible person	Dr. Heidi Feldmann
Language	English
Additional information	

Module WP 14: Minor Molecular and Cellular Genetics (Lab Course) (T1GB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 14.1 Research Lab Course in Molecular and Cellular Genetics (T1GB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 50 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The students carry out RNAi in tissue culture cells, GFP-tag proteins by homologous recombination in eukaryotic cells, and determine their sub-cellular localization using fluorescence microscopy. They reconstitute macromolecular complexes in vitro and map protein-protein interactions using yeast two hybrid screens.
Qualification goals	Students acquire expertise in • genetic methods of quantitative screening • experiments with quantitative read-out • in vitro constitution of protein complexes • fluorescence microscopy
Module assessment	Written report on or assessment of the practical laboratory course or written report on and assessment of the practical laboratory course
Grading	The module is graded.
Requirements for granting ECTS-	ECTS credits will be granted when the module

Points	examination (or the examination of pertinent mandatory and potential elective compulsory module parts) has/have been completed successfully.
Responsible person	Prof. Beckmann
Language	English
Additional information	

Module WP 15: Specific Supplement to Chemistry (Lab Course) (T1RX)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 15.1 Lab Course in Specific Supplement to Chemistry	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 51 (lectures) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces students to current, Chemistry-related research topics. Students work on a selected scientific project and are integrated in a research group. Students acquire the fundamentals of the selected research topic on the level of a scientific orientated Master's programme and develop possible solutions to open scientific problems.
Qualification goals	• Independet application of acquired skills and competences on a scientific problem • Evaluation of the own research results • Written presentation of results in reference to the scientific environment • Professional presentation of results
Module assessment	Lab assessment
Grading	The module is graded.
Requirements for granting ECTS-	ECTS-points are awarded for passing the exam, which is

Points	allocated to the module.
Responsible person	Dr. Thomas Engel
Language	German/English
Additional information	

Module WP 16: Supplement Advances Topics in Structural Biology (T1S1)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Seminar	WP 16.1 Advances Topics in Structural Biology (T1S2)	SoSe	30 h (2 SWS)	30 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with modules WP 5 and WP 43, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This lecture covers modern structural biology at an advanced level. The focus is on methods to reveal the three-dimensional structure of proteins and multiprotein complexes, including X-ray crystallography and electron microscopy.
Qualification goals	Students learn the theoretical and methodical basics to analyse the three-dimensional structure of proteins. The lecture prepares students to apply these methods during the laboratory course in Structural Biology and enables them to read and critical evaluate publications in Structural Biology.
Module assessment	Written exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsory module parts) has/have been completed successfully.
Responsible person	Prof. Hopfner

Language	English

Additional information

Module WP 17: Minor Physics: Atomic and Molecular Physics

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 17.1 Lecture in Atomic and Molecular Physics (E4.1)	SoSe	60h (4 SWS)	120 h	(6)
Tutorial	WP 17.2 Tutorial in Atomic and Molecular Physics (E4.2)	SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 9 ECTS-points. Class attendance is 6 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Physics
Elective guidelines	This module is associated with modules WP 52 and WP 53, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Konzepte und experimentelle Methoden der Atom- und Molekülphysik: Plancksche Strahlung, Bohr-Sommerfeldsche Quantenmechanik, H-Atom, Mehrelektronenatome, Atome in äußeren Feldern, Spektroskopie, Röntgenstrahlen, Molekülphysik.
Qualification goals	Wesentliches Lernziel sind Kenntnis und Verständnis obiger Lerninhalte, die Fähigkeit zu ihrer Anwendung und ihre Verknüpfung untereinander. Darüber hinaus stellen die Vertrautheit mit Methoden der Experimentalphysik und die Fähigkeit zur Interpretation der experimentellen Ergebnisse, zu ihrer Verifikation oder Falsifikation allgemeine Lernziele dar. Die Verbindung zu Phänomenen in der Natur sowie zur aktuellen Forschung soll den Studierenden bewusst werden.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Dean of Studies inPhysics
Language	German
Additional information	

Module WP 18: Minor Computer Sciences: Computer Science: Systems and Applications

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 18.1 LectureComputer Science: Systems and Applications	SoSe	30h (2 SWS)	60 h	(3)
Tutorial	WP 18.2 TutorialComputer Science: Systems and Applications	SoSe	45 h (3 SWS)	45 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 5 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Computer Science
Elective guidelines	This module is associated with module WP 56, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Gemeinsam mit der Vorlesung Einführung in die Informatik: Programmierung und Software-Entwicklung ist diese Lehrveranstaltung die Basis für die universitäre Ausbildung in der Informatik als Nebenfach. Als Inhalt ist deshalb eine breit angelegte Einführung in die wichtigsten Themen der Informatik aus systemnaher und anwendungsorientierter Sichtvorgesehen, um damit die Grundlage für das Verständnis von weiterführenden Themenaus diesen Lehrgebieten zu schaffen: • Grundlagen der Rechnerhardware (von-Neumann-Modell, Mehrkern-Prozessoren, Arbeits- und Permanentspeicher etc.) • Grundlagen von Betriebssystemen (Prozessmodell, Synchronisation nebenläufiger Prozesse, Speicherverwaltung etc.) • Grundlagen von Rechnernetzen (ISO/OSI-Modell, insbes. Medienzugriff, Wegewahl, etc. sowie TCP/IP)

	• Grundlagen von Datenbanksystemen (relationales Modell, relationale Algebra, SQL, Datenbank-Entwurf etc.) • Grundlagen des Data Mining (Klassifikation, Cluster-Analyse, Ausreißerbehandlung, Assoziationsregeln, etc. Das Modul besteht aus einer Vorlesung sowie Übungen in kleinen Gruppen. Die in der Vorlesung besprochenen Inhalte werden im Übungsteil anhand von praktischen Anwendungen eingeübt.
Qualification goals	Kenntnisse in den wichtigsten Grundlagen der Informatik aus systemnaher und anwendungsorientierter Sicht. Die Lehrveranstaltung hat das Ziel, ein Grundverständnis über die wichtigsten Vorgänge im Rechensystem aus der Hardwaresicht sowie aus der Sicht des Betriebssystems und der Systemsoftware (incl. der Kommunikation über Rechnernetze)auf einer geeigneten wissenschaftlichen Abstraktionsebene zu vermitteln. Ebenso sollen wichtige Grundkenntnisse aus den Anwendungsbereichen Datenbanksysteme und Data-Mining auf einem universitären Niveau vermittelt werden.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Christian Böhm
Language	German
Additional information	

Module WP 19: Minor Computer Sciences: Computer Architecture

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 19.1 LectureinComputer Architecture	SoSe	45h (3 SWS)	45 h	(3)
Tutorial	WP 19.2 TutorialinComputer Architecture	SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 5 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Computer Science
Elective guidelines	This module is associated with module WP 56, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Dieses Modul gibt einen Überblick über die binäre Darstellung von Informationen auf Computern, sowie über die Architektur und Arbeitsweise moderner Rechner nach von Neumann. Die klassischen Komponenten eines Computers werden eingeführt. Deren Interaktion wird zunächst theoretisch und dann mittels einer Maschinensprache und einer Assemblersprache praktisch behandelt. Es wird gezeigt, wie man mit Hilfe der Booleschen Algebra einfache Schaltungen und auch komplexere Komponenten eines Prozessors und des Speichers systematisch entwerfen und optimieren kann. Im Einzelnen werden behandelt: • Methoden zur binären Darstellung von Informationen im Rechner, • Realisierung von Speicher durch Schaltwerke sowie durch optische und magnetische Medien, • Boolesche Algebra zum Entwurf von Schaltungen, • Entwurf und Optimierung einfacher logischer

	Schaltungen in Prozessoren, • Komponenten der von Neumann Architektur und deren Optimierungen, • maschinennahe Assemblerprogrammierung, • das Zusammenspiel der unteren Ebenen eines Computers, sowie • Parallelisierung und Mehrprozessorsysteme.
Qualification goals	Die Studierenden entwickeln ein Grundverständnis des Entwurfs und der Architektur moderner Rechner und werden in den Zusammenhang zwischen höheren Programmiersprachen und der Abarbeitung einzelner Befehle auf Maschinenebene eingeführt. Insbesondere sollen sie ein Gefühl dafür entwickeln, welche Konsequenzen die Maschinenarchitektur für die Abarbeitung von Programmen hat, die in höheren Programmiersprachen geschrieben sind. Die Studenten lernen sich schnell und umfangreich in komplexe Systeme und Zusammenhängeeinzuarbeiten.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Claudia Linnhoff-Popien
Language	German/English
Additional information	**Literature:** • Andrew S. Tanenbaum, Todd Austin, Rechnerarchitektur: Von der digitalen Logik zum Parallelrechner, 6. Auflage, ISBN-13: 978-3-86894-238-5, • William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education, 8th Edition, ISBN-13: 978-0135064177, • David A. Patterson and John L. Hennessy, Morgan Kaufmann, Computer Organization and Design: The Hardware/Software Interface, 4th Edition, ISBN-13: 978-0123744937.

Module WP 20: Minor Computer Sciences: Programming and Modeling

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 20.1 Lecture in Programming and Modeling	SoSe	30h (2 SWS)	30 h	(2)
Tutorial	WP 20.2 Tutorial in Programming and Modeling	SoSe	45 h (3 SWS)	75 h	(4)

This module is comprised of 6 ECTS-points. Class attendance is 5 contact hours per week. Total time, including self-directed studies, is about 180.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Computer Science
Elective guidelines	This module is associated with module WP 56, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Dieses Modul führt in die grundlegenden Prinzipien der Programmierung und der Datenmodellierung mit einer funktionalen Programmierspache ein (derzeit Haskell). Dabei wird auf begriffliche Klarheit und präzise mathematische Fundierung mit formalen Methoden Wert gelegt. Die Themen sind unter anderem: • Funktionsbegriff und Basistypen, • Rekursion und Terminierung, • Benutzerdefinierte Datentypen, • Polymorphie, Typklassen, Module, • Funktionen höherer Ordnung und Currying, • Typen, Typprüfung, Typinferenz, • Pattern Matching, • Verzögerte Auswertung, Striktheit • Ein- und Ausgaben und andere Seiteneffekte.

Qualification goals	Das Modul zielt auf die Vermittlung des Folgenden: • Beherrschung von grundlegenden Konzepten der (allgemeinen sowie deklarativen) Programmierung. • Fähigkeit, kleine Algorithmen funktional zu programmieren und diese im Vergleich mit imperativen Lösungen zu bewerten. • Vorbereitung auf die zukünftige Entwicklung von Programmiersprachen.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. PhD Martin Hofmann
Language	German
Additional information	**Literature:** • Miran Lipovaca, "Learn You a Haskell for Great Good!", No Starch Press, 2011, ISBN1-59327-283-9, kostenlose online-version verfügbar, • Graham Hutton, "Programming in Haskell", Cambridge University Press, 2007, ISBN 0-52169269-5, • Bryan O'Sullivan, Don Stewart, John Goerzen, "Real World Haskell", O'Reilly, November2008, ISBN: 0-59651498-0, kostenlose online-version verfügbar, • Simon Thompson, "Haskell: The Caft of Functional Programming", Second Edition, Addison-Wesley, 1999. ISBN 0-201-34275-8, • Paul Hudak, John Peterson, Joseph Fasel, Ä Gentle Introduction To Haskell", 2000, kostenloses online Tutorial.

Module WP 21: Specialisation in Inorganic Chemistry - Modern Inorganic Main-group Chemistry (T1ID)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 21 Modern Inorganic Main-group Chemistry (T1ID)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module „modern inorganic main-group chemistry" gives insight in recent developments and achievements in inorganic main-group chemistry. Especially interest towards fundamental inorganic research should be aroused. Most of the content given in the two lectures i)modern aspects in inorganic main-group chemistry and ii) modern nitrogen chemistry has not be published in textbooks yet. The content is based and complementary on the lectures i) main-group chemistry I (bachelor program) and ii) main-group chemistry II (master program) and updated every year. Particularly modern synthetic strategies (super acids, high pressure chemistry, matrix isolation, flow reactors, weakly coordinating anions) are defined. Recent methods of characterization are going to be presented e.g. X-ray, multi-core NMR spectroscopy, Raman, unique MS techniques. Students should get familiar in critical comparison of experimental and theoretical results. Selected content from i)modern aspects in inorganic main-group chemistry: noble gas chemistry, halogen

	cations and halogen oxides, chemistry in super acid, high coordination numbers in main-group chemistry, aromaticity of main group elements, triel(I) derivatives. Selected content from i)modern nitrogen chemistry: modifications of nitrogen, N_5^+ cation, N_5^- anion, pentazoles. tetrazoles, triazoles, tetrazines, triazines, N-oxides, main-group azide chemistry, compounds with the highest nitrogen content, catenated nitrogen-chains.
Qualification goals	The students should get able to: • evaluate recent scientific results in inorganic main group chemistry. • understand modern methods of characterization (X-ray electron density measurements, neutralization reionisation mass spectrometry (NRMS), hetero-core and 2-dim NMR spectroscopy, matrix spectroscopy etc.) and interpret their data and results . • use practical theoretical methods independently. • transfer fundamental inorganic concepts such as HSAB, double bond rule, isolobal principle etc. to modern results and new compounds. • understand abilities and hazards of azide chemistry in all parts of chemical research.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Konstantin Karaghiosoff / Dr. Jörg Stierstorfer
Language	German/English
Additional information	Links: http://www.cup.lmu.de/ac/karaghiosoff/ http://www.cup.lmu.de/ac/stierstorfer/

Module WP 22: Specialisation in Inorganic Chemistry - Solid State Chemistry (T1IE)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 22.1 Solid State Chemistry II (T1IE)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Nearly all physical properties of a material depend on its electronic structure. Aim of this lecture is to understand fundamental properties (conductor/insulator/semiconductor, magnetism, superconductivity) from a chemical point of view and with principles of chemical bonding in solids. Content: Chemical bonding in solids, orbitals and energy bands, band structure methods and tools, Peierls-distortion with examples, electron-gas theories, the metallic state, intrinsic and doped semiconductors, Mott-insulators, cooperative magnetism, Pauli-paramagnetism, magnetoresistance, ferromagnetic half-metals, superconducting materials, basics of the BCS theory, metal-rich compounds, suboxides, metal clusters.
Qualification goals	The student should be able to identify a solid compound as metal, semiconductor or magnetic material by its electronic structure. Band structures of simple compounds should be analysed and interpreted. He knows different magnetic phenomena including the most important parameters. The major families of superconducting and an outline of the BCS

	theory is known. The student is able to define metal-rich compounds and understands principles of the chemical bonding in these materials.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. D. Johrendt
Language	German/English
Additional information	Web site of the lecture: http://www.cup.uni-muenchen.de/ac/johrendt/index.php?page=festkoerperchemie-2

Module WP 23: Specialisation in Inorganic Chemistry - Coordination chemistry (T1IF)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 23.1 Coordination chemistry II (T1IF)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The introductory lecture „Koordinationschemie"explores the subject matter from several directions. Its major goal is to address the various issues of current coordination chemistry by laying a focus on methods. Methodologically a very rich discipline, coordination chemistry has benefitted from the enormous progress of technical development. Moreover, its specific methods such as single-crystal structure analysis, the various spectroscopic methods as well as computational chemistry – the latter in terms of the DFT treatment of open-shell species – have experienced considerable progress recently. At the same time, these methods have found their way from specialist researchers to synthetically oriented research groups. It is, thus, the goal of the lecture to familiarize students with the methods and concepts that are standard for each experimentally working research group – methods that are part of practically every publication in the field of coordination chemistry. Among the areas of exploration: methods of coordination chemistry (NMR spectroscopy, X-ray crystallography,

	species distribution in complex equilibria, computational methods), synthesis of polynuclear complexes, spin coupling, supramolecular chemistry, bonding in coordination compounds (from crystal-field model to MO theory, spin coupling vs. metal–metal bonds, BS-DFT calculations), donor-acceptor ligands and none-innocent ligands, dinitrogen complexes), background of the 18-electron rule, metal clusters.
Qualification goals	Students are trained to critically evaluate published results of NMR investigations, X-ray analyses, and computer-chemical calculations. DFT calculations, mostly on open-shell species, are performed and interpreted independently by means of pre-selected programs. Students also learn to discern whether the predications of qualitative models (crystal-field theory, MO schemes, 18-e rule) can be recognized in a calculation's output.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. P. Klüfers
Language	German/English
Additional information	Web site of the lecture: http://www.cup.uni-muenchen.de/ac/kluefers/homepage/L_kc2.html

Module WP 24: Specialisation in Inorganic Chemistry - Spectroscopic Methods (T1IG)

(This module has been canceled/splitted into WP 78; WP 79 and WP 81)

Module WP 78: Specialisation in Inorganic Chemistry - Modern NMR-Spectroscopy in the Solid-State (T1IG-1)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 78.1a Solid-state NMR of nuclei with spin $I = ½$ (T1IG-1a)	WiSe	15h (1 SWS)	30 h	(1,5)
Lecture	WP 78.1b Solid-state NMR of quadrupolar nuclei ($I > ½$) (T1IG-1b)	SoSe	15h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	Nuclear Magnetic Resonance (NMR) spectroscopy is one of the most important analytic techniques in modern chemistry. Numerous analytical problems may be solved by using solution-state NMR (sometimes termed ‚high resolution' NMR). However, there is considerable scientific interest to also study compounds and materials such as glasses, ceramics, zeolites or polymers in the solid state. In this lecture series, starting from basic principles of NMR spectroscopy, we will discuss theory and practice of solid-state NMR, illustrated with various applications. Solid-state NMR can be successfully employed to characterise materials such as ceramics, zeolites or polymers. The majority of techniques applied in solid-state NMR, however, has been developed for nuclei with spin I=1/2. The nuclei present in inorganic materials (such as ^{11}B, ^{14}N, ^{23}Na, ^{27}Al or ^{45}Sc) are however isotopes with spin I>1/2 and hence possess are

	quadrupole moment. The NMR methods used for quadrupolar nuclei differ from those used for spin spin I=1/2. In this lecture series, starting from basic principles of solid-state NMR spectroscopy, we will discuss theory and practice of quadrupolar NMR, illustrated with various applications. Topics include: Basic principles of NMR spectroscopy (Bloch equations, effect of RF pulses, relaxation); anisotropic interactions in solid-state NMR (chemical shift, dipolar coupling, quadrupolar interaction); standard techniques for averaging anisotropies (Magic-Angle Spinning, spin decoupling); improving sensitivity (signal averaging, cross polarisation); structure elucidation by solid-state NMR (assigning coordination environments by chemical shift, measuring distances by REDOR, evaluating the symmetry of the electronic surroundings via quadrupolar interaction). Topics include: anisotropic interactions in solid-state NMR (chemical shift, dipolar coupling, quadrupolar interaction); standard techniques for averaging anisotropies (Magic-Angle Spinning, spin decoupling); NMR of quadrupolar nuclei (effect of the quadrupolar interaction for nuclei with spin I=1, and half-integer spin I>1/2); special NMR techniques for quadrupolar nuclei (MQMAS, STMAS, QCPMG, SPT); structure elucidation in inorganic solids via quadrupolar NMR (correlating NMR parameters with electronic structure, assignments using numerical quantum mechanical calculations).
Qualification goals	The students should acquire basic knowledge in theory and practice of solid-state NMR spectroscopy of quadrupolar nuclei. The students should be enabled to analyse solid-state NMR spectra of quadrupolar nuclei of medium complexity, to identify possible applications of quadrupolar NMR in research, and to critically evaluate solid-state NMR studies involving quadrupolar nuclei which have been published in the literature.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dr. Thomas Bräuniger
Language	German/English
Additional information	Web site of the lecture: http://www.cup.lmu.de/ac/braeuniger/

Module WP 79: Specialisation in Inorganic Chemistry - Modern NMR-Spectroscopy in Liquids (T1IG-2)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 79.1a Modern NMR-Spectroscopy in Liquids, part 1 (T1IG-2a)	WiSe	15h (1 SWS)	30 h	(1,5)
Lecture	WP 79.1b Modern NMR-Spectroscopy in Liquids, part 2 (T1IG-2b)	SoSe	15h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module withcompulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	Main topics are a) a short introduction into the principles of 1D NMR spectroscopy and the description and mode of operation of pulse sequences, b) important principles and 1D pulse sequences for the observation of ^{1}H, ^{13}C and in particular of hetero nuclei, c) basics of 2D NMR spectroscopy and d) important strategies and 2D pulse sequences used for structure elucidation of molecules. a): Properties of the nuclei, nuclei in a magneti8c field, energy levels, populations, selection rules, single and multiple quantum transitions, magnetization, vector description, excitation, relaxation, relaxation times and mechanisms, magnetic interaction, coupling, first order and high order spin systems, strongly and weakly coupled systems, subspectral analysis, simulation of NMR spectra. b) Basic pulse sequences, description of pulse sequences, FID-management, zero-filling, line-broadening, line-narrowing,

	measurement of relaxation times, double resonance experiments, selective and broadband decoupling, spin-tickling, NOE-effect, measurement ofthe NOE, gated decoupling, inverse gated decoupling, Hahn echo, SPT experiments, INEPT, DEPT, NMR of main group elements, NMR of metals, 1D-INADEQUATE experiments. c) Structure of a 2D NMR experiment, encoding ofthe information in the second dimension, fields of application. d) Heteronuclear and homonuclear J-resolved NMR spectroscopy, separation of heteronuclear and homonuclear scalar coupling, shift correlated 2D NMR spectroscopy, HETCOR, COSY, different types of COSY experiments (LR-COSY, DQF-COSY), TOCSY, inverse heterocorrelated 2D NMR spectroscopy, HMQC, HMBC, HSQC, 2D exchange spectroscopy, NOESY, EXSY, special experiments (2D-INADEQUATE, DOSY), field gradient methods.
Qualification goals	The lecture should give an overview on modern 1D and 2D pulse sequences and experiments and show the possible fields of application as well as the advantages of the different methods with respect to their application for structure determination in solution. With the help of the knowledge acquired in this lecture the students should be able to effectively apply 1D and 2D NMR spectroscopy in their own scientific research as well as later in their professional career.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Konstantin Karaghiosoff
Language	German/English
Additional information	Web site of the lecture: http://www.cup.uni-muenchen.de/ac/karaghiosoff/homepage/nmr.html

Module WP 81: Specialisation in Inorganic Chemistry - Spectroscopic Methods in Bioinorganic Chemistry (T1IG-3)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 81.1 Spectroscopic Methods in Bioinorganic Chemistry (T1IG-3)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module withcompulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	As an extension of the lecture Bioinorganic chemistry in the Bachelor, this unit deals with the key physical methods used in bioinorganic chemistry. Every method is explained in its physical foundations and presented by case studies in its bioinorganic application. Here, the possibilities, quality of gained information and the limits of every method are shown. Additionally, the suited combination of methods for an effective problem solving (e.g. for bioinorganic reaction mechanisms) as well as data analysis is explained. 1. Circular Dichroism and Magnetic Circular Dichroism (CD/MCD) 2. Fluorescence spectroscopy 3. X-ray absorption spectroscopy (XAS; EXAFS, XANES) 4. EPR spectroscopy 5. Electrochemical methods 6. UV/Vis spectroscopy

	7. Mößbauer spectroscopy Prior bioinorganic knowledge is advantageous but not mandatory, fundamentals of bioinorganic chemistry are repeated and deepened in case studies.
Qualification goals	The students learn the fundamentals of the presented methods and understand the underlying physical effects. For a given bioinorganic problem, they are able to choose suited methods and their combinations, understand the measured data, are able to analyze them and realize the limits of the chosen methods. In selected case studies of bioinorganic molecules and models, they learn to critically evaluate the errors and measurement inexactitude of the methods as well as to dissect inherent information of given models from information obtained by measurements.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. . L. Daumann
Language	English
Additional information	Handout

Module WP 25: Specialisation in Inorganic Chemistry – Special Lecutures in Inorganic Chemistry (T1IZ)

(This module has been canceled/splitted into WP 82 to WP 89)

Module WP 82: Specialisation in Inorganic Chemistry – Modern Inorganic Main-group Chemistry (T1IZ-1)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 82.1a Modern Aspects in Inorganic Main-group Chemistry (T1IZ-1a)	WiSe	15 h (1 SWS)	30 h	1,5
Lecture	WP 82.1b Modern nitrogen chemistry (T1IZ-1b)	SoSe	15 h (1 SWS)	30 h	1,5

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The module „modern inorganic main-group chemistry" gives insight in recent developments and achievements in inorganic main-group chemistry. Especially interest towards fundamental inorganic research should be aroused. Most of the content given in the two lectures i)modern aspects in inorganic main-group chemistry and ii) modern nitrogen chemistry has not be published in textbooks yet. The content is based and complementary on the lectures i) main-group chemistry I (bachelor program) and ii) main-group chemistry II (master program) and updated every year. Particularly modern synthetic strategies (super acids, high pressure chemistry, matrix isolation, flow reactors, weakly coordinating anions) are defined. Recent methods of characterization are going to be presented e.g. X-ray, multi-core NMR spectroscopy, Raman, unique MS techniques. Students should get familiar in critical comparison of experimental and theoretical results.

	Selected content from i) modern aspects in inorganic main-group chemistry: noble gas chemistry, halogen cations and halogen oxides, chemistry in super acid, high coordination numbers in main-group chemistry, aromaticity of main group elements, triel(I) derivatives. Selected content from i)modern nitrogen chemistry: modifications of nitrogen, N_5^+ cation, N_5^- anion, pentazoles. tetrazoles, triazoles, tetrazines, triazines, N-oxides, main-group azide chemistry, compounds with the highest nitrogen content, catenated nitrogen-chains.
Qualification goals	The students should get able to: • evaluate recent scientific results in inorganic main group chemistry. • understand modern methods of characterization (X-ray electron density measurements, neutralization reionisation mass spectrometry (NRMS), hetero-core and 2-dim NMR spectroscopy, matrix spectroscopy etc.) and interpret their data and results . • use practical theoretical methods independently. • transfer fundamental inorganic concepts such as HSAB, double bond rule, isolobal principle etc. to modern results and new compounds. • understand abilities and hazards of azide chemistry in all parts of chemical research.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	Die ECTS-Punkte werden vergeben bei Bestehen der dem Moduleingeordneten Moduleprüfung
Responsible person	Prof. Dr. Konstantin Karaghiosoff / Dr. Jörg Stierstorfer
Language	German/English
Additional information	Links to the Web sites of the lectures: http://www.cup.lmu.de/ac/karaghiosoff/ http://www.cup.lmu.de/ac/stierstorfer/

Module WP 83: Specialisation in Inorganic Chemistry – Organometallic Chemistry of Transition Metals (T1IZ-2)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 83.1a Organometallic Chemistry of Transition Metals (T1IZ-2a)	WiSe	15 h (1 SWS)	30 h	(1,5)
Lecture	WP 83.1b Carbonyl-Complexes and Analoga (T1IZ-2a)	SoSe	15 h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The content of the lecture „Coordination chemistry" of the bachelor program is deepened in light ofthe chemistry of compounds containing transition metal to carbon bonds. In the beginning ahistorical overview of the known classes of substances is given. Using papers from the actual literature the chemistry of mono-and multinuclear complexes (mainly containing metal to metal bonds) is treated. The emphasis lies in the field of synthetic concepts and a broad spectroscopic characterization using modern analytic methods. Furthermore the potential of the new compounds in light of possible applications in science and industry is valued. Content: historical development of organometallic chemistry; hapticity (bonding modes) of typical ligands in the chemistry of organometallic complexes; electron counting rules for comprehensing the composition of metal cluster compounds (18e rule, Wade`s rules for metal

	clusters); isolobal concept for comprehensive of analogies between organic molecules and metallorganic complexes and the combination of their fragments; analysis of isolobal analogies as possible synthetic strategies for metal clusters. Synthesis, bonding, properties, and spectroscopic characterization of following classes of substances: alkyl, acyl,alkinyl, vinylidene complexes; alkene, alkyne and benzyne complexes; Carbene and carbyne compounds; chemistry of metal carbonyl complexes (carbonyls, carbonylates, hydrido carbonyls, and nitrosyl carbonyl compounds).
Qualification goals	The students learn to interpret and evaluate results of the actual research in the field of organometallic chemistry of the transition metal complexes.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. H.-C. Böttcher
Language	German/English
Additional information	Link to the Web site of the lecture: http://www.cup.uni-muenchen.de/ac/boettcher/l_moc.html

Module WP 84: Specialisation in Inorganic Chemistry – Non Metal Fluorine Compounds (T1IZ-3)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 84.1a Fluorine Chemistry (T1IZ-3a)	SoSe	15 h (1 SWS)	30 h	(1,5)
Lecture	WP 84.1b Non metal Cations (T1IZ-3b)	SoSe	15 h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	s If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The lecture comprises a) a systematic overview ofthe fluorine compounds of non metals, their syntheses, structures, properties, reaction behavior and possible applications and b) the use of non metal fluorine compounds forthe synthesis of non metal cations as well as a description of the structures, properties, bonding and reactivity of non metal cations. a) Fluorine compounds of the noble gases, bonding, reaction behaviour, fluorine compounds ofthe chalcogens, O_2F, and O_2F_2, bonding situation and reactivity, binary N,F and P,F compounds, bonding in N,F and P,F compounds, fluorine compounds of the heavier pnictogens As, Sb and Bi, fluorine compounds of group 14. and group 13. elements. b) Xe and Kr containing cations, Xe_2^+, XeF^+, $Xe_2F_3^+$, halogen cations, homopolyatomic chalcogen cations, N_5^+, P_9^+, antimony and bismuth cations, syntheses, structures, bonding and reactivity.
Qualification goals	This lecture should give a systematic overview on fluorine

	compounds of main group non metals focusing in particular on synthesis, properties, bonding, reactivity and possible applications. The special importance of non metal fluorine compounds for the synthesis of non metal cations should introduce the students in the fascinating world of these unusual species. In addition of providing the basics of fluorine chemistry the lecture should teach the strategies employed for the synthesis and characterization of sensitive species with unusual properties.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Konstantin Karaghiosoff
Language	German/English
Additional information	Web site of the lecture: http://www.cup.uni-muenchen.de/ac/karaghiosoff/homepage/fluor.html

Module WP 85: Specialisation in Inorganic Chemistry – Applied Vibrational Spectroscopy and Chemistry in Superacids (T1IZ-4)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 85.1a Applied Vibrational Spectroscopy (T1IZ-4a)	WiSe	15 h (1 SWS)	30 h	(1,5)
Lecture	WP 85.1b Chemistry in Superacids (T1IZ-4b)	SoSe	15 h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The aim of the lecture is the study of chemistry in super acidic systems, a branch of molecular chemistry. [2]Superacids have an acadamic deep interest, but they are also used in established intustrial processes.[3]Methods of vibrational analyses are supposed to be applied especially on species existing in superacids (protonates molecules, cations). From the content: Methods of vibrational spectroscopy (infrared, Raman spectroscopy), spectra forecast, assignment of spectra, group frequencies, synthesis of protonated compounds, non-metal cations, polymetal cations.
Qualification goals	The students are supposed to interpret and critically evaluate published studies on vibrational spectroscopy. [2]Furthermore, the students should be able to apply the

	methods of vibrational spectroscopy on protonated molecules.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. A. Kornath
Language	German/English
Additional information	Web site of the lecture: http://www.cup.uni-muenchen.de/ac/kornath/teaching.htm

Module WP 86: Specialisation in Inorganic Chemistry – Introduction to Aquatic Chemistry (T1IZ-5)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 86.1a Introduction to Aquatic Chemistry, Part 1 (T1IZ-5a)	WiSe	15 h (1 SWS)	30 h	(1,5)
Lecture	WP 86.1b Introduction to Aquatic Chemistry, Part 2 (T1IZ-5b)	SoSe	15 h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points.Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	Water chemistry today is concerned with: • all sections of the water cycle in consederation of atmosphere and soil • the utilization and treatment of different raw waters to be used as drinking-, industrial-, bath-, mineral-, and curative water • the characteristics of water, its constituents and the different transformations in water or caused by water and the balance of waters • the treatment of process water before return in the natural water circle • the control, standardization, and development of analytical methods

	• the reactions and effects caused by different water types • (source: http://www.wasserchemische-gesellschaft.de/en/) Short summary: Part I: Main reaction types in water; adsorption phenomena; carbonic acid; speciation; natural waters; drinking water; analytic chemistry: classification and regulations, methods and techniques, evaluation and precision; Part II: pristine and acid rain; water treatment: groundwater and drinking water; fresh water speciation; sea water; computer-simulations
Qualification goals	The students should be able to describe how the chemistry in „real waters" differs from pure water. They should get acquainted with the geochemical relations that lead tothe different water types.Using the gained knowledge of legal regulations, they should be able to define the requirements for the analytical characterization of the different water types. Furthermore they should get familiar with the different applied analytical methods and be able to evaluate them. They should get familiar with the different technologies and methods that are used for treatment of natural waters and waste water and be able to discuss them. Finally they should be provided with sufficient knowledge to take an active part in public discussions related to topics like water quality and pollution.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. K. Sünkel
Language	German/English
Additional information	

Module WP 87: Specialisation in Inorganic Chemistry – Chemistry of High-Energy Materials (T1IZ-6)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 87.1a Chemistry of High-Energy Materials I (T1IZ-6a)	WiSe	15 h (1 SWS)	30 h	(1,5)
Lecture	WP 87.1b Chemistry of High-Energy Materials II (T1IZ-6b)	SoSe	15 h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points. Class attendance is 30 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The module Chemistry of High-Energy Materials gives the student an introduction and an overview over primary and secondary (high) explosives as well as propellant charges, rocket propellants and pyrotechnics. After a short (not comprehensive in scope) historical overview, the above mentioned classes of energetic materials are discussed systematically. Thermodynamic aspects as far as relevant to energetic materials are discussed as well as modern computational approaches to predict performance and sensitivity parameters. The most important performance criteria such as detonation velocity, detonation pressure and heat of explosion as well as the relevant sensitivity parameters such as impact and friction sensitivity and electrostatic discharge sensitivity are discussed in detail. Modern aspects of chemical synthesis including lead-free primary explosives and high-nitrogen compounds are also included in this module together with a discussion of

	high-energy materials for future defense needs.
Qualification goals	The most important aspect of this module is to counter-balance and fight against the loss of knowledge and know-how in the important area of the synthesis and safe handling of high-energy materials. Society needs now as much as ever in the military and civil sector advanced explosives, propellant charges, rocket propellants and pyrotechnics to meet the demands in defense and engineering. And who if not well trained and educated chemists would be able to deliver this expertise?
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas M. Klapötke
Language	English
Additional information	Links to the Web sites of the lectures: http://www.hedm.cup.uni-muenchen.de/index.html

Module WP 88: Specialisation in Inorganic Chemistry – Intermetallic Phases (T1IZ-7)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 88.1 Intermetallic Phases (T1IZ-7)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is jeweils 15 contact hours per week. Total time, including self-directed studies, is about 30 h.

Type of the Module	Optional module with compulsory courses.
Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	General properties of metals and intermetallic phases. Introduction in crystal structures and electronic structures of simple intermetallic solids, k space, band structures, density of states. Subdivision of intermetallic phases on the basis of various criteria (electronegativity difference, radius quotients, valence electron concentration). Laves phases, Frank-Kasper phases, Zintl phases, Hume-Rothery phases, interstitial phases, subvalent compounds. Further intermetallic systems. Phase diagrams. Technically relevant intermetallic systems.
Qualification goals	The students should be able to describe and discern different intermetallic classes based on simple concepts and to predict their respective formation. They should be capable of estimating relevant structural parameters and discuss the resulting electronic structures on the basis of simple examples. Furthermore, the students should suggest preparative strategies and evaluate possible areas of

	application.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dr. C. Hoch, Prof. Dr. W. Schnick
Language	German/English
Additional information	http://www.cup.lmu.de/ac/hoch/teaching/

Module WP 89: Specialisation in Inorganic Chemistry – Principles of Nanochemistry and Functional Materials (T1IZ-8)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 89.1a Functional Materials (T1IZ-8a)	SoSe	15h (1 SWS)	30 h	(1,5)
Lecture	WP 89.1b Principles of Nanochemistry (T1IZ-8b)	WiSe	15h (1 SWS)	30 h	(1,5)

This module is comprised of 3 ECTS-points. Class attendance is jeweils 15 contact hours per week. Total time, including self-directed studies, is about 30 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The course „Functional Materials" conceptually draws on the courses solid-state chemistry I and II on the bachelor and master level, respectively, and is designed to give an overview of selected topics in modern materials and solid-state chemistry. The course aims at providing a systematic physico-chemical basis of important classes of materials, and at highlighting their application potential based on selected examples. Emphasis is placed on modern inorganic, organic and hybrid materials systems at the intersection between basic and applied research, and on analyzing their structure-property-function relationships. Content: The lecture is divided into four main topics (carbon-based materials, hybrid materials, porous materials, photonic materials), each discussing different representatives (e.g. fullerenes, carbon nanotubes, graphene; nanocomposites, sol-gel materials, PHCs (polymer-clay hybrids); metal-organic and covalent organic frameworks, mesoporous materials; 1D, 2D and 3D photonic

	crystals). Physical properties and analytical methods (e.g. concepts of structure and bonding, porosity and surface determination, optical properties of photonic crystals) as well as fields of application (e.g. energy conversion, gas storage, medicine, electronics, optics) are discussed based on selected examples. The course „Principles of Nanochemistry“ gives an introduction into the concepts and current trends in the emerging field of chemical nanoscience. Although the term „nano“ is ubiquitous, the definition of „nanoscience“ and, in particular, „nanochemistry“, often remains vague. This course therefore aims at providing insights into the concepts, content and current topics of nanochemistry, as well as carving out differences and commonalities with classical chemistry. Emphasis will be placed on distinguishing the current ”nano-hype“ from actual physical phenomena specifically emerging in the nanoworld (e.g. quantum size confinement effects), and the potential of nanochemistry as a rapidly evolving multidisciplinary field will be critically evaluated. Content: The course is divided into ”concepts of nanochemistry“ (size confinement effects, quantum dots, surface plasmons, surface, shape and reactivity of nanomaterials, self-assembly), ”synthesis of nanostructures“ (nucleation and growth, synthesis of spherical, anisotropic and multi-component nanoparticles), and ”chemical patterning“ (”soft lithography“ and other chemical and physical lithographies, dip-pen nanolithography).
Qualification goals	Functional Materials: The students should be able to recognize important trends and properties of the materials classes discussed (structure – property relationships) and to transfer concepts of synthesis planning, characterization and functionality to related systems. The students should be able to comprehend and critically evaluate relevant scientific literature. Principles of nanochemistry: The students should be familiar with the concepts and physical basis of nanochemistry and they should be able to critically evaluate nanochemistry with respect to concepts in ”classical“ materials chemistry. They should independently be able to comprehend and reproduce fundamental experiments regarding the synthesis and analysis of nanostructures under appropriate conditions, and should be able to understand and critically evaluate relevant scientific literature.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. B. Lotsch
Language	German/English
Additional information	Link to the Web site of the lecture: http://www.cup.uni-muenchen.de/ac/lotsch/teaching.html

Module WP 93: Specialisation in Inorganic Chemistry – Solid-state and Materials Chemistry of Nitrides (T1IZ-10)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 93 Solid-state and Materials Chemistry of Nitrides (T1IZ-10)	SoSe	30h (2 SWS)	60 h	(3)

This module is comprised of 3 ECTS-points. Class attendance is jeweils 15 contact hours per week. Total time, including self-directed studies, is about 30 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semesters
Content	A systematic overview about nitrides and oxonitrides of main group elements of groups one to five will be given. The main focus is on syntheses, structural chemistry, materials properties and applications of the compounds. Furthermore, several side notes will cover important concepts with a high impact on solid-state and materials chemistry of nitrides, e.g. lattice energy, solid-state metathesis, thermal conductivity, light emitting diodes (LEDs) and semiconductors based on GaN, ammonothermal syntheses, compound semiconductor and determination of band gaps as well as luminescence.
Qualification goals	The students should be able to understand and apply a broad spectrum of modern synthetic techniques. Applying modern concepts they will be able to describe different classes of nitrides, discuss their specific syntheses and properties. Additionally, the students learn to suggest and discuss synthetic strategies and evaluate areas of applications.
Module assessment	Exam or oral examination

Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. W. Schnick
Language	German
Additional information	Link to the Web site of the lecture: http://www.cup.uni-muenchen.de/ac/schnick/

Module WP 26: Specialisation in Organic Chemistry – Physical-Organic Chemistry (T1OD)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 26.1 Physical-Organic Chemistry (T1OD)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Introducing to a view on organic molecules and their reactions that is based on energetic terms. By introducing Benson increments, radical stabilization energies and acidity functions for the characterization of very strong acids and bases the fundamental knowledge is acquired, which allows the students to derive relative free energies of reactants, products and intermediates of organic reactions. The Hammett equation is introduced as a prominent example of a linear free energy relationship, and it is demonstrated how kinetic and thermodynamic dimensions can be linked. Theories and models of (organic) chemical reactivity, such as More O'Ferrall-Jencks diagrams, the Hammond-Leffler analysis, the reactivity selectivity principle, the Klopman-Salem concept of charge and frontier orbital control, the Curtin-Hammett principle and the Marcus equation are presented and their scope is discussed.
Qualification goals	Students will recognize the interrelation of chemical thermodynamics and kinetics, basics that are typically acquired in lectures of Physical Chemistry, with the

	properties and reactions of organic molecules that are objects of teaching activities in Organic Chemistry. Students will be enabled to make use of physicochemical data that is available from scientific tables or internet sources in order to predict reactivities and selectivities of organic transformations and to use the data as a strategic tool for planning syntheses. By learning about the basics of linear free energy relationships the students will be enabled to derive mechanisms of reactions and use effects of substituents for a targeted development of catalysts.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	PD Dr. Armin Ofial
Language	German/English
Additional information	

Module WP 27: Specialisation in Organic Chemistry - The Chemistry of Heterocycles (T1OE)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 27.1 The Chemistry of Heterocycles (T1OE)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Students will be given a systematic overview of the structure, the properties and the reactivity of heterocycles as a function of their respective ring sizes, the number and type of heteroatoms, and their degree of saturation. Typical examples will be selected for an in-depth discussion of synthetic strategies and their occurence in biologically relevant systems. In addition the role of heterocycles in general concepts and theories in organic reactivity will be discussed.
Qualification goals	Students know the structure, the properties and the reaction types of standard heterocycles. Using this foundation students are able to predict the structure and the properties of novel heteroycles. This also includes an understanding of the role of heterocyclic systems in biologically important processes. The students are able to plan the synthesis of new heterocycles and are able to plan the synthesis of other organic compounds utilizing the particular reactivity of heterocyclic systems.

Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dr. Thomas Magauer
Language	German/English
Additional information	

Module WP 28: Specialisation in Organic Chemistry - Modern Synthetic Methods (T1OF)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 28.1 Modern Synthetic Methods (T1OF)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	New developments in organic synthesis will be discussed with particular emphasis on the use of organometallic reagents and transition metal catalysts. In the area of organometallic reagents the important role of magnesium- and zink-based organometallics is emphasized. In the chapter on transition metal catalysts the focus is on modern cross coupling reactions and the respective ligand systems.
Qualification goals	The students should be able to design synthetic targets with optimized knowledge. The students should also be able to identify the most relevant areas of application for modern organometallics and of transition metal catalysts.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. Paul Knochel
Language	German/English
Additional information	Link to the Web site of the lecture: http://www.knochel.cup.uni-muenchen.de/index.php?new-synthetic-methods

Module WP 29: Specialisation in Organic Chemistry – Synthesis Planning (T1OG)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 29.1 Synthesis Planning (T1OG)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The course covers the strategies and tactics of modern total synthesis. Following general considerations concerning the choice of suitable target molecules, it deals with the synthesis of vitamins and drugs that are prepared on a kilo and ton-scale, respectively. Subsequently, small carbocyclic and heterocyclic molecules, such as prostaglandins or cocaine, are covered. This is followed by the discussion of more complex polycyclic structures that include "classics in total synthesis", such as longifolene, steroids, morphine strychnine and tetrodotoxin. The importance of symmetry considerations in synthesis is demonstrated with highly symmetric hydrocarbons, such as cubane or dodecahedrane. After lectures on biomimetic synthesis and acyclic stereoselection, exemplified by daphniphyllum alkaloids and macrolides, the course concludes with the famous Woodward-Eschenmoser synthesis of Vitamin B12. If time permits, the "total chemical synthesis" of proteins with modern methods will be covered as well.

Qualification goals	Upon successful completion ofthis course, students should be able to design total syntheses of simple target molecules. Furthermore, they should be able to analyze published syntheses with respect to their strategic elegance and synthetic efficiency.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Dirk Trauner
Language	German/English
Additional information	

Module WP 30: Specialisation in Organic Chemistry – Glycochemistry (T1OH)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 30.1 Glycochemistry (T1OH)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Carbohydrates represent an important class of natural products, that carry important functions not only as energy storage and structural materials, but also in intracellular communication. Against the background of the biological role of carbohydrates and glycoconjugates important current developments in glycobiology will be presented. This includes an initial recapitulation of occurence, function, and reactivity of carbohydrates (and their mimetics), complemented by modern methods for the regio- and stereoselective synthesis of oligosaccharides and glycoconjugates. This latter part includes standard protecting group strategies as well as enzymatic glycoside syntheses and biosynthetic routes for N-/O-glycoproteins. The important biological roles of sialic acids and of selected glycolipids will be discussed.
Qualification goals	Students are competent in terms of discussing the structure, the diversity and the properties of carbohydrates. They are able to recognize the connection between structure, conformation, stereochemistry and properties of carbohydrates, and are well-versed in

	defining and applying synthetic strategies for glycosides and oligosaccharides. The students are also familar with the central role of carbohydrates in the context of inter- and intracellular communication. Building on this expertise the students can answer questions on the biological and potential medicinal role of carbohydrates, for example in the area of vaccine development or antitumor therapies.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Anja Hoffmann-Röder
Language	German/English
Additional information	**Literature:** [1] T. Lindhorst, Essentials of Carbohydrate Chemistry and Biochemistry [2] M. E. Taylor, K. Duckhammer, Glycobiology, Oxford Univ. Press 2003 [3] A. Varki, R. D. Cummings, J. D. Esko, et al. (Eds.) Essentials of Glycobiology, Cold Spring Harbor Laboratory Press 2009.

Module WP 31: Specialisation in Organic Chemistry - Radicals in Chemistry and Biology (T1OI)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 31.1 Radicals in Chemistry and Biology (T1OI)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The course offers a comprehensive and detailed discussion of all aspects of radicals and radical ions, many of which have been mentioned briefly in the chemistry bachelor program. This includes an introductory comparison of thermochemical and kinetic data of open shell systems that are essential in areas such as organic synthesis, polymer chemkistry, or biological chemistry. This is followed by the discussion of synthetically important radical reactions with particular emphasis on reduction and C-C bond forming reactions. After addressing shortly the specifics in reactions of radical ions and biradicals, both of which play important roles in medicinally important reactions, the lecture moves on to biologically important radical reactions. This latter chapter is subdivided into the unwanted and destrictive radical chemistry behind the autoxidation of lipids and important biopolymers, and the well-controlled radical chemistry of enzymes. This last chapter includes examples from P450 oxidation chemistry, enzymes dependent on B_{12} and SAM cofactors, and ribonucleotide

	reductases (RNRs).
Qualification goals	Students can understand and critically analyze research publications on the role of radicals in organic synthesis, polymer chemistry and biological chemistry. Students can furthermore employ thermochemical and kinetic data to design and optimize radical chain reactions, and to validate mechanistic proposals made in the literature.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hendrik Zipse
Language	Englisch
Additional information	Link to the Web site of the lecture: http://www.cup.uni-muenchen.de/oc/zipse/radicalsinchemistryandbiology.html

Module WP 32: Specialisation in Organic Chemistry - Basics of Cloning, Genomics and Proteomics (T1OJ)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 32.1 Basics of Cloning, Genomics and Proteomics (T1OJ)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters
Content	The course covers modern cloning strategies and protein purification methods. This goes in hand with a discussion of methods for protein analytics and proteom analysis. These are the methods that are today used for target discovery and validation in medical research.In the framework of personalized medicine the course covers the discussion of next generation sequencing methods and we are teaching the interplay between bioorganic chemistry and medicine in this context.
Qualification goals	The students • can transfer the basic principles of how biomolecules are chemically modified to substance classes not explicitly covered in the practical part of the course. • will learn to study and to characterize the purity of biomolecules with the help of modern techniques such as mass spectrometry. • - will learn the basic safety regulations important for

	handling and working with genetically modified organism.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas Carell
Language	German/English
Additional information	

Module WP 33: Specialisation in Organic Chemistry - Coenzymes and Biosynthesis (TIOK)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 33.1 Coenzymes and Biosynthesis (TIOK)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	We are discussing the basic biosynthesis pathways to amino acids, carbohydrates and nucleic acids. Their importance for modern pharmaceutical research is described.The course covers the cofactor based reaction mechanisms and we are comparing the mechanisms with standard organic chemistry mechanisms.The basic principles of enzyme catalysis will be taught in line with enzyme catalysis in modern organic chemistry.
Qualification goals	The students: • learn the basics principles of biosynthesis and will acquire the knowledge to clone, express and purify the involved proteins including protein characterisation. • will acquire competence in the fields of biological chemistry and protein biotechnology.
Module assessment	Exam or oral examination
Grading	Passed/ not passed

Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas Carell
Language	Englisch
Additional information	

Module WP 34: Specialisation in Organic Chemistry – Special Lecture in Organic Chemistry (T1OZ)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 34.1 Special Lecture in Organic Chemistry (T1OZ)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 30 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The course broadens and deepens special professional knowledge in the field of Organic Chemistry, the particular topics of which change from semester to semester. This particular format provides the opportunity to integrate new topics into the organic chemistry curriculum.
Qualification goals	Students are introduced to up-to-date topics of current research in Organic Chemistry. They broaden their already acquired knowledge with current and special topics. New information is integrated in existing knowledge to formulate and discuss scientific problems.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. Hendrik Zipse
Language	German/English
Additional information	

Module WP 91: Specialisation in Organic Chemistry – Multi-Dimensional NMR Spectroscopy (T1OL)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 91.1 Multi-Dimensional NMR Spectroscopy for Structure Elucidation of Big Molecules (T1OL)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 30 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The lecture deals with structure elucidation of large molecules using NMR spectroscopy, with a special focus on proteins. Building upon the Bachelor's courses, we go into detail for the method's physical basics. We introduce the product operator formalism (complementing the vector model) and the most important building blocks of today's NMR pulse sequences. A second part deals with the application of the technique for big biological molecules. This part consists of basics for (isotope-labeled) expression of proteins/RNAs, resonance assignment using 3D and 4D experiments ("sequential walk"), structure calculation using inter-atomic distances and angular restraints, as well as characterization of molecule dynamics based on quantification of various relaxation parameters. Here we demonstrate how NMR spectroscopy can indeed differentiate and employ signals of molecules larger than 30 kDa and why NMR is indispensable in wide areas of natural sciences, characterizing structural and dynamics parameters as well

	as molecule-molecule interactions precisely and with atomic resolution. In a third part, the methodological peculiarities, incl. Magic-Angle Spinning etc., of (technically even more intriguing) solid-state NMR spectroscopy will be considered, with which structure and dynamics also of non-soluble proteins can be accessed.
Qualification goals	The students are supposed to gain an understanding of NMR spectroscopy as an important method in structural chemistry and structural biology. They are to be capable of understanding and verifying published studies in the context of NMR spectroscopy. Finally, they are supposed to gain knowledge about the different ways of employing NMR spectroscopy for their own biochemical work in future projects.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Rasmus Linser
Language	Englisch
Additional information	Link zur Web-Seite der Vorlesung: http://www.cup.lmu.de/oc/linser/teaching/

Module WP 92: Specialisation in Organic Chemistry – Supramolecular Chemistry (T1OS)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 92.1 Supramolecular Chemistry (T1OS)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 30 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The concepts and perspectives of supramolecular chemistry are presented and their importance in the area of chemical and biological systems is discussed. The underlying fundamental principles of molecular recognition, the design of receptors, supramolecular systems in catalysis, transport processes in membranes as well as the construction of supramolecular aggregates and machines are explained and put into the context of organic synthesis and molecular chemistry.
Qualification goals	The aim is to learn about the basic principles of supramolecular chemistry and develop the ability to develop supramolecular systems.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. Oliver Trapp
Language	German/English
Additional information	

Module WP 35: Specialisation in Physical Chemistry – Energyconversion (T1PD)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 35. Energyconversion (T1PD)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	In this course we will discuss the global energy landscape and traditional technologies as a starting point for the treatment of selected sustainable energy conversion strategies. The focus will be on the physicochemical foundations and recent materials developments addressing these challenges. Emphasis will be placed on solar energy conversion with photovoltaic devices including classical semiconductor, excitonic and third generation solar cells, and the generation of solar fuels through photoelectrochemical and artificial photosynthesis concepts. Moreover, we will address the mechanisms and materials for electrochemical energy storage using batteries and capacitors, as well as different types of fuel cells.
Qualification goals	The students should gain an understanding of the global energy landscape and traditional energy technologies. Moreover, they should understand the physicochemical foundations and recent materials developments regarding solar energy conversion with photovoltaic devices including classical semiconductor, excitonic and third

	generation solar cells, and the generation of solar fuels through photoelectrochemical and artificial photosynthesis concepts. Moreover, they should gain an understanding of the mechanisms and materials for electrochemical energy storage using batteries and capacitors, as well as different types of fuel cells.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas Bein
Language	German/English
Additional information	

Module WP 36: Specialisation in Physical Chemistry - Electrochemistry: fundamentals and applications (T1PE)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 36.1 Electrochemistry: fundamentals and applications (T1PE)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Fundamental concepts of electrochemistry, basic electrochemical characterization techniques and their application inelectrochemical energy conversion and storage processes: thermodynamics of electrochemical processes (free energy and potential, Fermi level), electrochemical kinetics(rate limiting steps of electrode reactions, Butler-Volmer equation, Tafel equation, microscopic theories of charge transfer), mass transport in electrochemical processes (general mass transfer equation, Nernst-Planck equation, Fick's laws of diffusion, migration and diffusion in liquid electrolytes, coupled electron/ion transport in semiconducting layers, electron/ion transport in membrane layers), elementary steps and mechanisms of electrochemical processes, structure of interfaces (metal-solution interface, semiconductor-solution interface), electroanalytical techniques (potentiodynamic methods (voltammetry), potentiostatic/galvanostatic methods, transient methods, electrochemical impedance spectroscopy). The introduced concepts will be used as a basis for

	explanation of principles and functionality of the devices involving charge transport processes such as electrochemical sensors, batteries, fuel cells, photovoltaic cells and electroactive layers.
Qualification goals	Understanding of fundamental concepts of charge transfer and charge transport processes in modern electrochemistry, their practical application for characterization of electrochemical processes and interpretation of results of different electrochemical techniques
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. D. Fattakhova-Rohlfing, Prof. Dr. T. Bein
Language	Englisch
Additional information	**Literature:** • A.J. Bard and L.R. Faulkner "Electrochemical Methods: Fundamentals and Applications" Wiley, (2001), ISBN 978-0471043720; • C.H. Haman, A. Hamnett, W. Vielstich "Electrochemistry" Wiley-VCH (2007), ISBN978-3527310692

Module WP 37: Specialisation in Physical Chemistry - Introduction to Electron Microscopy (T1PF)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 37.1 Introduction to Electron Microscoy (T1PF)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This lecture introduces the basic imaging theory for conventional and scanning TEM. Geometrical optics approaches are briefly repeated before the wave-optical imaging theory is provided. Established imaging modes (bright field, dark field, Z-contrast) are presented in detail, first on he basis of single scattering and kinematical diffraction concepts so as to train the student's intuition for interpreting experimental data in terms of closed-form analytical models. The final part introduces theories for multiple scattering such as Bloch waves and multislice, and outlines four-dimensional TEM. By combining real- and diffraction space information, 4D-TEM enables the measurement of atomic electric fields and charge densities.
Qualification goals	First, a comprehensive understanding of wave-optical image formation including aberrations is acquired. Second, competences in the knowledge and application of single- and multiple scattering theories are gained. Third, students learn the capabilities of cutting-edge (S)TEM techniques, such that this lecture enables the conception

	and interpretation of atomically-resolved (S)TEM experiments in nanotechnology and life sciences.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Müller-Caspary
Language	German/English
Additional information	

Module WP 38: Specialisation in Physical Chemistry - Microscopy for Nanotechnology (T1PG)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 38.1 Microscopy for Nanotechnology (T1PG)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The first topics of this lecture are the physical basics of optical microscopy, the propagation of electromagnetic fields and of the optical near- and far-field. In the area of optical microscopy, confocal microscopy and different super-resolution techniques are discussed as examples.The lecture then introduces the fundamentals of scanning electron and transmission electron microscopy and discusses the different interactions between electrons and matter.Then the image formation process is sketched for both methods.The last part of the lecture introduces the fundamentals of scanning probe microscopy using the examples scanning tunnelling, scanning force and scanning near-field optical microscopy.
Qualification goals	The first aim of the lecture is to develop a general understanding of wave propagation and of the resulting diffraction limit of conventional microscopes.Using the examples of confocal light and scanning electron microscopy, the fundamental differences resulting from light and material waves are illustrated.The second aim is to develop a general understanding of the fundamental

	concepts and principles of scanning probe microscopy. Using scanning tunnelling und scanning force microscopy as examples, common features and essential differences are to be recognized. Overall the lecture aims at introducing different modern high resolution microscopy techniques and highlights common aspects and differences together with the specific areas of application of the different techniques.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Achim Hartschuh
Language	German/English
Additional information	

Module WP 39: Specialisation in Physical Chemistry – Solid-State Spectroscopy (T1PH)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 39.1 Solid-State Spectroscopy (T1PH)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This course presents selected physical properties of solids as independent units in a series of lectures. Using experimental and simulated examples, the lectures aim to convey a clear understanding of the central solid state aspects, and weekly alternates with computer exercises (Matlab, Octave, Python) under tight supervision, leading to an in-depth understanding. The content starts with kinematic near- and far-field diffraction (Fresnel,Fraunhofer) at atoms, molecules, nanoparticles and infinite solids. Electronic properties, such as the emergence of a band structure, are presented within the framework of 1D and 2D model systems. This is followed by a wave-optical treatment of of imaging in a light- and electron microscope which is exemplified using meta-materials and crystalline solids. Finally the course deals with phase retrieval based on pure diffraction experiments (Ptychography), as is widely used in, e.g., X-ray scattering, and introduces approaches to simulate multiple scattering (multislice) with low implementation effort.

Qualification goals	The students gain knowledge of the fundamental theoretical solid-state concepts, so as to understand the methodological backgrounds of diffraction- and imaging-based characterisation of solid-state nanostructures. Moreover, the course lays the basis to interpret data of light-, Xray- and electron scattering experiments correctly. Importantly, the students learn to set up own computer programs for this purpose, whereas no prior skills are required. By implementing and visualising selected concepts, the participants get to know the computer as a versatile tool for scientific simulations, visualisations, experimental evaluations. Basic competences in programming are acquired for the autonomous scientific work in ongoing studies.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Müller-Caspary
Language	German/English
Additional information	

Module WP 40: Specialisation in Physical Chemistry - Fluorescence Microscopy and Spectroscopy (T1PI)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 40.1 Fluorescence Microscopy and Spectroscopy (T1PI)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	During this course, we will discuss the basics of Fluorescence Spectroscopy and Microscopy including a classical and semi-classical description of the interaction of light with matter leading to absorption and stimulated emission, the structure of fluorescent molecules and the Jablonski diagram and the different processes that occur during fluorescence. Themes that we cover in detail include: Excitation and Emission Spectra, the Strickler-Berg Relationship, Fluorescence Lifetime Measurements in the time domain and frequency domain, Quenching and the Stern-Volmer equation, Förster Resonance Energy Transfer, Anisotropy and Fluorescence Correlation Spectroscopy. An introduction will be given to fluorescence instrumentation and principles of photon detection and single-photon counting.
Qualification goals	Upon completion of this course, the student should have a solid understanding of the fundamental processes that occur during fluorescence, detailed knowledge of some of the most popular applications of fluorescence

	spectroscopy and a theoretical understanding of how instruments used in fluorescence spectroscopy and microscopy function.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Don C. Lamb, PhD
Language	English
Additional information	**Literature:** • Parson, W. W. *Modern Optical Spectroscopy*; Springer: Berlin Heidelberg New York, 2007. • Lakowicz, J. R. *Principles of Fluorescence Spectroscopy, 3rd ed*; Springer Science+Business Media: New York, 2006.

Module WP 41: Major Physical Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Colloquium	WP 41.1 Expert colloquium in Physical Chemistry (T1ZP)	WiSe/ SoSe	45 h (3 SWS)	135 h	(6)
Lecture	WP 41.1.1 (=WP 35) Energyconversion	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.2 (=WP 36) Electrochemistry: fundamentals and applications	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.3 (=WP 37) Introduction to Electron Microscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.4 (=WP 38) Microscopy for Nanotechnology	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.5 (=WP 39) Solid-State Spectroscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.6 (=WP 40) Fluorescence Microscopy and Spectroscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.4.7 (=WP 58) Laserspectroscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.4.8 (=WP 59) Heterogeneous Catalysis	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.9 (=WP 60) Surface Physics	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.10 (=WP 61) Nanoscience	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 41.2.11 (=WP 62) Special Lecture in Physical Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 9 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with optional and compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 6 (lab course) if selected as a major subject.

	In this module three of the courses WP 41.2.1 to WP 41.2.11 must be elected.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 or 2 semesters.
Content	The module broadens and deepens special professional knowledge from the field of Physical Chemistry. Three advanced lectures covering current topics of Physical Chemistry are chosen.
Qualification goals	Students are introduced to up-to-date topics of current research in Physical Chemistry. They broaden their already acquired knowledge with current and special topics from Physical Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Bein
Language	German/English
Additional information	

WP 41.1: Expert colloquium in Physical Chemistry (T1ZP)

Type of the submodule	Required course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	none
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Experts (internal and external) present current results of their research in the Physical Chemistry Colloquium. The students have to post-process the scientific talks including literature search.
Qualification goals	Students are introduced to up-to-date topics of current research in Physical Chemistry. They broaden their already acquired knowledge with current and special topics from Physical Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	s. WP 41
Grading	-
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Bein
Language	German/English
Additional information	

Module WP 42: Major Theoretical Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Colloquium	WP 42.1 Expert colloquium în Theoretical Chemistry (T1ZT)	WiSe/SoSe	45h (3 SWS)	135 h	(6)
Lecture	WP 42.2.1 (=WP 63) Theory of chemical dynamics: Molecular dynamics	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 42.2.2 (=WP 64) Theory of chemical dynamics: Quantum dynamics	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 42.2.3 (=WP 65) Density Functional Theorie	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 42.2.4 (=WP 66) Theoretical Solid-State Chemistry	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 42.2.5 (WP 67) Linear Scaling Quantum Methods for large Molecules	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 42.2.6 (=WP 68) Special Lecture in Theoretical Chemistry	WiSe/SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 15 ECTS-points. Class attendance is 9 contact hours per week. Total time, including self-directed studies, is about 450 h.

Type of the Module	Optional module with optional and compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 7 (lab course) if selected as a major subject. In this module three of the courses WP 42.2.1 to WP 42.2.6 must be elected.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 or 2 semesters.

Content	The module broadens and deepens special professional knowledge from the field of Theoretical Chemistry. Three advanced lectures covering current topics of Theoretical Chemistry are chosen.
Qualification goals	Students are introduced to up-to-date topics of current research in Theoretical Chemistry. They broaden their already acquired knowledge with current and special topics from Theoretical Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Ochsenfeld
Language	German/English
Additional information	

WP 42.1: Expert colloquium in Theoretical Chemistry (T1ZT)

Type of the submodule	Required course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	none
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Experts (internal and external) present current results of their research in the Theoretical Chemistry Colloquium. The students have to post-process the scientific talks including literature search.
Qualification goals	Students are introduced to up-to-date topics of current research in Theoretical Chemistry. They broaden their already acquired knowledge with current and special topics from Theoretical Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	s. WP 42
Grading	-
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Ochsenfeld
Language	German/English
Additional information	

Module WP 43: Minor Structural Biology (Lab Course) (T1SB)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lab Course	WP 43.1 Research Lab Course in Structural Biology (T1SB)	WiSe/ SoSe	150h (10 SWS)	120 h	9

This module is comprised of 9 ECTS-points. Class attendance is 10 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with the modules WP 5 and WP 43, if selected as a minor subject.
Entry requirements	Successfull Participation at WP 5
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The students perform basic crystallization trials, assess the amino acid sequence using bioinformatic tools, process X-ray data sets from a synchrotron source and solve the protein crystal structure by MAD. Students will process samples for the negative stain procedure of electron microscopy and visualise stained particles. They will experience sample preparartion for cryo-EM and how to acquire Low-Dose images. Cryo-EM data will be processed for 3-D reconstruction.
Qualification goals	Students acquire expertise in state-of-the-art methods of solving three-dimensional protein structures and the architecture of large protein complexes.
Module assessment	Written report on or assessment of the practical laboratory course or written report on and assessment of the practical laboratory course
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsory module parts) has/have

	been completed successfully.
Responsible person	Prof. Hopfner
Language	English
Additional information	

Module WP 44: Minor Inorganic Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 44.0.1 (=WP 21) Modern Inorganic Main-group Chemistryv	SoSe	30h (2 SWS)	60 h	(3)
Lecture	WP 44.0.2 (=WP 22) Solid-State Chemistry II	WiSe	30h (2 SWS)	60 h	(3)
Lecture	WP 44.0.3 (=WP 23) Coordination Chemistry II	WiSe	30h (2 SWS)	60 h	(3)
Lecture	WP 44.0.4 (WP 24) Spectroscopic Methods	WiSe/ SoSe	30h (2 SWS)	60 h	(3)
Lecture	WP 44.0.5 (=WP25) Special Lecture in Inorganic Chemistry	WiSe/ SoSe	30h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with optional courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 8 (lab course) if selected as a minor subject. In this module two of the courses WP 44.0.1 to WP 44.0.5 must be elected.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special professional knowledge from the field of Inorganic Chemistry. Two lectures covering basic principles and current topics of Inorganic Chemistry are chosen.
Qualification goals	Students acquire knowledge in basic principles in Inorganic Chemistry and are introduced to current research in Inorganic Chemistry. They broaden their already acquired knowledge with current and special topics from Inorganic Chemistry. New information is

	integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Klapötke
Language	German/English
Additional information	

Module WP 45: Minor Organic Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 45.0.1 (=WP 26) Physical-Organic Chemistry	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.2 (=WP 27) The Chemistry of Heterocycles	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 25.0.3 (=WP28) Modern Synthetic Methods	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.4 (=WP 29) Synthesis Planning	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.5 (=WP 30) Glycochemistry	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.6 (=WP 31) Radicals in Chemistry and Biology	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.7 (=WP 32) Lecturein Chemical Biology	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.8 (=WP 33) Advanced Topics in Chemical Biology	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 45.0.9 (=WP 34) Special Lecture in Organic Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.10 (=WP 34a) Multi-Dimensional NMR Spectroscopy for Structure Elucidation of Big Molecules	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 4.2.11 (=WP 34b) Supramolecular Chemistry	WiSe/	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with optional courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 9 (lab course) if selected as a minor subject. In this module two of the courses WP 45.0.1 to WP 45.0.9 must be elected.
Entry requirements	none

Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special professional knowledge from the field of Organic Chemistry. Two lectures covering basic principles and current topics of Organic Chemistry are chosen.
Qualification goals	Students acquire knowledge in basic principles in Organic Chemistry and are introduced to current research in Organic Chemistry. They broaden their already acquired knowledge with current and special topics from Organic Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hendrik Zipse
Language	German/English
Additional information	

Module WP 46: Minor Physical Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 46.0.1 (=WP 35) Energyconversion	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.2 (=WP 36) Electrochemistry: Fundamentals and Applications	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.3 (=WP 37) Introduction to Electron Microscopy	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.4 (=WP 38) Microscopy for Nanotechnology	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.5 (=WP 39) Solid-State Spectroscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.6 (=WP 40) Fluorescence Microscopy and Spectroscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.7 (=WP 58) Laserspectroscopy	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.8 (=WP 59) Heterogeneous Catalysis	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.9 (=WP 60) Surface Physics	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.10 (=WP 61) Nanoscience	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 46.0.11 (=WP 62) Special Lecture in Physical Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with optional courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 10 (lab course)

	if selected as a minor subject. In this module two of the courses WP 46.0.1 to WP 46.0.11 must be elected.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special professional knowledge from the field of Physical Chemistry. Two lectures covering basic principles and current topics of Physical Chemistry are chosen.
Qualification goals	Students acquire knowledge in basic principles in Physical Chemistry and are introduced to current research in Physical Chemistry. They broaden their already acquired knowledge with current and special topics from Physical Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Bein
Language	German/English
Additional information	

Module WP 47: Minor Theoretical Chemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (optional courses)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 47.0.1 (=WP 63) Theory of Chemical Dynamics: Molecular Dynamics	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 47.0.2 (=WP 64) Theory of Chemical Dynamics: Quantum Dynamics	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 47.0.3 (=WP 65) Density Functional Theorie	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 47.0.4 (=WP 66) Theoretical Solid-State Chemistry	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 47.0.5 (=WP 67) Linear Scaling Quantum Methods for large Molecules	SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 47.0.6 (=WP 68) Special Lecture in Theoretical Chemistry	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with optional courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 11 (lab course) if selected as a minor subject. In this module two of the courses WP 47.0.1 to WP 47.0.6 must be elected.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special professional knowledge from the field of Theoretical Chemistry. Two lectures covering basic principles and current topics of Theoretical Chemistry are chosen.

Qualification goals	Students acquire knowledge in basic principles in Theoretical Chemistry and are introduced to current research in Theoretical Chemistry. They broaden their already acquired knowledge with current and special topics from Theoretical Chemistry. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Ochsenfeld
Language	German/English
Additional information	

Module WP 48: Minor Chemical Biology (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 48.1 (=WP 32) Basics of Cloning, Genomics and Proteomics (T1OJ)	WiSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 48.2 (WP 33) Coenzymes and Biosynthesis (T1OK)	SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 12 (lab course) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters.
Content	The module broadens and deepens special professional knowledge from the field of Chemical Biology.
Qualification goals	Students are introduced to up-to-date topics of current research in Chemical Biology. They broaden their already acquired knowledge with current and special topics. New information is integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas Carell
Language	German/English

Additional information

Module WP 49: Minor Biochemistry (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 49.1 Lecture in Biochemistry (T1Y1)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 49.2 Advanced Topics in Biochemistry (T1Y2)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 13 (lab course) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 2 semesters.
Content	This module complements knowledge in Biochemistry.
Qualification goals	The courses introduce students to up-to-date topics of Biochemistry. Students broaden their knowledge with current and special information. This information should get intregrated in existing knowledge to express and discuss scientific problems. The acquired knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Hopfner
Language	English

Additional information

Module WP 50: Minor Molecular and Cellular Genetics (Lectures)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 50.1 Lecture in Molecular and Cellular Genetics (T1G1)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 50.2 Advanced Topics in Molecular and Cellular Genetics(T1G2)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Master's degree Biochemistry
Elective guidelines	This module is associated with module WP 14 (lab course) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special knowledge from the field of Molecular and Cellular Genetics. The lectures cover genetic mechanisms underlying complex cellular processes and the multiple levels of regulation of gene expression after transcription.
Qualification goals	Students are introduced to up-to-date topics of current research in Molecular and Cellular Genetics. They acquire knowledge of special topics about regulation of gene expression and about genetic mechanisms controlling complex cellular processes. New information get integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course
Module assessment	Written exam or oral examination

Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsory module parts) has/have been completed successfully.
Responsible person	Prof. Beckmann
Language	English
Additional information	

Module WP 51: Specific Supplement to Chemistry (Lectures) (T1RY and T1RZ)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 51.1 Lecture in Specific Supplement to Chemistry (T1RY)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)
Lecture	WP 51.2 Advanced Topics in Specific Supplement to Chemistry (T1RZ)	WiSe/ SoSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	-
Elective guidelines	This module is associated with module WP 15 (lab course) if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This module complements knowledge in Chemistry.
Qualification goals	The courses introduce students to up-to-date topics of Chemistry. Students broaden their knowledge with current and special information. This information should get intregrated in existing knowledge to express and discuss scientific problems. The acquired knowledge will be implemented during the practical course.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dr. Thomas Engel

Language	German/English

Additional information

Module WP 52: Minor Physics: Particle Physics

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 52.1 Lecture in Particle Physics (E5.1)	WiSe	45 h (3 SWS)	75 h	(4)
Tutorial	WP 52.2Tutorial in Particle Physics (E5.2)	WiSe	15 h (1 SWS)	45 h	(2)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Physics
Elective guidelines	This module is associated with modules WP 17, WP 54 or WP 55, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Konzepte und experimentelle Methoden der Kern- und Teilchenphysik: Aufbau der Atomkerne, Kernreaktionen und Kernzerfälle, Instrumente der Kern- und Teilchenphysik, Reaktionen und Zerfälle von Hadronen, Elementarteilchen und elementare Wechselwirkungen.
Qualification goals	Wesentliches Lernziel sind Kenntnis und Verständnis obiger Lerninhalte, die Fähigkeit zu ihrer Anwendung und ihrer Verknüpfung untereinander. Darüber hinaus stellen die Vertrautheit mit Methoden der Experimentalphysik und die Fähigkeit zur Interpretation der experimentellen Ergebnisse, zu ihrer Verifikation oder Falsifikation allgemeine Lernziele dar. Die Verbindung zu Phänomenen in der Natur sowie zur aktuellen Forschung soll den Studierenden bewusst werden.
Module assessment	exam
Grading	The module is graded.

Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dean of Studies inPhysics
Language	German
Additional information	

Module WP 53: Minor Physics: Solid-State Physics

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 53.1 Lecture in Solid-State Physics (E6.1)	WiSe	45 h (3 SWS)	75 h	(4)
Tutorial	WP 53.2 Tutorial in Solid-State Physics (E6.2)	WiSe	15 h (1 SWS)	45 h	(2)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programmePhysics
Elective guidelines	This module is associated with modules WP 17, WP 54 or WP 55, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Konzepte und experimentelle Methoden der Festkörperphysik: Kristallstrukturen, Gitterschwingungen, mechanische, thermische, dielektrische, magnetische und optische Eigenschaften kristalliner Festkörper, Isolatoren, Halbleiter, Metalle, Supraleitung.
Qualification goals	Wesentliches Lernziel sind Kenntnis und Verständnis obiger Lerninhalte, die Fähigkeit zu ihrer Anwendung und ihre Verknüpfung untereinander. Darüber hinaus stellen die Vertrautheit mit Methoden der Experimentalphysik und die Fähigkeit zur Interpretation der experimentellen Ergebnisse, zu ihrer Verifikation oder Falsifikation allgemeine Lernziele dar. Die Verbindung zu Phänomenen in der Natur sowie zur aktuellen Forschung soll den Studierenden bewusst werden.
Module assessment	Klausur
Grading	The module is graded.

Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dean of Studies inPhysics
Language	German
Additional information	

Module WP 54: Minor Physics: Quantum Mechanics

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 54.1 Lecture in Quantum Mechanics (T2.1)	WiSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 54.2 Tutorial in Quantum Mechanics (T2.2)	WiSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 9 ECTS-points. Class attendance is 6 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Physics
Elective guidelines	This module is associated with modules WP 52 or WP 53, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Konzepte und theoretische Methoden der Quantenmechanik: Physikalischen Grundlagen der Quantenmechanik, mathematische Darstellungen der Quantenmechanik, Schrödinger-, Heisenberg- und Wechselwirkungsbild, Bahndrehimpuls und Spin, Anwendungen auf quantale Systeme (z.B. harmonischer Oszillator, Wasserstoffatom).
Qualification goals	Wesentliches Lernziel sind Kenntnis und Verständnis obiger Lerninhalte und der hierzu erforderlichen Mathematik sowie die Fähigkeit zur Anwendung der Lerninhalte und ihrer Verknüpfung untereinander. Darüber hinaus stellen die Vertrautheit mit Methoden der Theoretischen Physik und die Fähigkeit zur Modellbildung, zur Deduktion von Ergebnissen aus Modellen allgemeine Lernziele dar. Die Verbindung zu Phänomenen in der Natur sowie zur aktuellen Forschung soll den Studierenden bewusst werden.
Module assessment	Klausur

Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dean of Studies inPhysics
Language	German
Additional information	

Module WP 55: Minor Physics: Statistical Physics

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 55.1 Lecture in Statistical Physics (T4.1)	WiSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 55.2 Tutorial in Statistical Physics (T4.2)	WiSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 9 ECTS-points. Class attendance is 6 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Physics
Elective guidelines	This module is associated with modules WP 52 or WP 53, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Konzepte und theoretische Methoden der Statistischen Physik: Grundlagen der Statistischen Physik, statistische und phänomenologische Thermodynamik, Anwendungen (z.B. klassische Vielteilchensysteme, Phasenübergänge, Quantengase).
Qualification goals	Wesentliches Lernziel sind Kenntnis und Verständnis obiger Lerninhalte und der hierzu erforderlichen Mathematik, sowie die Fähigkeit zur Anwendung der Lerninhalte und ihrer Verknüpfung untereinander. Darüber hinaus stellen die Vertrautheit mit Methoden der Theoretischen Physik und die Fähigkeit zur Modellbildung, zur Deduktion von Ergebnissen aus Modellen allgemeine Lernziele dar. Die Verbindung zu Phänomenen in der Natur sowie zur aktuellen Forschung soll den Studierenden bewusst werden.
Module assessment	Klausur
Grading	The module is graded.

Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Dean of Studies inPhysics
Language	German
Additional information	

Module WP 56: Minor Computer Sciences: Introduction to Progamming

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 56.1 Lecture in Introduction to Programming	WiSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 56.2Tutorial in Introduction to Programming	WiSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 9 ECTS-points. Class attendance is 6 contact hours per week. Total time, including self-directed studies, is about 270 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Computer Science
Elective guidelines	This module is associated with modules WP 18 to WP 20 or WP 57, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Dieses Modul gibt eine Einführung in die imperative, objekt-orientierte und nebenläufige Programmierung anhand einer höheren Programmiersprache, z.B. Java. Neben Kenntnissen in de rProgrammierung werden allgemeine Grundlagen, Konzepte, Methoden und Techniken zur Darstellung, Strukturierung und Verarbeitung von Daten sowie zur Entwicklung von Algorithmen behandelt. Dabei wird auf begriffliche Klarheit und präzise mathematische Fundierung mit formalen Methoden Wert gelegt. Im Einzelnen werden vermittelt: • Grundbegriffe zu Programmen und ihrer Ausführung, • Syntax von Programmiersprachen und ihre Beschreibung, • Grunddatentypen und imperative Kontrollstrukturen, • Komplexität und Korrektheit imperativer

	Programme, • Rekursion, • Einfache Sortierverfahren, • Einführung in den objekt-orientierten Programmentwurf, • Klassen, Schnittstellen und Pakete, • Vererbung und Ausnahmebehandlung, • Objektorientierte Realisierung von Listen- und Baumstrukturen, • Grundkonzepte der nebenläufigen Programmierung: Threads, Synchronisation und Verklemmung, • Einführung in UML-Diagramme. • Benutzung einer Entwicklungsumgebung, derzeit Eclipse.
Qualification goals	Die Studierenden werden in die Lage versetzt, Lösungen für kleinere und überschaubare Probleme algorithmisch umzusetzen und mit einer höheren Programmiersprache als ausführbare Programme zu realisieren. Die Benutzung einer Entwicklungsumgebung wie Eclipse fördert die Professionalisierung. Des Weiteren entwickeln die Studierenden ein Verständnis für die allgemeinen Prinzipien der Programmierung und der Programmiersprachen, das den Grundstein dafür legt, dass die Studierenden sich (nach weiteren Erfahrungen im Laufe des Studiums) in beliebige Programmiersprachen schnell und präzise einarbeiten können.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Hans Jürgen Ohlbach
Language	German
Additional information	**Literature:** • Java ist auch eine Insel, von Christian Ullenboom, Gilileo Computing, ISBN = 978-3-8362-1802-3 Ein leichteres einführendes Buch ist • Java kompakt, von Hözl, Read und Wirsing, Springer Vieweg, ISBN 978-3-642-28503-58

Module WP 57: Minor Computer Sciences: Operating Systems

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 57.1 Lecture in Operating Systems	WiSe	45h (3 SWS)	45 h	(3)
Tutorial	WP 57.2 Tutorial in Operating Systems	WiSe	30 h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 6 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Computer Science
Elective guidelines	This module is associated with module WP 56, if selected as a minor subject.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Dieses Modul gibt eine Einführung in die relevanten Komponenten moderner Betriebssysteme und der dazu benötigten Aspekte der Rechnerarchitektur. Dabei wird zunächst auf Methoden zur Prozessverwaltung und Prozesskontrolle, insbesondere von nebenläufigen Prozessen, eingegangen. Insbesondere werden Methoden zur Erkennung und Vermeidung von Konflikten (Deadlocks und Race Conditions) bei Mehrfachzugriff auf gemeinsame Ressourcen behandelt. Im Einzelnen werden vermittelt: • die Entwicklungsgeschichte der Betriebssysteme, • das Zusammenspiel der unteren Ebenen eines Computers, • Technische Grundlagen zu Maschinenprogrammen, Unterprogrammen, Prozeduren und rekursiven Prozeduraufrufen, • Strategien zur Prozessverwaltung in Betriebssystemen,

	• die Unterstützung des Betriebssystems zur Parallelisierung von Programmen, • Strategien zur Ressourcenverwaltung und zur Koordinierung von Prozessen, • Techniken zur Speicherverwaltung sowie zur Kontrolle von Ein- und Ausgabekanälen, • lokale und verteilte Interprozesskommunikation.
Qualification goals	Dieses Modul vermittelt den Studierenden die nötigen Grundkenntnisse zur gezielten Nutzung der speziellen Struktur und technischen Eigenschaften moderner Betriebssysteme. Somit wird eine wichtige Basis zur späteren Einarbeitung in die Entwicklung optimierter und skalierbarer Programme für moderne Betriebssysteme geschaffen.
Module assessment	Exam or oral examination
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Claudia Linnhoff-Popien
Language	German
Additional information	**Literature:** • William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall, 7thEdition, 2011, ISBN-13 978-0132309981 • A.S. Tanenbaum, Modern Operating Systems, Prentice Hall, 3rd Edition, 2007, ISBN-13978-0136006633 • A. Silberschatz, P. Galvin, J. Peteron, Operating System Concepts, John Wiley and Sons,8th Edition, 2011, ISBN-13 978-1118112731

Module WP 58: Specialisation in Physical Chemistry - Laserspectroscopy (T1PJ)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 58.1 Laserspectroscopy (T1PJ)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The lecture treats the theoretical, experimental and conceptual basics of laser spectroscopy. This includes the properties of laser light, the general setup of lasers and their working principles, different laser types and the generation of short laser pulses.A series of different applications are introduced, including fluorescence-, ultrafast- and non-linearspectroscopy.
Qualification goals	The students develop the understanding of the laser process and the requirements for generating laser light. They get know different scientific questions that can be addressed by laser spectroscopy. They are able to evaluate different laser spectroscopic methods according to their usability towards given sample systems and problem sets.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-	ECTS-points are awarded for passing the exam, which is

Points	allocated to the module.
Responsible person	Prof. Dr. A. Hartschuh, Prof. D. Lamb, Prof. Dr. E. Riedle
Language	German/English
Additional information	

Module WP 59: Specialisation in Physical Chemistry - Heterogeneous Catalysis (T1PK)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 59.1 Heterogeneous Catalysis (T1PK)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The course treats the physico-chemical basis of heterogeneous catalysis. This includes our current understanding of the binding of molecules to solid surfaces and of adsorption processes, surface diffusion and chemical reactions of particles on surfaces. Surface-specific spectroscopic and microscopic methods are presented. By microkinetics and current in situ experiments this approach is linked to industrial catalytic processes.
Qualification goals	The course aims at an understanding of the methods of surface chemistry and its application to applied catalysis. It teaches the capability of applying basic knowledge about kinetics, thermodynamics, and quantum mechnics to a topical research field. It teaches knowledge about novel experimental techniques and how to apply this knowledge by means of examples from current research.
Module assessment	Exam or oral examination

Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Joost Wintterlin
Language	German/English
Additional information	

Module WP 60: Specialisation in Physical Chemistry –Surface Physics (T1PL)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 60.1 Surface Physics (T1PL)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Surface physics forms the basis of all interactions of solids with their environments. Examples are chemical reactions with gas molecules, epitaxial methods, the processes at electrodes in electrochemistry, and adhesion. The course treats the current knowledge about the geometry and electronic structure of solid surfaces. It treats important experimental methods, such as scanning probe techniques, diffraction at surfaces, and photoelectron spectroscopy.
Qualification goals	The course aims at an understanding of the physical properties of solid surfaces as two-dimensional systems. It teaches the ability to apply the tools of classical three-dimensional solid state physics, e.g., the reciprocal lattice, and models, such as the quasi-free electron and tight-binding theory, to two-dimenional systems. It teaches the pertinent experimental methods in order to provide access to the current literature on surface physics.
Module assessment	Exam or oral examination

Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Joost Wintterlin
Language	German/English
Additional information	

Module WP 61: Specialisation in Physical Chemistry - Nanoscience (T1PM)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 61.1 Nanoscience (T1PM)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This lecture provides an introduction to chemical strategies for the design of nanostructures in different dimensionalities, ranging from nanoparticles, rods and wires, layered structures and thin films to extended networks. These strategies will be contrasted with the lithographic top-down techniques used in the semiconductor industry. A focus will be on physicochemical foundations such as the physical chemistry of surfaces, electrostatic and steric interactions, and nucleation theory. We will discuss design concepts involving weak interactions, such as hydrogen bonds, hydrophobic interactions and liquid crystals, coordinative bonds in supramolecular systems, colloidal interactions, self-assembly, as well as templating techniques for the generation of nanostructures. We will also cover present and potential applications of nanostructured materials, including solar energy, chemical sensors, molecular wires, and targeted drug release.
Qualification goals	The students should gain an understanding of modern chemical strategies for the design of nanostructures in

	different dimensionalities, ranging from nanoparticles, rods and wires, layered structures and thin films to extended networks. They should understand the concepts of lithographic top-down techniques used in the semiconductor industry. The students should know the relevant physicochemical foundations such as the physical chemistry of surfaces, electrostatic and steric interactions, and nucleation theory. They should have a firm understanding of design concepts involving weak interactions, such as hydrogen bonds, hydrophobic interactions and liquid crystals, coordinative bonds in supramolecular systems, colloidal interactions, self-assembly, as well as templating techniques for the generation of nanostructures. Moreover, they should know about present and potential applications of nanostructured materials, including solar energy, chemical sensors, molecular wires, and targeted drug release.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Thomas Bein
Language	German/English
Additional information	

Module WP 62: Specialisation in Physical Chemistry – Special Lecture (T1PZ)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 62.1 Special Lecture in Physical Chemistry (T1PZ)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The course broadens and deepens special professional knowledge in the field of Physical Chemistry, the particular topics of which change from semester to semester. This particular format provides the opportunity to integrate new topics into the physical chemistry curriculum.
Qualification goals	Students are introduced to up-to-date topics of current research in Physical Chemistry. They broaden their already acquired knowledge with current and special topics. New information is integrated in existing knowledge to formulate and discuss scientific problems.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. Bein
Language	German/English
Additional information	

Module WP 63: Specialisation in Theoretical Chemistry - Theory of Chemical Dynamics: Molecular Dynamics (T1TD)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 63.1 Theory of Chemical Dynamics: Molecular Dynamics (T1TD)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Principles of molecular dynamics to describe canonical ensembles and application to current topics of chemistry. Classical molecular dynamics (MD): Parametrization of force fields and solution of Newtons equations of motion for the nuclei. Introduction to various algorithms including integrators to describe the temporal evolution (trajectory) of the particles, definition of inital and boundary conditions as well as suitable approximations for the calculation of short and long range interactions. Discussion of the stability issue of trajectories. Characterization of thermodynamical and kinetic properties by appropriate correlation functions. MD simulations in the canonical ensemble introducing the concepts of thermostat and barostat. Continuum models as alternative description of the solvent. Improvement of the theoretical description for finite sized reactive centers by on-the-fly dynamics: explicit solution of the Schrödinger equation of the electrons, while keeping the classical description for the nuclear motion (Newton).

	Applications from chemistry and biology. Implementation of an MD algorithm for a Lennard-Jones Fluid as MATLAB code.
Qualification goals	Understanding of molecular dynamical problems and transfer of the theory to mathematical algorithms by developing and using own MATLAB codes as well as the visualization of the results
Module assessment	Presentation (20+10 Min) and Programming
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. R. de Vivie-Riedle
Language	German/English
Additional information	**Literature:** • D. Frenkel, B. Smit, Understanding Molecular Simulation - From Algorithms to Applications, Academic Press (2002), ISBN 0-12-267351-4. • A. R. Leech, Molecular Modelling - Principles and Applications, Prentice Hall (2001), ISBN 0-582-38210-6.

Module WP 64: Specialisation in Theoretical Chemistry - Theory of Chemical Dynamics: Quantum Dynamics (T1TE)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 64.1 Theory of Chemical Dynamics: Quantum Dynamics (T1TE)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Principles of quantum dynamics and applications to current topics in femtochemistry: solution of the timedependent Schrödinger equation (TDSE) for the nuclear dynamics in molecular systems by means of different methods. General definition and characterization of wavepackets, solution of the TDSE in the eigenstate basis for analytic solvable systems, Fourier Transformation theorems connected to the fast solution of the TDSE, propagators for the time evolution in ab initio potentials of arbitrary molecular systems,light-matter interaction. Applications: Ultrafast dynamics, theoretical description of pump-probe spectroscopy, control of chemical reactions by femtosecond pulses, implementation of propagation algorithms in MATLAB codes as well as simulation of selected examples.
Qualification goals	Understanding of quantum dynamical problems and transfer of the theory to mathematical algorithms by developing and using own MATLAB codes as well as the

	visualization of the results
Module assessment	Presentation (20+10 Min) plus Programming
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. R. de Vivie-Riedle
Language	German/English
Additional information	**Literature:** David Tannor „Introduction to Quantum Mechanics: A Time-dependent Perspective" University Science Books (2007), ISBN 1-891389-23-8

Module WP 65: Specialisation in Theoretical Chemistry - Density Functional Theorie (T1TF)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 65.1 Density Functional Theorie (T1TF)	WiSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The lecture provides an overview of quantum-chemical methods for calculating molecular systems: Hartree-Fock (HF); density-functional theory (DFT); mathematical background covering functional calculus; overview of most important exchange correlation functionals; time dependent DFT; further developments of DFT based methods.
Qualification goals	Basic understanding of quantum chemical methods and their importance for calculations in chemistry
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	PD Dr. J. Minar

Language	German/English
Additional information	**Literatur:** • Szabo, N. S. Ostlund, Modern Quantum Chemistry (Introduction to Advanced Electronic Structure Theory), Dover Publications; F. Jensen; Introduction to Computational Chemistry; Wiley-VCH;Ira N. Levine; Quantum Chemistry; Pearson International Edition • Parr, Yang: Density functional theory of atoms and molecules, Oxford University Press

Module WP 66: Specialisation in Theoretical Chemistry – Theoretical Solid-State Chemistry (T1TG)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 66.1 Theoretical Solid-State Chemistry (T1TG)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	
Qualification goals	
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Ebert
Language	German/English

Additional information

Module WP 67: Specialisation in Theoretical Chemistry - Linear Scaling Quantum Methods for large Molecules (T1TH)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 67.1 Linear Scaling Quantum Methods for large Molecules (T1TH)	SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The lecture provides insights into modern developments in quantum chemistry for calculating large molecular systems: density matrix, density operator, projector properties; the metric; linear-scaling methods for calculating the Fock matrix; avoiding the diagonalization in SCF theory; linear-scaling energy gradients; Laplace-based methods; calculation of molecular properties for large molecules; linear-scaling MP2 energies and MP2 energy gradients
Qualification goals	Advanced understanding of modern quantum-chemical methods for calculating complex molecular systems
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. C. Ochsenfeld
Language	German/English
Additional information	**Literature:** Reviews in Computational Chemistry, Volume 23, Wiley-VCH

Module WP 68: Specialisation in Theoretical Chemistry – Special Lecture in Theoretical Chemistry (T1TZ)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 68.1 Special Lecture in Theoretical Chemistry (T1TZ)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The course broadens and deepens special professional knowledge in the field of Theoretical Chemistry, the particular topics of which change from semester to semester. This particular format provides the opportunity to integrate new topics into the theoretical chemistry curriculum.
Qualification goals	Students are introduced to up-to-date topics of current research in Theoretical Chemistry. They broaden their already acquired knowledge with current and special topics. New information is integrated in existing knowledge to formulate and discuss scientific problems.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.

Responsible person	Prof. Dr. C. Ochsenfeld
Language	German/English
Additional information	

Module WP 69: Specialisation in Quantum Chemistry (T1TX und T1TY)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 68.1 Lecture Quantum Chemistry (T1TX)	SoSe	30h (2 SWS)	60 h	(3)
Exercise	WP 68.1 Exercise Quantum Chemistry (T1TY)	SoSe	30h (2 SWS)	60 h	(3)

This module is comprised of 6 ECTS-points. Class attendance is 4 contact hours per week. Total time, including self-directed studies, is about 180 h.

Type of the Module	Optional module with compulsory courses.
Applicability to other degree programmes	Bachelor's programme Chemistry and Biochemistry
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	Part 1: The lecture provides deeper insights into quantum-chemical methods and the quantum-chemical calculation of molecular properties: HF, DFT, CI, CC; fundamental aspects with respect to the computational effort and the scaling behavior; energy gradients; higher energy derivatives; response equations, CPSCF theory; calculation of properties such as IR, Raman, NMR, etc. Part 2: Discussion of the Born-Oppenheimer approximation including topics like conical intersections and their role in photochemistry. Within this context diabatic and adiabatic potential energy curves as well as non-adiabatic couplings are introduced. Separation of the stationary Schrödinger equation for the nuclei in the case of electronically coupled and uncoupled states. Presentation of various search algorithms to locate minima, transition states and minimum energy paths. Advanced methods for electron correlation and to describe electronically excited states. The focus is on

	configuration interactions and related methods like Complete Active Space –SCF.
Qualification goals	Advanced understanding of quantum-chemical methods as well as of the ab-initio calculation of molecular properties. Solid understanding of advanced quantum chemical problems and methods to calculate potential energy surfaces of electronically excited states. Understanding of search algorithms to characterize multidimensional energy surfaces.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Regina de Vivie-Riedle, Prof. Dr. C. Ochsenfeld
Language	German/English
Additional information	**Literatur:** • Szabo, N. S. Ostlund, Modern Quantum Chemistry (Introduction to Advanced Electronic Structure Theory), Dover Publications • F. Jensen; Introduction to Computational Chemistry; Wiley-VCH • Ira N. Levine; Quantum Chemistry; Pearson International Edition

Module WP 70: Specialisation in Biochemistry (T1Y1)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 70.1 Lecture in Biochemistry (T1Y1)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This module complements knowledge in Biochemistry.
Qualification goals	The courses introduce students to up-to-date topics of Biochemistry. Students broaden their knowledge with current and special information. This information should get intregrated in existing knowledge to express and discuss scientific problems.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Hopfner
Language	German/English

Additional information

Module WP 71: Advanced Specialisation in Biochemistry (T1Y2)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 71.1 Advanced Studies in Biochemistry (T1Y2)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This module deepens knowledge in Biochemistry.
Qualification goals	Students further broaden their knowledge with current and special information. This information should get intregrated in existing knowledge to express and discuss scientific problems.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Hopfner
Language	German/English

Additional information

Module WP 72: Specialisation in Structural Biology (T1S2)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 72.1 Lecture in Structural Biology (T1S2)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This lecture covers modern structural biology at an advanced level. The focus is on methods to reveal the three-dimensional structure of proteins and multiprotein complexes, including X-ray crystallography and electron microscopy.
Qualification goals	Students learn the theoretical and methodical basics to analyse the three-dimensional structure of proteins. The lecture prepares students to apply these methods during the laboratory course in Structural Biology and enables them to read and critical evaluate publications in Structural Biology.
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsory module parts) has/have been completed successfully.

Responsible person	Prof. Hopfner
Language	English
Additional information	

Module WP 73: Specialisation in Molecular and Cellular Genetics (T1G1)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 73.1 Lecture Molecular and Cellular Genetics (T1G1)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special knowledge from the field of Molecular and Cellular Genetics. The lectures cover genetic mechanisms underlying complex cellular processes and the multiple levels of regulation of gene expression after transcription.
Qualification goals	Students are introduced to up-to-date topics of current research in Molecular and Cellular Genetics. They acquire knowledge of special topics about regulation of gene expression and about genetic mechanisms controlling complex cellular processes. New information get integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS credits will be granted when the module examination (or the examination of pertinent

	mandatory and potential elective compulsory module parts) has/have been completed successfully.
Responsible person	Prof. Beckmann
Language	English
Additional information	

Module WP 74: Advanced Specialisation in Molecular and Cellular Genetics (T1G2)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 74.1 Advanced In-depth Studies Molecular and Cellular Genetics (T1G2)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	The module introduces special knowledge from the field of Molecular and Cellular Genetics. The lectures cover genetic mechanisms underlying complex cellular processes and the multiple levels of regulation of gene expression after transcription.
Qualification goals	Students are introduced to up-to-date topics of current research in Molecular and Cellular Genetics. They acquire knowledge of special topics about regulation of gene expression and about genetic mechanisms controlling complex cellular processes. New information get integrated in existing knowledge to formulate and discuss scientific problems. The acquired theoretical knowledge will be implemented during the practical course
Module assessment	Exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory

Points	and potential elective compulsory module parts) has/have been completed successfully.
Responsible person	Prof. Beckmann
Language	English
Additional information	

Module WP 75: Discipline Specific Studies in Chemistry (T1RV)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 75.1 Topics in Discipline Specific Studies in Chemistry (T1RV)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This module allows supplementing knowledge in, but also beyond Chemistry.
Qualification goals	The students advance in the lecture to modern topics for their future career. They broaden their acquired knowledge with special and current information. The information should be integrated into existing knowledge to word and to dicuss scientific questions.
Module assessment	Oral presentation or exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. R. de Vivie-Riedle
Language	German/English

Additional information

Module WP 76: Advanced Discipline Specific Studies in Chemistry (T1RW)

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Lecture	WP 76.1 Advanced Topics in Discipline Specific Studies in Chemistry (T1RW)	WiSe/ SoSe	30h (2 SWS)	60 h	3

This module is comprised of 3 ECTS-points. Class attendance is 2 contact hours per week. Total time, including self-directed studies, is about 90 h.

Type of the Module	Optional module with compulsory course.
Applicability to other degree programmes	-
Elective guidelines	If a minor subject is selected, specialisation courses from modules WP 21 to WP 40, WP 58 to WP 76, WP 78, WP 79, WP 81 to WP 89, WP 91 to WP 93 have to be selected with 15 ECTS in total.
Entry requirements	none
Study pathway level	Between semester 1 and 3
Duration	The module spans 1 semester.
Content	This module allows supplementing knowledge in, but also beyond Chemistry.
Qualification goals	The students advance in the lecture to modern topics for their future career. They broaden their acquired knowledge with special and current information. The information should be integrated into existing knowledge to word and to dicuss scientific questions.
Module assessment	Oral presentation or exam or oral examination
Grading	Passed/ not passed
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. R. de Vivie-Riedle
Language	German/English

Additional information

Module P 1: Master's Degree Module

Degree programme	Master's degree: Chemistry

Assigned courses

Course Type	Course Title (compulsory)	Rotation	Contact Hours	Self-directed Studies	ECTS
Masterarbeit	P1.1 Master's thesis	WiSe/ SoSe		900 h	30

This module is comprised of 30 ECTS-points. Total time, including self-directed studies, is about 900 h.

Type of the Module	Compulsory module with compulsory course
Applicability to other degree programmes	none
Elective guidelines	none
Entry requirements	Successfull participation in two compulsory modules of WP 1, WP 3, WP 6 und WP 7
Study pathway level	Semester 4
Duration	The module spans 1 semester.
Content	Focus of the thesis is the work on a special chemical question, including a written scientific report.
Qualification goals	Competence to compile and present a focused topic during 10 weeks in a complete manner. Ability to work in a team or a project. The students get theoretical and practical understanding in specific challenges in chemistry. They may design and realize experiments correctly, as well as present and discuss the results in a report in form and content properly.
Module assessment	Master's thesis
Grading	The module is graded.
Requirements for granting ECTS-Points	ECTS-points are awarded for passing the exam, which is allocated to the module.
Responsible person	Prof. Dr. Regina de Vivie-Riedle
Language	German/English
Additional information	

Map of the area of the HighTechCampus^{LMU} Großhadern

Address:
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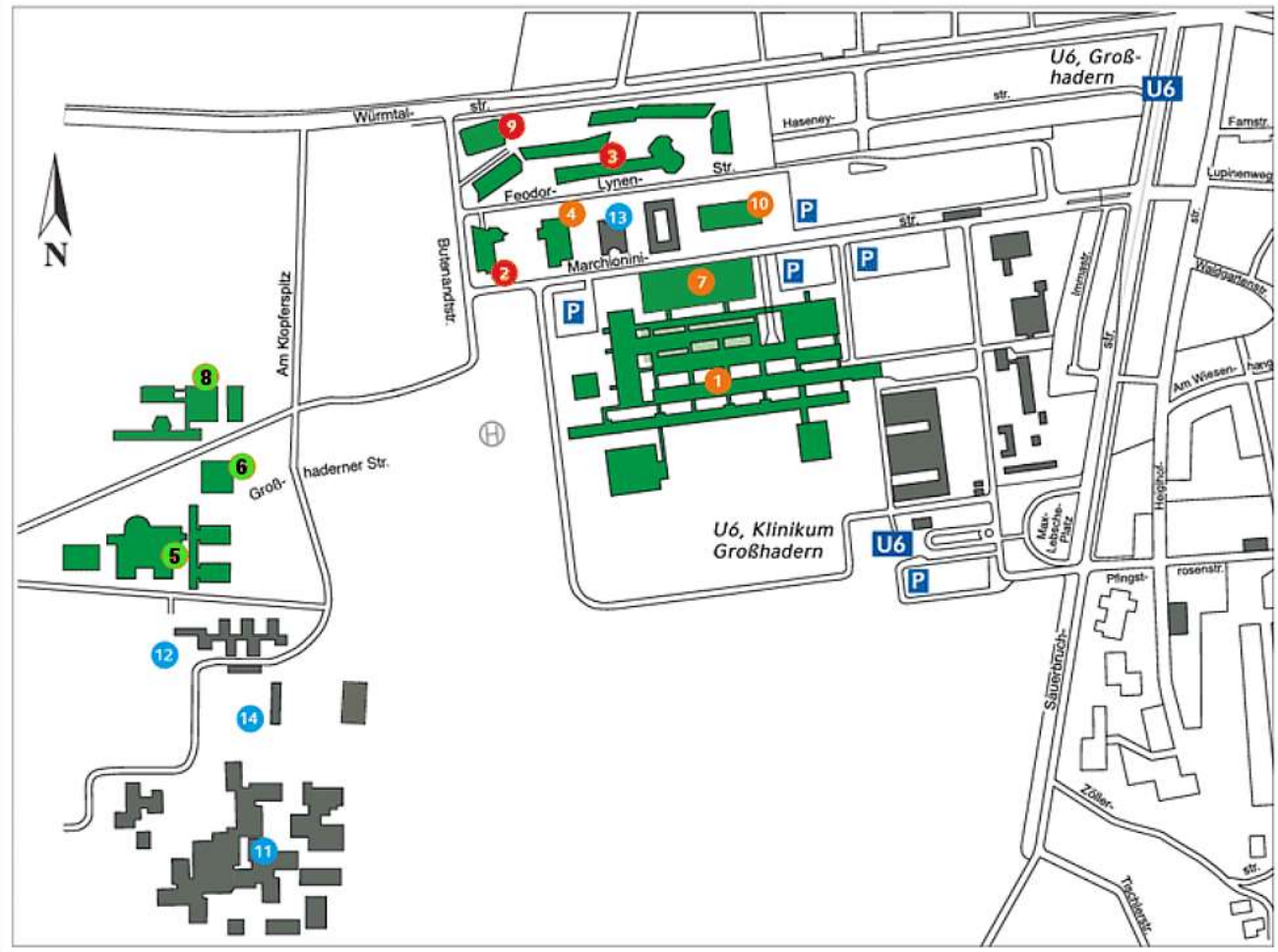
81377 Munich / Germany



1 Klinikum der Universität München, Standort Großhadern 2 Genzentrum 3 Fakultät für Chemie und Pharmazie 4 Zentrum für Neuropathologie und Prionenforschung 5 Fakultät für Biologie/Biozentrum 6 Campuszentrum 7 Operationszentrum 8 Biomedizinisches Centrum 9 Forschungszentrum für Molekulare Biosysteme (BioSysM) 10 Zentrum zur Erforschung von Schlaganfall, Demenz und neurodegenerativen Erkrankungen 11 Max-Planck-Institute für Biochemie und Neurobiologie 12 Innovations- und Gründerzentrum Biotechnologie (IZB) 13 Helmholtz Zentrum München – Hämatologikum 14 BioM GmbH