Modulhandbuch für den Studiengang Master of Science (M.Sc.)

Material Science

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1. List of abbreviations

Forms of teaching:

- Lecture (V)
- Laboratory exercise (LÜ)
- Field exercise (FÜ)
- Tutorial (Ü)
- Excursion (E)
- Internship (P)
- Seminar (S)
- Final thesis (A)

Credit points and workloads etc.:

- ECTS-credit points, ECTS-credits (ECTS-LP)
- Credit points (CP) (Leistungspunkte, LP)
- European Credit Transfer and Accumulation System (ECTS)
- Semester load, credit hours (SWS)
- Hours (Std.)
- Winter semester (WiSe)
- Summer semester (SoSe)
- Compulsory module or course (PF)
- Compulsory elective module or course (WPF)
- General examination regulations (Rahmen-Prüfungsordnung, Rahmen-PO) of the University of Koblenz
- Programme examination regulations[1] (Studiengangs-Prüfungsordnung, Studiengangs-PO)

Other

- Koblenz University of Applied Sciences (HAW) (Hochschule Koblenz)

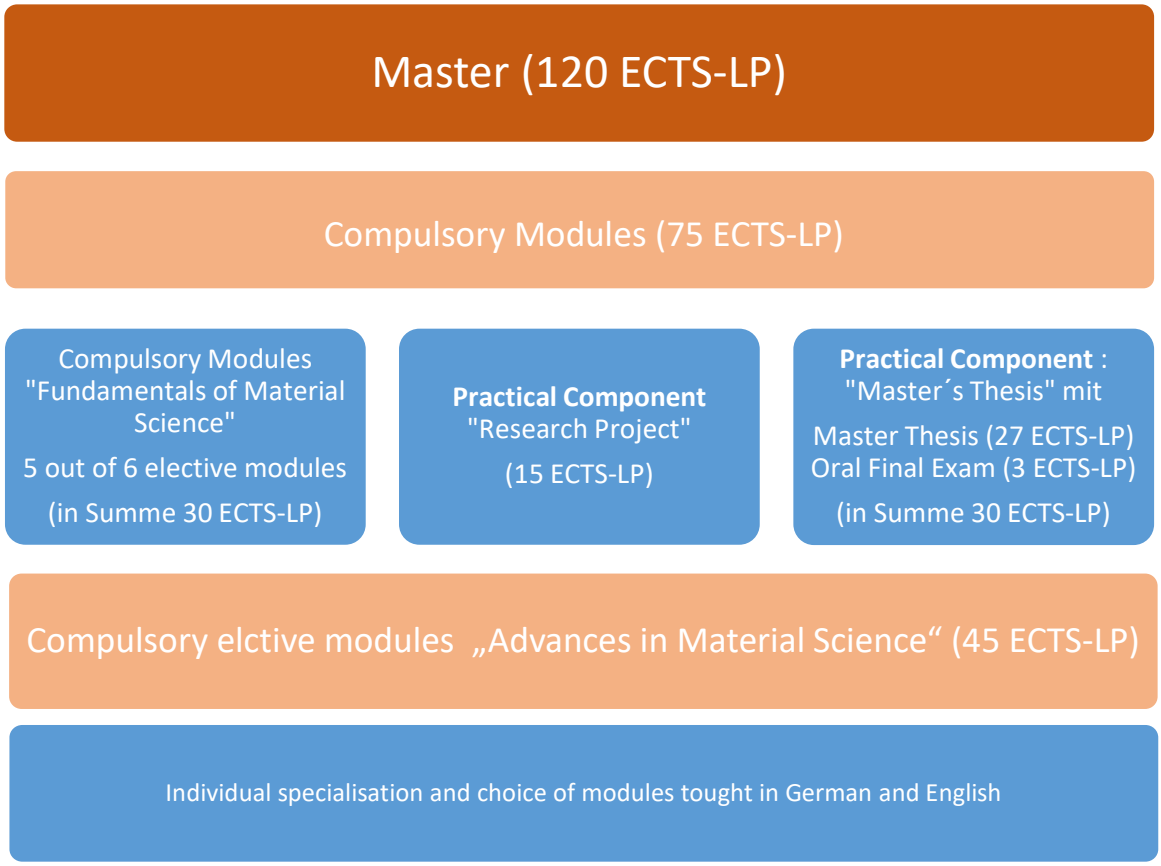
[1] Prüfungsordnung für den Bachelorstudiengang „Angewandte Naturwissenschaften“ und den Masterstudiengang „Material Science“ an der Universität Koblenz (Studiengangs-PO Angewandte Naturwissenschaften / Material Science)

2. Course description and structure of the degree programme

The "M.Sc. Material Science" Master's degree programme is a research-oriented scientific study programme and teaches subject-specific and interdisciplinary knowledge, skills and methods. It prepares students for a further scientific qualification (doctorate) or a job in a materials science field. The study programme comprises 120 ECTS-credit points (ECTS-LP) and has a standard period of study of four terms. The Master's, which is designed to be studied internationally, opens up an English-language study path in the compulsory and compulsory elective areas.

In terms of subject matter, the Master's programme focuses on later connectivity in the student's own faculty, e.g. a doctorate in the field of materials science (metals, ceramics, plastics). The topic of "sustainability" is addressed both in the subject, discipline courses and in the "Sustainable Functional Materials" module.

The courses offered in the Master's degree programme are structured as follows:



The Master's degree (120 ECTS-LP in total) consists of a compulsory module "Fundamentals of Material Science" with the option of choosing 5 out of 6 modules from: Ceramic Materials, Sustainable Functional Materials, Polymer Chemistry and Natural Products Chemistry, Physics of Metals, Polymer Science and Surface Science. The remaining module not taken from the compulsory module can also be taken in the compulsory elective module "Advances in Material Science", as long as this is also offered.

The compulsory elective module "Advances in Material Science" is divided into German and English modules worth 45 ECTS-LP. All students must take a cross-thematic compulsory module entitled "Recent Research Topics" on current academic issues.

As part of the international orientation of the study programme, it is important to ensure that students are qualified for the domestic job market, which includes important generic key skills as well as German language skills. This is where the Interdisciplinary Career and Study Centre's Skills Academy (Interdisziplinäres Karriere- und Studienzentrum, IKaruS) will make a contribution with the module "Language and Soft Skills for Material Science".

The following modules can also be considered for the compulsory elective module, as long as they are not taken twice: Physics of Matter; Thermochemical Modeling, Applied Theoretical Physics, Special Topics and Methods in Material Sciences 1, Special Topics and Methods in Material Sciences 2; Analytical Chemistry; Technical Chemistry; Biochemistry, Catalysis; Organic Synthetic Chemistry; Glass Materials; Structure of Substances 1; Structure of Substances 2; Nuclear Medicine, Computed Tomography and X-ray Diagnostics.

A "mobility module" in the compulsory elective module of 5-30 ECTS-credit points allows students to take modules from accredited study programmes outside the university, for example during a stay abroad or at partner universities.

There is no entitlement to the offer of a particular module or participation in a particular module outside the underlying programme examination regulations (Studiengangs-Prüfungsordnung).

Central Student Advisory service with the person responsible for the degree program is recommended after the first semester.

3. Study plan

The following study plan makes it possible to adhere to the standard period of study, as the compulsory modules planned for each term are coordinated by the examination board without overlapping. The timing of the internships (i.e. laboratory exercises, research project, etc.) can be varied during the lecture-free period) and the compulsory elective modules.

Compulsory modules (75 ECTS-LP)					
Module number	**Module code**	**Title**	**PF/ WPF**	**Value / ECTS-LP**	**Recom-mended term**
Practical module "Research Project" (15 ECTS-LP)					
1	03XX2401	Research Project	PF	15	2 (summer se-mester / 3 (winter semes-ter)
Practical module: "Master's Thesis" with Master's thesis (27 ECTS-Credits) and final oral examination (3 ECTS-LP) (in total 30 ECTS-LP)					
2	03XX2490	Master's Thesis	PF	27	4 (summer se-mester)
2	03XX2499	Final Oral Examination	PF	3	4 (summer se-mester)
Compulsory module "Fundamentals of Material Science" 5 out of 6 compulsory elective modules (in total 30 ECTS-LP)					
3	03CH2404	Sustainable Functional Materials	WPF	6	1 (winter se-mester) 2 (summer se-mester)
4	03PH2503	Surface Science	WPF	6	1/3 (winter se-mester)
5	03PH2505	Polymer Science	WPF	6	2 (summer se-mester) / 3 (winter se-mester)
6	03PH2403	Physics of Metals	WPF	6	2 (summer se-mester) / 3 (winter se-mester)
7	03CH2907	Ceramic Materials	WPF	6	1/2 or 3 (win-ter semester) or also in 4 (summer se-mester)

8	03CH2403	Polymer Chemistry and Natural Products Chemistry	WPF	6	3 (winter semester)
Compulsory elective modules "Advances in Material Science" (45 ECTS-LP)					
Module number	Module code	Title		Value / ECTS-LP	Recommended term
9	03XX2405	Recent Research Topics	PF	3	3 (winter semester)
10	03PH2903	Physics of Matter	WPF	6	2 (summer semester) / 3 winter semester
11	03CH2402	Thermochemical Modeling	WPF	6	1 -2 (winter semester)
12	03PH2504	Applied Theoretical Physics	WPF	6	1 -2 (winter semester)
13	03PH2413	Special Topics and Methods in Material Sciences 1	WPF	3-6	1-2 (winter semester)
14	03CH2404	Analytical chemistry	WPF	7	3-4 (winter semester) or 1/2
15	03CH2405	Technical chemistry	WPF	7	3-4 (winter semester) or 1/2
16	03CH2406	Biochemistry	WPF	7	2 (summer semester) 3 (winter semester)
17	03CH2417	Catalysis	WPF	7	2 (summer semester)
18	03CH2418	Organic synthesis chemistry	WPF	3	1 (winter semester)
19	GLASS	Glass materials (offered by the HAW)	WPF	5	acc. to HAW
20	03CH2420	Structure of Substances 1	WPF	6	1 (winter semester)
21	03CH2421	Structure of Substances 2	WPF	6	2 (summer semester)
22	03XX2422	Mobilitätsmodul / Mobility Module	WPF	5-30	
23	Interdisciplinary Career and Study Centre[2]	Language and Soft Skills for Material Science	WPF	1-3	

[2] Interdisziplinäres Karriere- und Studienzentrum, IKaruS

24	03IN2424	Special Topics and Methods in Computational Sciences	WPF	3-9	1-2 (winter semester)
25	03PH2425	Special Topics and Methods in Material Sciences 2	WPF	3-6	1-2 (winter semester)
26	03PH2413	Nuclear medicine, computer tomography and X-ray diagnostics	WPF	5	1-2 (winter semester)

There is no entitlement to the offer of a particular module or to participation in a particular module outside the underlying examination regulations.

4. General information on the Master's degree programme

Contact person for the Master's programme: Prof. Dr. S. Mascotto

On the following pages, all modules and their courses are listed together with the credit points (ECTS-LP) of the respective module for the Master's degree programme.

The credit points per module comprise the time for contact time and self-study (referred to as workload in total) according to the formula 1 CP = 30 hours. As the students' workload in terms of preparation and follow-up work varies greatly between the individual types of course, average values are used in the calculation. The average workload in hours is calculated from the sum of contact time and independent study time according to the following formula: Workload = 30 times ECTS-LP or credit points (LP); whereby the specified contact times in hours result from the estimation 1 SWS = 15 hours.

5. Courses and examinations

Examinations for the individual modules can take the form of ungraded coursework (Studienleistung), coursework relevant for the examination (graded) (prüfungsrelevante Studienleistung), module examinations/exams (Modulprüfung) or partial module examinations (Modulteilprüfung) in the form of written, oral or practical work (for details, see general examination regulations - Rahmenprüfungsordnung). The form of the examinations as well as the duration and number of pages are specified in this module handbook. The examination date will be announced at the beginning of the first course of the module. Students are obliged to take their first attempt either directly after the degree of the course or before the start of the next term (cf. examination regulations). An examination that is not graded as sufficient can be repeated twice. If the second retake is also not graded at least "sufficient" (4.0), the examination is deemed to have been definitively failed; a new retake of the same examination is generally excluded. If this happens with a compulsory module, the degree can no longer be achieved (see examination regulations). There is no entitlement to be offered a particular module or to participate in a particular module outside of the underlying examination regulations.

The headers of the following module descriptions contain information on the type (compulsory or compulsory elective module) and title of the module, the credit points (CP) to be earned (ECTS-

LP), the number of semester load, credit hours (SWS) and self-study time, the workload in hours (Std.) and the course cycle. The courses are differentiated according to lectures (V), laboratory exercises (LÜ), tutorials (Ü), internships (P), seminars (S) and final thesis (A). Section 2 describes the expected learning outcomes and the professional competences that students should acquire by the end of the degree programme and to the acquisition of which each module contributes in a specific way. Section 3 "Contents" contains a brief description of the main subjects of the courses.

This is followed by further information on frequency, individual course requirements, forms of examination, the language of instruction, literature, the teaching units involved and the module coordinators.

6. Module descriptions

6.1 Compulsory area

The compulsory area consists of the two practical modules "Research Project" (15 CP) and "Master's Thesis" (30 CP) as well as the compulsory module "Fundamentals of Material Science" (30 CP) (75 CP in total):

Practical module "Research Project" (15 ECTS-LP)

Module 1 - Research Project **03XX2401**						15 credit points (CP) Compulsory module			
Workload 450 hrs.			**Semester** from 2nd term (recommended)			**Duration** 1 term			
1	**Courses**				**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
	1.1	P	Research Project	3924011	Mandatory	0 SWS 0 hrs.	420 hrs.	1	14
	1.2	S	Seminar	3924012	Compulsory	1 SWS 15 hrs.	15 hrs.	5	1
2	**Learning outcomes / competences** **3924011 - Research Project**								

	The students • have the ability to work themselves into a scientific field in a given time under professional guidance; • they are able to reflect and classify the results into the status of knowledge and can document the results in English; • are able to achieve, adapt and apply scientific results; • improve their communication abilities and other social competences by means of teamwork, group discussions and presentations. **3924012 - Seminar (S)** The students • have the ability to work themselves into a scientific field in a given time under professional guidance; • they are able to reflect and classify the results into the status of knowledge and can document the results in English.
3	**Contents** **3924011 - Research Project (P)** • Knowing about scientific methods for acquiring, assessing and presenting knowledge • The project seminar offers insight into scientific work • Awareness of relevant questions of the subject • Awareness of relevant publications of the subject **3924012 - Seminar (S)** • Knowing about scientific methods for acquiring, assessing and presenting knowledge • The project seminar offers insight into scientific work. • Awareness of relevant questions of the subject • Awareness of relevant publications of the subject
4	**Frequency of the offer** every term **3924011 - Research Project (P)** every term **3924012 - Seminar (S)** every term
5	**Teaching language** **3924011 - Research Project (P)**

	German or English **3924012 - Seminar (S)** German or English
6	**Individual course requirements** None
7	**Forms of examination** Module exam Research Project Project work including term paper (Bericht) in English (written, duration 13 weeks, the number of pages of the term paper depends on the chosen task and is determined in discussion with the assessor) in accordance with the examination regulations.
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 15/120
10	**Module coordinator** Prof. Dr. Simone Mascotto
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3924011 - Research Project (P)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3924012 - Seminar (S)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature**

	Will be announced in the respective course
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) in a comparable form: M.Sc. Applied Natural Sciences (20193)
14	**Other information** (1) During the Master's programme, a research project must be completed. The aim of the research project is to work on a disciplinary topic under expert supervision and, as far as possible, independently within a specified period of time. The Research Project serves to deepen the study of scientific literature and to acquire theoretical and practical competences at the current level of a specialised field. It should provide insights into current scientific issues in the chosen field. It can be carried out in all research areas of the subjects involved in the study programme (chemistry or physics). Upon request, it can also be completed in industry or external research institutes, provided that a person authorised to examine in accordance with § 31 of the general examination regulations ("Rahmenprüfungsordnung") of the University of Koblenz takes on the supervision. (2) The candidate must be able to work independently under professional guidance within a specified period of time to familiarise themselves with a field, reflect on it, classify it according to the current state of knowledge and document the results in writing in English. Progress on the research project must be reported in a seminar. The candidate must provide evidence of this in a project paper written in English. (3) Registration for the Research Project usually takes place after completion of the first term. (4) Supervision of the Research Project is provided by a person from the group of persons authorised to examine in accordance with § 31 of the general examination regulations of the University of Koblenz ("Rahmenprüfungsordnung"). Research Projects carried out outside the university must be approved by the examination board before commencement. Upon request, the examination board may, in consultation with the programme coordinator, approve the completion of a research project in industry or at external research institutes, provided that the project sponsor declares in writing his or her willingness to evaluate the project work in accordance with paragraph 2. (5) The workload for the research project comprises 15 credit points (450 working hours). The period from the assignment of the topic to the candidate to the submission of the project work is 13 weeks. At the request of the candidate, the examination board may, in agreement with the supervisor, extend the processing time by a maximum of one month. The standard period of study must be observed. (6) The topic, task and number of pages of the project work must be limited by the supervisor in such a way that the deadline for completion can be met.

Practical module: "Master's Thesis" (30 ECTS-LP): Master's thesis (27 ECTS-LP) and final oral examination (3 ECTS-LP)

Module 02 **Master's thesis and final oral examination**								30 credit points (LP) Compulsory module
03XX2490 / 03XX2499								
Workload			**Semester**			**Duration**		
900 hrs.			4th term (recommended)			1 term		
1	**Courses**			**Compul-sory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
	A	Master thesis	03XX2490	Man-da-tory	0 SWS 0 hrs.	810 hrs.	1	27
	A	Final oral examina-tion	03XX2499	Man-da-tory	0 SWS 0 hrs.	90 hrs.	1	3

2 **Learning outcomes / competences**

03XX2490 - Master thesis (A)

The students

- can independently handle a scientific question under expert guidance
- master the principles of scientific working and publishing
- can write a paper about the results obtained.

03XX2499 - Final oral examination (A)

The students

- present the knowledge gained in a form appropriate to the subject
- defend the master`s thesis in a discussion
- master the principles of scientific work and presentation

3 **Contents**

03XX2490 - Master thesis (A)

The aim of the master's thesis is to show that candidates are able to work on a defined physics or chemistry problem by applying scientific methods within a set deadline. Here the means of the solution as well as the solution itself are to be presented and interpreted in an understandable and correct way.

	The master`s thesis can only be issued when the research project work has been completed successfully. The Examining Board may allow exceptions in special cases. The candidate must complete a subject-related topic within a set time frame. Candidates are expected to have the ability to largely independently deliver scientific results, to identify and solve any problems that arise, to critically evaluate and classify them according to their level of knowledge and in an appropriate manner appropriate to the subject form to document and to present the results in writing. **03XX2499 - Final oral examination (A)** The oral final exam completes the master's programme. The candidate must present and discuss the results of the master's thesis in the oral final exam in an appropriate manner.
4	**Frequency of the offer** every term **03XX2490 - Master thesis (A)** every term **03XX2499 - Final oral examination (A)** every term
5	**Teaching language** **03XX2490 - Master thesis (A)** German or English **03XX2499 - Final oral examination (A)** German or English
6	**Individual course requirements** **03XX2490 - Master thesis (A)** In accordance with § 5(4), admission to the Master's thesis is granted to those who 1. proves the provision of any additional credit points due to a lack of prior knowledge or credit points from previous studies in the amount of up to 30 in accordance with § 5(3) of the general examination regulations of the University of Koblenz (“Rahmenprüfungsordnung”), additionally 2. has acquired at least 83 LP. 3. has agreed the provisional topic for a Master's thesis with a supervisor. **03XX2499 - Final oral examination (A)** Passing the Master's thesis (03XX2490)
7	**Forms of examination**

	Master's thesis (Masterarbeit) in accordance with examination regulations (written - 20 weeks) The number of pages of the master´s thesis depends on the chosen task and is determined in discussion with the assessor. Final oral examination (Mündliche Abschlussprüfung, Kolloquium/Verteidigung) as final oral examination according to examination regulations. (oral - 30 min.)
8	**Requirements for the awarding of credit points** **03XX2490 - Master thesis (A)** Submission of the master's thesis to a reasonable extent in German or English after a processing period of 20 weeks. Passing the master's thesis in accordance with the examination regulations. **03XX2499 - Final oral examination (A)** Passing the final oral exam in accordance with the Examination Regulations.
9	**Importance of the grade for the final grade** 30/120
10	**Module coordinator** Prof. Dr. Simone Mascotto
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **03XX2490 - Master thesis (A)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **03XX2499 - Final oral examination (A)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the relevant working group or researched in the course of the work.
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)

14	**Other information** **03XX2490 - Master thesis (A)** The processing time for the master's thesis is 20 weeks. The master's thesis can be carried out in all areas of "Material Sciences" or, as well as in industry or external research institutes in Germany and abroad, as far as a supervisor does the supervision according to § 31 general examination regulations (“Rahmenprüfungsordnung” of the University of Koblenz).

Compulsory module "Fundamentals of Material Science" (30 ECTS-LP)

The compulsory module "Fundamentals of Material Science" (30 ECTS-LP) consists of modules from the Chemistry Department and Physics Department. From this, 5 out of 6 modules are to be taken (depending on the offer): Ceramic Materials (6 ECTS-LP), Sustainable Functional Materials (6 ECTS-LP), Polymer Chemistry and Natural Products Chemistry (6 ECTS-LP); Physics of Metals (6 ECTS-LP), Polymer Science (6 ECTS-LP) and Surface Science (6 ECTS-LP).

Module 03 - Sustainable Functional Materials

03CH2404

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	1st/2nd term (recommended)	2 terms

1 **Courses**

				Compulsory/ elective	**Contact time**	**Self-study**	**Planned Group size**	**LP**
3.1	V	Sustainable Synthesis and Processing of Materials	3324041	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
3.2	V	Materials for Energy Storage and Conversion	3324042	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competences**

3324041 - Sustainable Synthesis and Processing of Materials (V)

The students
- know basic ideas, fundamental principles and methods of solid state chemistry;

	• understand material production strategies and technologies on the basis of green chemistry descriptors; • are able to recognize, describe and elaborate sustainability aspects in different material fabrication procedures; • become familiar with the language of condensed matter and key theories and concepts. **3324042 - Materials for Energy Storage and Conversion (V)** The students • know basic ideas, fundamental principles and methods of defect chemistry and electrochemistry; • are able to recognize and describe structural and functional properties of materials and indicate their role in respective energy-related applications; • understand energy storage and conversion technologies and their underlying working principles; • become familiar with the language of electrochemistry and key theories and concepts.
3	**Contents** **3324041 - Sustainable Synthesis and Processing of Materials (V)** • Green chemistry synthesis methods of functional materials (e.g. hydrothermal synthesis) • Sintering and green sintering procedures • Raw materials • Recycling strategies • Net zero strategies in the chemical industry (e.g. CO_2footprint reduction) **3324042 - Materials for Energy Storage and Conversion (V)** • Concepts of solidstate electrochemistry (defect chemistry, ionic and electronic transport in solids) • Li- and post Li-ion batteries • Hydrogen storage materials • Fuel cells and power-to-X devices • Solar to fuel devices
4	**Frequency of the offer** **3324041 - Sustainable Synthesis and Processing of Materials (V)** every winter semester **3324042 - Materials for Energy Storage and Conversion (V)** every summer semester
5	**Teaching language** **3324041 - Sustainable Synthesis and Processing of Materials (V)** English **3324042 - Materials for Energy Storage and Conversion (V)**

	English
6	**Individual course requirements** None
7	**Forms of examination** Partial module examination: Sustainable Synthesis and Processing of Materials: Exam (Klausur) of 45 min. Partial module examination: Materials for Energy Storage and Conversion: Oral exam of 20 min
8	**Requirements for the awarding of credit points** Passing the partial module examinations **3324041 - Sustainable Synthesis and Processing of Materials (V)** Passing the partial module examination **3324042 - Materials for Energy Storage and Conversion (V)** Passing the partial module examination
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Prof. Dr. Simone Mascotto
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3324041 - Sustainable Synthesis and Processing of Materials (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3324042 - Materials for Energy Storage and Conversion (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)

14	**Other information**

Module 04 - Surface Science

03PH2503

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	1st/3rd term (recommended)	1 term

1 **Courses**

				Compulsory/ elective	**Contact time**	**Self-study**	**Planned Group size**	**LP**
4.1	V	Fundamentals of surface science	3525031	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
4.2	V	Applications and analytical methods of surface science	3525032	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competences**

3525031 - Fundamentals of Surface Science (V)

The students

- can explain the particular characteristics of surfaces and discuss related problems,
- know the basics of reaction kinetics and other phenomena on surfaces,
- are aware of the interactions with different states of matter and the importance of clean surfaces,
- are able to transfer their knowledge to experiments for specific tasks and develop their own experimental schemes.

3525032 - Applications and Analytical Methodologies of Surface Science (V)

The students

- can explain the basic concepts and ideas of vacuum,
- develop an understanding of the countervailing effects relevant to the realization of vacuum systems and are able to evaluate technical possibilities,
- are able to explain applications and trends in surface processing and can evaluate existing experimental setups,

	• are able to describe and analyze independently typical detection techniques in surface science and evaluate their limitations.
3	**Contents** **3525031 - Fundamentals of Surface Science (V)** • surface structure • Interactions of surfaces with matter • gas adsorption on surfaces • preparation of clean surfaces **3525032 - Applications and Analytical Methodologies of Surface Science (V)** • Physics behind vacuum technology • design of vacuum systems • deposition techniques and thin film growth • diffraction on surfaces and scattering methods • microscopy on surfaces • chemical surface analysis
4	**Frequency of the offer** winter term only **3525031 - Fundamentals of surface science (V)** winter term only **3525032 - Applications and analytical methods of surface science (V)** winter term only
5	**Teaching language** **3525031 - Fundamentals of Surface Science (V)** English **3525032 - Applications and Analytical Methodologies of Surface Science (V)** English
6	**Individual course requirements** none
7	**Type of examination** Module examination (Klausur) Surface Science (written - 90 min.)
8	**Requirements for the awarding of credit points** Passing the module examination
9	**Importance of the grade for the final grade**

	6/120
10	**Module coordinator** Dr. Wouter Jolie
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3525031 - Fundamentals of surface science (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3525032 - Applications and analytical methods of surface science (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective course
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20145) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Eng. Applied Physics (91) M.Sc. Mathematical Modeling of Complex Systems (20184) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20183) M.Sc. Mathematical Modeling, Simulation and Optimization (20194) M.Sc. Applied Natural Sciences (20193)
14	**Other information**

Module 05 - Polymer Science **03PH2505**						6 credit points (CP) Compulsory elective module
Workload 180 hrs.		**Semester** 2nd/3rd term (recommended)		**Duration** 2 terms		
1	**Courses**	**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**

	5.1	V	Polymer Physics	3525051	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
	5.2	V	Characterization and Application of Polymer Materials	3525052	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competences**

3525051 - Polymer Physics (V)

The students

- can independently explain basic models describing the properties of different types of polymers and in different states
- are able to understand how the peculiarities of the polymer structure such as connectivity affects their physical properties.
- develop on the basis of the covered basic concepts their own solving schemes
- are able to transfer the discussed basic concepts to actual, scientific topics in polymer science.

3525052 - Characterization and Application of Polymer Materials (V)

The students

- can independently explain the characterization and processing methods covered in this course
- can identify for the most important physical properties of polymer materials (3525051 Polymer Physics) the correct characterization methods and are aware of their technical realization
- they can give an overview over representative results for typical polymer systems and understand of which relevance these are for the processing and application of polymer materials
- are able to understand the environmental impact of polymeric materials and strategies for increasing sustainability of polymeric materials
- are able to transfer the discussed basic concepts to actual, scientific topics in polymer science

3 **Contents**

3525051 - Polymer Physics (V)
- Synthesis & molecular weight distributions
- Chain models
- Polymer solutions, polymer blends, block copolymers
- Semi-crystalline state
- Polymer dynamics & viscoelasticity
- Mechanical properties of polymers

3525052 - Characterization and Application of Polymer Materials (V)
- Determination of molecular weights
- Thermal characterization
- Mechanical testing
- Scattering methods
- Polymer processing

	• Environmental impact of polymers • Sustainability of polymeric materials, e.g. recycling, biopolymers etc.
4	**Frequency of the offer** from summer semester **3525051 - Polymer Physics (V)** only in the summer semester **3525052 - Characterization and Application of Polymer Materials (V)** only in the winter semester
5	**Teaching language** **3525051 - Polymer Physics (V)** English **3525052 - Characterization and Application of Polymer Materials (V)** English
6	**Individual course requirements** Knowledge from 3525051 Polymer Physics for 3525052 Characterization and Application of Polymer Materials
7	**Type of examination** Partial module examination (Klausur) 3525051: Polymer Physics as an exam (written - 45 min.) Partial module examination (Klausur) 3525052: Characterization and Application of Polymer Materials as exam (written - 45 min.)
8	**Requirements for the awarding of credit points** Passing the partial module examinations **3525051 - Polymer Physics (V)** Passing the partial module examination **3524032 - Characterization and Application of Polymer Materials (V)** Passing the partial module examination
9	**Importance of the grade for the final grade** 6/120

10	**Module coordinator** Prof. Dr. Silke Rathgeber
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3525051 - Polymer Physics (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3525052 - Characterization and Application of Polymer Materials (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20145) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Eng. Applied Physics (91) M.Sc. Mathematical Modeling of Complex Systems (20184) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20183) M.Sc. Mathematical Modeling, Simulation and Optimization (20194) M.Sc. Applied Natural Sciences (20193)
14	**Other information**

Module 06 - Physics of Metals

03PH2403

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	2nd/3rd term (recommended)	2 terms

1	**Courses**	**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**

	6.1	V	Physics of Metals 1	3524031	Man-da-tory	2 SWS 30 hrs.	60 hrs.	30	3
	6.2	V	Physics of Metals 2	3524032	Man-da-tory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competencies**

3524031 - Physics of Metals 1 (V)

The students

- know one-, two- and three-dimensional defects in metallic lattice structures
- are able to explain the physical properties of those defects
- understand and develop a model of the physical interaction between metallic defects and structural stresses
- can transfer their knowledge to technical behavior of different failure modes under static, cyclic and dynamic loads

3524032 - Physics of Metals 2 (V)

The students

- know binary systems of metals and can explain their thermodynamic derivation
- students know ternary systems
- develop a model for hardening effects in metallic structures
- can transfer their knowledge to real alloys and impurities

3 **Content**

3524031 - Physics of Metals 1 (V)
- Basics of metallic lattice structures
- Point defects and crystal dislocations
- Work hardening
- Fracture mechanics

3524032 - Physics of Metals 2 (V)
- Binary systems in metallurgy
- Ternary systems in metallurgy
- Solid solution hardening
- Precipitation hardening
- Time-Temperature-Transition Diagram and dilatrometric measurements

4 **Frequency of the programme**

from summer term

3524031 - Physics of Metals 1 (V)
summer term only

	3524032 - Physics of Metals 2 (V) winter term only
5	**Teaching language** **3524031 - Physics of Metals 1 (V)** English **3524032 - Physics of Metals 2 (V)** English
6	**Individual course requirements** none **3524032 - Physics of Metals 2 (V)** Finishing of curse 3524031 - Physics of Metals 1 (V)
7	**Type of examination** Partial module examination (Klausur) 3524031: Physics of Metals 1 (written - 45 min.) Partial module examination (Klausur) 3524032: Physics of Metals 2 (written - 45 min.)
8	**Requirements for the awarding of credit points** Passing the partial module examinations: 3524031 - Physics of Metals 1 (V) 3524032 - Physics of Metals 2 (V)
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Dr. Wouter Jolie
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3524031 - Physics of Metals 1 (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3524032 - Physics of Metals 2 (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics

12	**Literature** Will be announced in the relevant courses
13	**Use of the module (in other study programmes)** **M.Sc. Material Science (20242)** M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20145) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20183) M.Sc. Applied Natural Sciences (20193) M.Eng. Applied Physics (91)
14	**Other information**

Module 07 - Ceramic Materials

03CH2907

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	1st/2nd term (recommended)	2 terms

1

				Compulsory/ elective	**Contact time**	**Self-study**	**Planned Group size**	**LP**
7.1	V	Ceramic Materials - Materials Constitution and Design	3329071	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
7.2	V	Ceramic Materials - Properties of Advanced Ceramics	3329072	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competences**

3329071 - Ceramic Materials - Materials Constitution and Design (V)

The students

- get an understanding about different classes of ceramic materials and their related properties as well as their industrial application. Based on several industrial processes the advantages of using ceramic materials are demonstrated.

	3329072 - Ceramic Materials - Properties of Advanced Ceramics (V) The students • develop an understanding of design-properties- relations of ceramic materials based on design and composition of chosen raw materials. They see, that out of the group of so many different materials the so called best solutions are used due to the mineralogical constitution. Often ceramic materials are part of highly integrated materials solutions so that they own very specific properties inside of multi material devices.
3	**Contents** **3329071 - Ceramic Materials - Materials Constitution and Design (V)** • Different ceramics like oxides, nitrides, silicate ceramics, bio ceramics, glasses and refractories are explained in case studies. • The distinct processing technology to produce various ceramics are demonstrated to exemplify how the mineralogical composition and the production route influences the future field in later industrial use. **3329072 - Ceramic Materials - Properties of Advanced Ceramics (V)** Chemical properties (chemical analysis of composition, examination of reliability against chemical aggressive media, determination of compatibility inside heterogeneous systems), physical properties (thermal, mechanical, electrical, magnetic, optical properties) and mineralogical properties (different crystallographic constitution types, various raw materials categories, x-ray based experimental methods, microscopical techniques) - all with examples.
4	**Frequency of the offer** Every term **3329071 - Ceramic Materials - Materials Constitution and Design (V)** only in the winter term **3329072 - Ceramic Materials - Properties of Advanced Ceramics (V)** only in the summer term
5	**Teaching language** **3329071 - Ceramic Materials - Materials Constitution and Design (V)** English **3329072 - Ceramic Materials - Properties of Advanced Ceramics (V)** English
6	**Individual course requirements** none
7	**Type of examination**

	Partial module examination (Klausur) 3329071: Ceramic Materials - Materials Constitution and Design / written exam (duration - 45 min.) Partial module examination (Klausur)3329072: Ceramic Materials - Properties of Advanced Ceramics / written exam (duration - 45 min.)
8	**Requirements for the awarding of credit points** Passing the partial module examinations **3329071 - Ceramic Materials - Materials Constitution and Design (V)** successful passing of partial module examination **3329072 - Ceramic Materials - Properties of Advanced Ceramics (V)** successful passing of partial module examination
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Prof. Dr. Peter Quirmbach
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3329071 - Ceramic Materials - Materials Constitution and Design (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3329072 - Ceramic Materials - Properties of Advanced Ceramics (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 08 - Polymer Chemistry and Natural Products Chemistry

03CH2408

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	3rd term (recommended)	1 term

1

Courses				**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
8.1	V	Polymer chemistry	3324031	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
8.2	V	Natural products chemistry	3324082	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2

Learning outcomes / competences

3324031 - Polymer chemistry (V)

The students

- identify and distinguish between the most important classes of polymeric compounds.
- are able to present synthetic methods for specific polymers and explain their technological importance.
- know the most important analytical methods for the characterization of polymeric materials regarding their composition, their chemical structure and material properties.
- know about the technological use of polymers and know about actual trends in polymer chemistry.

3324082 - Natural products chemistry (V)

The students

- know the most important natural product classes and can present their occurrence and their physiological effects.
- know essential concepts for synthesis planning of complex molecules like e.g. retro-synthetic methods.
  Use their basic chemical knowledge from modules from bachelor courses to develop synthetic strategies for simple example molecules.

3

Contents

3324031 - Polymer chemistry (V)

- polymers in solution and in the solid state

	• semi-crystalline and amorphous polymers • polymer analytics • polymers as materials • step-growth and chain-growth polymerization • radical, ionic and catalytic polymerization • technical processes of polymerization and polymer modification • polymer degradation • actual trends in polymer chemistry 3324082 - Natural products chemistry (V) • Terpenes and steroids • Biogenic amines and alkaloids • Amino acids, peptides and proteins • carbohydrates • lipids • nucleosides, nucleotides and nucleic acids • antibiotics and chemotherapeutics
4	**Frequency of the offer** only in the winter semester **3324031 - Polymer chemistry (V)** only in the winter semester **3324082 - Natural products chemistry (V)** only in the winter semester
5	**Teaching language** **3324031 - Polymer chemistry (V)** English **3324082 - Natural products chemistry (V)** English
6	**Individual course requirements** **3324031 - Polymer chemistry (V)** The students possess sufficient knowledge of substance classes in organic chemistry and their typical reactivities.
7	**Type of examination** Module exam Polymer Chemistry and Natural Products Chemistry as exam (Klausur) (written - 90 min.)
8	**Requirements for the awarding of credit points** Passing the module exam

9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Prof. Dr. Wolfgang Imhof
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry 3324031 - Polymer chemistry (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry 3324082 - Natural products chemistry (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) M.Sc. Applied Natural Sciences (20193)
14	**Other information**

6.2 Compulsory elective module "Advances in Material Science" (45 ECTS-LP)

The compulsory elective module "Advances in Material Science" is divided into Germanand English-language modules amounting to 45 ECTS-LP. All students must take a cross-topic compulsory module "Recent Research Topics (03XX2405)" on current scientific issues. As part of the international orientation of the study programme, it is also important to ensure that students are qualified for the domestic job market. Learning the German language (and culture) is an important competence here. The offerings of the Interdisciplinary Career and Study Centre's (Interdisziplinäres Karriere- und Studienzentrum, IKaruS) Skills Academy make a contribution here as part of the "Language and Soft Skills for Material Science" module.

The compulsory elective module "Advances in Material Science" can be designed by selecting from the following modules: Thermochemical Modeling (6 ECTS-LP), Structure of Substances 1 (6 ECTS-LP); Structure of Substances 2 (6 ECTS-LP); Analytical Chemistry (7 ECTS-LP); Technical Chemistry (7 ECTS-LP); Biochemistry (7 ECTS-LP); Catalysis (7 ECTS-LP); Organic Synthetic Chemistry (7 ECTS-LP); Glass Materials (5 ECTS-LP); Physics of Matter (6 ECTS-LP), Applied Theoretical

Physics (6 ECTS-LP), Special Topics and Methodologies in Material Sciences 1 (3-6 ECTS-LP), Special Topics and Methodologies in Material Sciences 2 (3-6 ECTS-LP), Nuclear Medicine, Computed Tomography and X-ray Diagnostics (5 ECTS-LP), Mobility Module (5-30E CTS-LP), Language and Soft Skills for Material Science (1-3 ECTS-LP) and Special Topics and Methodologies in Computational Sciences (3-9 ECTS-LP).

The following modules are currently being considered by Koblenz University of Applied Sciences and the Faculty of Computer Sciences at the University of Koblenz for import into the module shells "Special Topics and Methodologies in Computational Sciences (3-9 ECTS-LP)" and "Special Topics and Methodologies in Material Sciences 1 and 2 (3-6 ECTS-LP each)": Laser spectroscopy and laser material analysis; Modern methods in high-resolution imaging; X-ray physics; Physical fundamentals of laser beam sources; Applied machine learning; Computer models for applied physics with Python; Artificial intelligence; Modern object-oriented programming; AI on embedded systems; Applied deep learning; Software engineering; Microcontroller technology; Statistics for scientists and engineers; Scientific data analysis (5 ECTS credits each).

Module 9 - Recent Research Topics

03XX2405

3 credit points (CP)
Compulsory module

Workload	**Semester**	**Duration**
90 hrs.	3rd term (recommended)	1 term

1

Courses				Compulsory/ elective	Contact time	Self-study	Planned Group size	LP
9.1	S	Recent Research Topics	3924031	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2

Learning outcomes / competences

3924031 - Recent Research Topics (S)

The students

- can collect, understand, assess and present information extracted from current publications in English
- are capable of participating in scientific discussions in English

3

Contents

3924031 - Recent Research Topics (S)

Current topics from lecture and research e.g.:
- Metallic materials

	• Ceramics • Glass • Plastic materials • Surfaces
4	**Frequency of the offer** Winter semester 3924031 - Recent Research Topics (S) Winter semester
5	**Teaching language** 3924031 - Recent Research Topics (S) English
6	**Individual course requirements** None
7	**Forms of examination** Module exam Recent Research Topics as a term paper (Hausarbeit) in the form of a presentation (written - 2 wo.) The number of pages of the term paper depends on the chosen task and is determined in discussion with the assessor. 3924031 - Recent Research Topics (S) Coursework (Studienleistung): Consultation on the work with the supervisor and trial presentation and participation in at least 8 seminars (compulsory attendance) (practical - 1 term)
8	**Requirements for the awarding of credit points** Passing the module examination. 3924031 - Recent Research Topics (S) Proof of participation in at least 8 seminar lectures.
9	**Importance of the grade for the final grade** 3/120
10	**Module coordinator** Prof. Dr. Peter Quirmbach

11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3924031 - Recent Research Topics (S) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 10 - Physics of Matter (EN) / Physik der Materie (DE)

6 credit points (CP)
Compulsory elective module

03PH2903

Compulsory elective courses in the field of solid state/material physics
Courses with a total of 6 CP must be taken.
Either the courses 3525011 and 3525012 (Solid State Physics, English) must be taken together.
or
Courses 3511081, 3511082 and 3529011 (Materials Physics, German) must be taken together.

Compulsory elective courses from the field of solid state/material physics
Courses with a total of 6 CP must be taken.
Either courses 3525011 and 3525012 (Solid State Physics, English) must be taken together
or
courses 3511081, 3511082 and 3529011 (Materials Physics, German) must be taken together.

10a Solid State Physics

6 credit points (CP)
compulsory elective module

03PH2501

Workload	term	**Duration**
180 hrs.	2nd term (recommended)	1 term

1

Courses				Compul-sory/ elective	Contact time	Self-study	Planned Group size	CP
10.1	V	Solid State Physics	3525011	Com-pul-sory	3 SWS 45 hrs.	75 hrs.	40	4
10.2	Ü	Solid State Physics	3525012	Com-pul-sory	1 SWS 15 hrs.	45 hrs.	40	2

2 Learning outcomes / competencies

3525011 - Solid State Physics (V)

The students

- know basic ideas, fundamental experiments and methods of solid state physics
- understand macroscopic material properties on the basis of microscopic interactions
- are able to describe different kinds of matter mathematically and can predict material properties, both electronic and thermal, in solids.
- become familiar with the language of condensed matter and key theories and concepts.

	3525012 - Solid State Physics (Ü) The students • have the ability to solve relevant problems quantitatively and know the mathematical terms and methodological in the field of solid state physics and can handle them confidently • broaden their analytical and problem-solving skills. • are able to acquire, adapt and apply current research results.
3	Content 3525011 - Solid State Physics (V) • crystal structure • binding mechanisms • mechanical, thermal and electronic properties • semi-conductors 3525012 - Solid State Physics (Ü) • crystal structure • binding mechanisms • mechanical, thermal and electronic properties • semi-conductors
4	Frequency of the programme summer term only 3525011 - Solid State Physics (V) summer term only 3525012 - Solid State Physics (Ü) summer term only
5	**Teaching language** 3525011 - Solid State Physics (V) English 3525012 - Solid State Physics (Ü) English
6	**Individual course requirements** none
7	**Examination forms** Module examination (Klausur) Solid State Physics (written - 90 min.)
8	**Requirements for the awarding of credit points**

	Passing the module examination.
9	Weighting of the grade for the final grade 6/120
10	**Module coordinator** Prof. Dr. Silke Rathgeber
11	**Responsible organization** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3525011 - Solid State Physics (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3525012 - Solid State Physics (Ü) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the relevant courses
13	**Use of the module (in other degree programs)** M.Sc. Material Science (20242) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Sc. Mathematical Modeling of Complex Sys- tems (20142) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Ma- terials (20145) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Eng. Applied Physics (91) M.Sc. Mathematical Modeling of Complex Systems (20184) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Ma- terials (20183) M.Sc. Mathematical Modeling, Simulation and Optimization (20194) M.Sc. Applied Natural Sciences (20193)
14	**Other information**

Or

10b Materials physics

03PH2901

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	2nd term (recommended)	1 term

1

Courses				Compul-sory/ elective	Contact time	Self-study	Planned Group size	LP
10.3	V	Solid state physics	3511081	Com-pul-sory	2 SWS 30 hrs.	45 hrs.	40	3
10.4	Ü	Solid state physics	3511082	Man-da-tory	1 SWS 15 hrs.	30 hrs.	40	1
10.5	V	Finite element method	3529011	Man-da-tory	2 SWS 30 hrs.	30 hrs.	40	2

2

Learning objectives and competences

3511081 - Solid State Physics (V)

The students

- have a sound and structured knowledge of solid state physics.
- acquire structured knowledge of the terms mentioned;
- have knowledge of the relevant core ideas and key experiments as well as the measurement methods and orders of magnitude of the central variables.
- understand macroscopic material properties on the basis of microscopic interactions
- are able to describe different types of matter mathematically and can predict electronic and thermal material properties in solids.

35110812- Solid State Physics (Ü)

The students

- have the ability to deal quantitatively with simple relevant problems and know the mathematical terms and methods in the field of solid state physics and can handle them confidently.
- can apply mathematical methods and formalisms to solve physical problems in the field of solid state physics.
- expand their analytical and problem-solving skills.

3529011 - Finite element method (V)

	The students • gain an insight into the virtual product development process and an overview of current simulation methods using the finite element method (FEM) in research and development for the academic and industrial environment.
3	**Contents** 3511081 - Solid State Physics (V) • Crystal structure; bonds; defects; phase diagrams and phase transitions; • Experimental methods and analytical techniques; • mechanical, thermal and electrical properties; • Dispersion relations and state densities; • Model concepts of conduction and resistance; • Semiconductor; 3511082 - Solid State Physics (Ü) • Crystal structure; bonds; defects; phase diagrams and phase transitions; • Experimental methods and analytical techniques; • mechanical, thermal and electrical properties; • Dispersion relations and state densities; • Model concepts of conduction and resistance; • Semiconductor; 3529011 - Finite Element Methodology (V) • Introduction to the finite element method; • Exemplary presentation of the potential of the FEM; • Illustration of the sequence of an FEM analysis (pre-processing, analysis, post-processing); • Introduction to the theory of elasticity; derivation of the mathematical principles for simple finite elements; application of bars and beams in 2D and 3D space; • Tutorials on applications using a computer-aided FE programme.
4	**Frequency of the offer** 3511081 - Solid State Physics (V) only in the summer semester 3511082 - Solid State Physics (Ü) only in the summer semester 3529011 - Finite element method (V) only in the summer semester
5	**Teaching language** 3511081 - Solid State Physics (V) German 3511082 - Solid State Physics (Ü) German

	3529011 - Finite element method (V) German
6	**Individual course requirements** None
7	**Forms of examination** Module exam Materials Physics: Exam (Klausur) of 90 min.
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Prof. Dr. Silke Rathgeber
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3511081 - Solid State Physics (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3511082 - Solid State Physics (Ü) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3529011 - Finite element method (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) M.Eng. Applied Physics (91) M. Eng. Ceramic Science and Engineering
14	**Other information**

Module 11 - Thermochemical Modelling

03CH2402

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	1st/2nd term (recommended)	2 terms

1

Courses				Compul-sory/ elective	Contact time	Self-study	Planned Group size	LP
11.1	V	Thermodynamics of condensed phases	3324021	Man-da-tory	2 SWS 30 hrs.	60 hrs.	30	3
11.2	Ü	Thermochemistry	3329081	Man-da-tory	2 SWS 30 hrs.	60 hrs.	30	3

2

Learning outcomes / competences

3324021 - Thermodynamics of condensed phases (V)

The students

- are capable of transforming chemical reaction processes to case-studies and to transfer energetic correlations to the conditions of real processing equipment in order to calculate and model the relations between chemical reactions and the correlations with the environment

3329081 - Thermochemistry (Ü)

The students

- shall be enabled to understand and handle by themselves the modeling tools from the sector of application of modern computer-aided processes (Computer Aided Thermochemistry CAT) as well as by using the software to learn about and present the necessary instruments to describe material changes depending on high temperatures

3

Contents

3324021 - Thermodynamics of condensed phases (V)
- basics of chemical thermodynamics and thermodynamics
- energetic consideration of heterogeneous chemical reactions

3329081 - Thermochemistry (Ü)
- Calculation of thermo-chemical correlations with the help of the Software FactSage 6.3
- Modeling of real engineering processes

4	**Frequency of the offer** Every term 3324021 - Thermodynamics of condensed phases (V) only in the winter term 3329081 - Thermochemistry (Ü) only in the summer term
5	**Teaching language** 3324021 - Thermodynamics of condensed phases (V) English 3329081 - Thermochemistry (Ü) English
6	**Individual course requirements** none
7	**Type of examination** Partial module examination Thermodynamics of condensed phases written exam (Klausur) (duration - 45 min.) Partial module examination Thermochemistry written exam (Klausur) (duration - 45 min.)
8	**Requirements for the awarding of credit points** passing of partial module exams 3324021 - Thermodynamics of condensed phases (V) successful passing of partial module exam 3329081 - Thermochemistry (Ü) successful passing of partial module exam
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** apl. Prof. Dr. Almuth Sax
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry

	3329071 - Ceramic Materials - Materials Constitution and Design (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry 3329072 - Ceramic Materials - Properties of Advanced Ceramics (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 12 - Applied Theoretical Physics

03PH2504

6 credit points (CP)
Compulsory elective module

Workload	**semester**	**Duration**
180 hrs.	1st/2nd term (recommended)	2 terms

1

Courses				Compul-sory/ elective	Contact time	Self-study	Planned Group size	LP
12.1	V	Applied Theoretical Physics 1	3525041	Man-da-tory	2 SWS 30 hrs.	60 hrs.	30	3
12.2	V	Applied Theoretical Physics 2	3525042	Man-da-tory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competencies**

3525041 - Applied Theoretical Physics 1 (V)

The students:

- can name various fields, where mathematical concepts of theoretical physics are important for the description of real world problems in nature and technology
- know the fundamental definitions, theorems and methods related to the application of theoretical physics

	• can analyze the assumptions related to the mathematical description for given systems • can apply mathematical methods to solve problems in theoretical physics • can evaluate suggested solutions, can modify existing solutions and develop own solving schemes 3525042 - Applied Theoretical Physics 2 (V) The students: • can name various fields, where advanced concepts of theoretical physics are important for the description of real world problems in nature and technology • know the fundamental definitions, theorems and methods related to the application of theoretical physics • can analyze - the assumptions related to the mathematical description for given systems • can apply mathematical methods to solve problems in -theoretical physics • can evaluate suggested solutions, can modify existing solutions and develop own solving schemes
3	**Content** 3525041 - Applied Theoretical Physics 1 (V) • mathematical concepts in theoretical physics • reaction-diffusion-systems • nonlinear physics • non-equilibrium physics • applications of theoretical physics in nature and technology 3525042 - Applied Theoretical Physics 2 (V) • advanced concepts in theoretical physics • advanced nonlinear physics • stochastic systems • discrete theoretical concepts in physics • applications of theoretical physics in nature and technology
4	**Frequency of the programme** from winter term 3525041 - Applied Theoretical Physics 1 (V) winter term only 3525042 - Applied Theoretical Physics 2 (V) summer term only
5	**Teaching language** 3525041 - Applied Theoretical Physics 1 (V) English 3525042 - Applied Theoretical Physics 2 (V) English

6	**Individual course requirements** none
7	**Type of examination** Partial module examination 3525041: Applied Theoretical Physics 1 (Klausur) (written - 45 min.) Partial module examination 3525042: Applied Theoretical Physics 2 (Klausur) (written - 45 min.)
8	**Requirements for the awarding of credit points** Passing the partial module examinations 3524041 - Applied Theoretical Physics 1 (V) 3524042 - Applied Theoretical Physics 2 (V)
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** apl. Prof. Dr. Björn Wolle
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3525041 - Applied Theoretical Physics 1 (V) Faculty 3 - Mathematics / Natural Sciences -> Mathematics Institute 3525042 - Applied Theoretical Physics 2 (V) Faculty 3 - Mathematics / Natural Sciences -> Mathematics Institute
12	**Literature** Will be announced in the relevant courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20145) M.Sc. Mathematical Modeling of Complex Systems (20142) M.Eng. Applied Physics (91) M.Sc. Mathematical Modeling of Complex Systems (20184)

	M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20183) M.Sc. Mathematical Modeling, Simulation and Optimization (20194) M.Sc. Applied Natural Sciences (20193)
14	**Other information**

Module 13 - Special Topics and Methodologies in Material Sciences 1

3-6 credit points (CP)
Compulsory elective module

03PH2413

Courses or modules from external accredited study programmes amounting to 3-6 ECTS-LP can be included in the module after prior consultation with the person responsible for the study programme.

Workload	**Semester**	**Duration**
90-180 hrs.	1st/2nd term (recommended)	1-2 terms

1 Courses

				Compulsory/ elective	Contact time	Self-study	Planned Group size	LP
13.1	V	Special topics and methods of materials science	3524131	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3
13.2	V	Special Topics and Methodologies in Material Sciences	3524132	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competences**

3524131 - Special Topics and Methodologies in Materials Science (V)

The students

- gain an insight into a field of current research in materials science

3524132 - Special Topics and Methodologies in Material Sciences (V)

The students

- have in-depth knowledge in material sciences

3 **Contents**

	3524131 - Special Topics and Methodologies in Materials Science (V) • Insight into an area of current research in materials science 3524132 - Special Topics and Methodologies in Material Sciences (V) • In-depth specialist knowledge in material sciences • English specialized terminology in material sciences
4	**Frequency of the offer** every term 3524131 - Special Topics and Methodologies in Materials Science (V) every term 3524132 - Special Topics and Methodologies in Material Sciences (V) every term
5	**Teaching language** 3524131 - Special Topics and Methodologies in Materials Science (V) German 3524132 - Special Topics and Methodologies in Material Sciences (V) English
6	**Individual course requirements** None
7	**Forms of examination** Module exam Special Topics and Methodological Methods in Material Sciences as exam (Klausur) (written - 90 min.)
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 3-6/120
10	**Module coordinator** Frau Prof. Dr. Silke Rathgeber
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3524131 - Special Topics and Methodologies in Materials Science (V)

	Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics 3524132 - Special Topics and Methodologies in Material Sciences (V) Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 14 - Analytical Chemistry

03CH2404

7 credit points (LP)
Compulsory elective module

Workload	**Semester**	**Duration**
210 hrs.	3rd/4th term (recommended)	2 terms

1 Courses

				Compulsory/ elective	Contact time	Self-study	Planned Group size	LP
14.1	V	Analytical Chemistry 1	3311085	Mandatory	2 SWS 30 hrs.	90 hrs.	80	4
14.2	V	Analytical Chemistry 2	3321102	Mandatory	2 SWS 30 hrs.	60 hrs.	80	3

2 **Learning outcomes / competences**

3311085 - Analytical Chemistry 1 (V)

The students

- have knowledge and understanding of important environmental chemical processes and environmental analytical methods and the underlying physico-chemical principles
- are able to critically assess analysis results
- know the basics and applications for the structural elucidation of organic compounds using selected spectroscopic methods

	3321102 - Analytical Chemistry 2 (V) The students • gain knowledge of the physical principles of selected methods in surface analysis and their possible applications • have knowledge of the basic principles of electron microscopy (SEM, TEM ...), scanning probe microscopy (STM, AFM ...), electron spectroscopy (PES, XPS, AES, EELS ...) and secondary ion mass spectrometry (SIMS) • have the ability to select methods for specific questions and to qualitatively and quantitatively evaluate the results obtained
3	**Contents** 3311085 - Analytical Chemistry 1 (V) • Qualitative and quantitative analysis, methods for sampling environmental samples, sample preparation procedures, chromatographic analysis procedures, quality assurance in analytical chemistry, evaluation of environmental analytical results, • Fundamentals of modern spectroscopic methods, applications of modern spectroscopic methods to selected groups of substances, derivation of structure-property relationships, structural information and structural models 3321102 - Analytical Chemistry 2 (V) • Surface analysis in ultra-high vacuum: fundamentals of electron spectroscopy, electron detectors for measuring photoelectron spectra, evaluation of XPS spectra, intensities, chemical shift Applications of XPS analysis in materials research • Overview of modern methods of surface and layer analysis: Mass spectroscopic methods in surface analysis, ion scattering, special methods of analysis on nanometer layers, examples of the application and performance of surface analytical methods • Methods of optical microscopy: scanning electron microscopy and EDX analysis, scanning probe microscopy and UHV surface analysis (XPS)
4	**Frequency of the offer** from winter semester 3311085 - Analytical Chemistry 1 (V) only in the winter semester 3321102 - Analytical Chemistry 2 (V) only in the summer semester
5	**Teaching language** 3311085 - Analytical Chemistry 1 (V) German 3321102 - Analytical Chemistry 2 (V) German

6	**Individual course requirements** None
7	**Forms of examination** Module exam Analytical Chemistry as exam (Klausur) or oral exam (mündlich) (only after consultation with the module coordinator; a binding determination and communication will take place at the latest at the beginning of the respective course) (written or oral - 90/20 min.)
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 7/120
10	**Module coordinator** Prof. Dr. Simone Mascotto
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3311085 - Analytical Chemistry 1 (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3321102 - Analytical Chemistry 2 (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** B.Sc. Applied Natural Sciences (20241) M.Sc. Material Science (20242) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20145)

	B.Sc. Applied Natural Sciences (20181) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20183)
14	**Other information**

Module 15 - Technical Chemistry

03CH2405

7 credit points (LP)
Compulsory elective module

Workload	**Semester**	**Duration**
210 hrs.	3rd/4th term (recommended)	2 terms

1

Courses				**Compul-sory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
15.1	V	Technical Chemistry 1	3311086	Man-da-tory	2 SWS 30 hrs.	90 hrs.	40	4
15.2	V	Technical Chemistry 2	3321103	Man-da-tory	2 SWS 30 hrs.	60 hrs.	40	3

2 **Learning outcomes / competences**

3311086 - Technical Chemistry 1 (V)

The students

- know structural description of solids (e.g. glass, ceramic, metal, alloy)
- have an understanding of the relationship between microscopic structure and macroscopic properties
- have knowledge of the relevance of the properties of solids for technical applications and processes in practice; knowledge of the fundamentals and practical implementation of chemical conversions on an industrial scale
- have the skills to describe chemical-industrial processes with their complex material and energetic interrelationships

3321103 - Technical Chemistry 2 (V)

The students

- can explain the physical, chemical and technological causes of corrosion processes
- know different types of corrosion and their critical boundary conditions

	• have knowledge of the laws governing corrosion processes • can illustrate corrosion processes using model materials as examples
3	**Contents** **3311086 - Technical Chemistry 1 (V)** • Operations with reaction and process engineering principles of chemical production processes as well as their project planning and optimization • Operation of chemical plants and plant safety • kinetic and thermodynamic principles of chemical reaction engineering; reactor models; chemical production processes **3321103 - Technical Chemistry 2 (V)** • Corrosion reactions on metallic and non-metallic materials, corrosion laws and kinetic descriptions, effect of corrosion on material and component resistance, behavior of material composites as a result of corrosion, effect of corrosion on other material properties, corrosion testing equipment and possibilities, modeling of corrosion processes
4	**Frequency of the offer** from winter semester **3311086 - Technical Chemistry 1 (V)** only in the summer semester **3321103 - Technical Chemistry 2 (V)** only in the winter semester
5	**Teaching language** **3311086 - Technical Chemistry 1 (V)** German **3321103 - Technical Chemistry 2 (V)** German
6	**Individual course requirements** None
7	**Forms of examination** Module exam Technical Chemistry as Written exam (Klausur) or oral exam (mündlich) (only after consultation with the module coordinator; a binding determination and communication will be made at the latest at the beginning of the respective course) (written or oral - 90/20 min.)

8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 7/120
10	**Module coordinator** Prof. Dr. Peter Quirmbach
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3311086 - Technical Chemistry 1 (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3321103 - Technical Chemistry 2 (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** B.Sc. Applied Natural Sciences (20241) M.Sc. Material Science (20242) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20145) B.Sc. Applied Natural Sciences (20181) M.Sc. Chemie und Physik funktionaler Materialien / Chemistry and Physics of functional Materials (20183)
14	**Other information**

Module 16 – Biochemistry **03CH2406**		7 credit points (LP Compulsory elective module
Work load	**Study semester**	**Duration**
210 hrs	2nd/3rd term (recommended)	2 terms

1	**Courses**				**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned group size**	**CP**
	16.1	V	Biochemistry	3327041	elective	2 SWS 30 hrs	60 hrs	30	4
	16.2	V	Bioanalytical and Clinical Chemistry	3327021	elective	2 SWS 30 hrs	60 hrs	30	3

2 **Learning outcomes / competences**

3327041– Biochemistry (V)

The students

- are able to understand and reproduce biochemical questions on a molecular basis;
- learned the basic structures and pathways in biochemistry and the key organic reactions and reaction mechanisms of relevance for understanding how some biochemical processes work on a chemical basis;
- have a deepened understanding on regulatory processes and mechanisms of hormonal communication and signal transduction.

3327021– Bioanalytical and Clinical Chemistry (V)

The students

- learned about modern techniques in biochemistry and bioanalytics;
- gained knowledge about structure-based drug design (including bioinformatic approaches);
- are able to select theoretically suitable separation and analysis methods for biomolecules in order to characterise compounds from complex matrices.
- know about laboratory and diagnostic techniques for the detection and measurement of biochemical changes in diseases and learn opportunities and limitations associated with these laboratory techniques
- are able to interpret clinical chemistry laboratory tests.

3 **Contents**

3327041 – Biochemistry (V)

- The lecture will include knowledge about biosynthesis as well as degradation pathways of biomolecules in the human organism (metabolism), and the molecular basics of intra- and intercellular signalling;
- The lecture will present regulatory mechanisms of signalling and signal processing in terms of hormones, hormone receptors, hormonal regulation, signal transduction, membrane receptors, kinase cascades, intracellular linkage of signal pathways (crosstalk), transcription regulation, covalent modification of signal proteins and transcription factors;
- Selected present scientific problems and research trends in biochemistry, especially with respect to the research on pathophysiological conditions (development of diseases) will be addressed.

3327021– Bioanalytical and Clinical Chemistry (V)

	• main strategies and methods of analytical biochemistry and clinical chemistry as, for example, sequencing of DNA and proteins, peptide and protein analytics, structural analysis of proteins, qualitative and quantitative description of protein-protein/ligand interactions and the use of data bases will be addressed; • focus in clinical chemistry will be laid on hematology and respective application areas • modern techniques such as biosensing and imaging as well as concepts of „omics" technologies will be addressed as well • the basics of clinical chemistry and laboratory testing • the pathobiochemical and pathophysical alterations present in exemplary diseases and the selection of biomarkers
4	**Frequency of the course** only summer semester **3327041– Biochemistry (V)** only summer semester **3327021– Bioanalytical and Clinical Chemistry (V)** only winter semester
5	**Teaching language** **3327041– Biochemistry (V)** English **3327021– Bioanalytical and Clinical Chemistry (V)** English
6	**Requirements for participation** none
7	**Types of examination** Module examination (Modulprüfung): written exam (Klausur) (90 min)
8	**Requirements for the awarding of credit points** passing the written exam

Module 17 - Catalysis

03CH2417

7 credit points (LP)
Compulsory elective module

Workload	**Semester**	**Duration**
210 hrs.	2nd term (recommended)	1 term

1

Courses				**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
17.1	V	Biocatalysis	3327042	elective	2 SWS 30 hrs.	60 hrs.	30	3
17.2	V	Transition metal catalysis	3321123	elective	2 SWS 30 hrs.	90 hrs.	30	4

2

Learning outcomes / competences

3327042– Biocatalysis (V)

The students

- are able to mechanistically interpret catalytical reactions and understand the respective modes of action on a molecular level;
- understand thermodynamic and kinetic implications of the use of catalysts;
- understand the basic principles and differences of organocatalysis, biocatalysis and enzyme catalysis;
- are able to discuss selected examples of enzymes as target structures with respect to strategies and possibilities of intervention if biochemical processes are misdirected (therapeutical potential);
- learned how to implement biocatalysis into organic synthetic and biotechnological applications

3321123 – Transition Metal Catalysis (V)

Students

- understand the basic principles of catalysis and can comparatively assess homogeneous and heterogeneous catalytic systems with regard to mechanism, selectivity and application;
- have a sound command of the coordination chemistry concepts and elementary steps underlying organometallic catalytic cycles;
- are familiar with major industrial applications of homogeneous and heterogeneous catalysis and can evaluate their mechanistic, kinetic and economic aspects;
- can select, design and compare suitable catalyst systems for a given catalytic objective and explain modern synthesis and characterization methods;
- understand the role of catalysis in environmentally relevant processes (e.g. pollutant degradation, sustainable synthetic chemistry) and can assess its significance for society.

3	**Contents** **3327042– Biocatalysis (V)** • The lecture will present topics related to catalytic chemistry in the area of basic principles of catalysis, organocatalysis, biocatalysis and enzymology (enzyme properties and structure, classification, mechanisms, chemistry of enzyme cofactors); • The role of catalytic reactions in connection with a more sustainable chemistry will be presented; • The application of enzymes in organic synthesis, biotechnology, and synthetic biology will be highlighted (including engineering of desired enzyme functions). **3321123 – Transition Metal Catalysis (V)** • Fundamentals and significance of catalysis; comparison of homogeneous, heterogeneous and enzyme catalysis • Thermodynamic and kinetic concepts: selectivity, activity, stability • Coordination chemistry and ligand design: complexes, d orbitals, 18-electron rule • Elementary steps of catalytic cycles: oxidative addition, reductive elimination, insertion, migration • Industrial applications of homogeneous catalysis: cross-coupling reactions (Suzuki, Heck, Negishi), hydrogenation, hydroformylation, olefin metathesis, polymerization (Ziegler–Natta and metallocene catalysts) • Types and structure of heterogeneous catalysts: metal nanoparticles, oxides, supported systems, MOFs • Kinetic mechanisms of heterogeneous catalysis: Langmuir–Hinshelwood, Eley–Rideal, Mars–van Krevelen • Environmental catalysis (exhaust gas aftertreatment, CO_2 conversion); synthesis strategies and characterization of heterogeneous catalysts (sol–gel, impregnation, XRD, XPS, TEM, operando spectroscopy)
4	**Frequency of the offer** only in the summer semester **3327042– Biocatalysis (V)** only in the summer semester **3321123 - Transition Metal Catalysis (V)** only in the summer semester
5	**Teaching language** **3327042– Biocatalysis (V)** English **3321123 – Transition Metal Catalysis (V)** English
6	**Individual course requirements**

	None
7	**Forms of examination** Module exam Catalysis as individual exam (mündlich, Einzelprüfung) (oral - 20 min.)
8	**Requirements for the awarding of credit points** Passing the module examination
9	**Importance of the grade for the final grade** 7/120
10	**Module coordinator** Prof. Dr. Simone Mascotto
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3327042– Biocatalysis (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3321123 – Transition Metal Catalysis (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Ed. Lehramt Chemie – Gym 20103-2 M.Sc. Material Science (20242)
14	**Other information**

Module 18 - Organic synthesis chemistry **03CH2418**		3 credit points (CP) Compulsory elective module
Workload 90 hrs.	**Semester** 1 term (recommended)	**Duration** 1 term

1	**Courses**				**Com-pul-sory/ elec-tive**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
	18.1	V	Chemistry of het-erocycles	3321114	elec-tive	2 SWS 30 hrs.	60hou rs	30	3
2	**Learning outcomes / competences** **3321114 - Chemistry of Heterocycles (V)** The students • can recognize the most important classes of heterocyclic compounds on the basis of their molecular structure and correctly apply the nomenclature of heterocycles • are able to explain synthetic processes for the generation of heterocycles and can make statements about the reactivity of the compounds based on the molecular structure								
3	**Contents** **3321114 - Chemistry of Heterocycles (V))** • Knowledge of the structure and reactivity of the most important classes of heterocyclic compounds • Influence of heteroatoms on the reactivity of the compounds compared to pure carbocyclic substances • typical synthesis routes to the various heterocycles • Use of heterocyclic compounds in technical and pharmaceutical applications								
4	**Frequency of the offer** **3321114 - Chemistry of Heterocycles (V)** only in the winter semester								
5	**Teaching language** **3321114 - Chemistry of Heterocycles (V)** German								
6	**Individual course requirements** none								
7	**Forms of examination**								

	Module exam: Exam (written) (Klausur) (duration 90 min)
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 3/120
10	**Module coordinator** Prof. Dr. Wolfgang Imhof
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3321114 - Chemistry of Heterocycles (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Ed. Lehramt Chemie Gym
14	**Other information**

Module 19 - Glass materials **GLASS**		5 credit points (CP) Compulsory elective module
Workload	**Semester**	**Duration**

150 hrs.			1 term (recommended)			2 terms			
1	**Courses**				**Com-pul-sory/ elec-tive**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
	19.1	V	Glass materials	GLASS	Man-da-tory	4 SWS 60 hrs.	90 hrs.	unlim-ited	5
2	**Learning outcomes / competences** After this module, students will have basic knowledge in the following areas: • Specialist knowledge of glass materials, fields of application and manufacturing processes, refractory building materials in contact with molten glass • Basics of glass structure knowledge on material design / application goals Subject-related competences: The students are able to: • develop application-related aspects Methodological competences: The students are able to: • Apply academic forms of work • present content orally, argue and lead discussions on economic issues Interdisciplinary competencies: The students are able to: • Develop new solution concepts in a structured manner; • Select alternative solution concepts; • Evaluate these alternative solution concepts; • Work on tasks independently; • Actively participate in teams; • to further develop their cooperation and conflict resolution skills; • Acting on your own responsibility									
3	**Contents** Technology and refractory building materials in contact with glass • Basic knowledge of the structure and function of glass tanks • Relevant product groups and special features (construction glass, commercial glass, technical glass, glass ceramics) • Fused cast materials: Production, properties, areas of application in glass production • Corrosion mechanisms in the case of glass contact: Significance of the different types of convection								

	• Corrosion mechanisms in the superstructure / regenerator: reactions caused by dust and evaporation products (e.g. silica corrosion) Fundamentals of glass chemistry and materials • Selected relevant product groups (automotive glazing, tubular glass, glass fibers, solar glass) • Mixture reactions and basics • Eutectic and peritectic melts in ternary systems • Phase balance when cooling melts • Quantitative determination of batches for the targeted development of glass materials • Ion effect in melting phases, glass phases and silicate materials • Silicate chemical basics • Comparative field strength as a tendency in the interpretation of physical-chemical parameters and in the formation of structure- and phase-related material properties • Silicate and glass formation (Dietzel's field strength theory) • Viscosity and surface tension of silicate melts • Reversible thermal expansion in binary and ternary glasses • Knowledge of the microstructural and chemical composition of glasses (basic glass formation, phase separation) • The effectiveness of the strategies is explained using selected examples of the synthesis of natural substances and active pharmaceutical ingredients.
4	**Frequency of the offer** only in the summer semester
5	**Teaching language** German
6	**Individual course requirements** none
7	**Forms of examination** Module exam: Written exam (Klausur) (duration 90 min)
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 5/120

10	**Module coordinator** Prof. Dr. Pacal Seffern
11	**Responsible institution** Koblenz University of Applied Sciences --> Faculty of Building Arts and Materials, Materials Engineering Glass and Ceramics
12	**Literature** • Vogel, W., Glaschemie 3rd edition, Springer, Berlin, 1992 • Nölle, G.: Technik der Glasherstellung, Deutscher Verlag für Grundstoffindustrie, Leipzig, 1977 • Höland, W., Glaskeramik, vdf Hochschulverlags AG ETH Zurich, 2006 • Scholze, H., Glass - Nature, Structure and Properties, 3rd ed., Springer, Berlin, 1988 • Feltz, A., Amorphous Inorganic Materials and Glasses, VCH, Weinheim, 1993 • Lohmeyer, S. Werkstoff Glas I - III, expert verlag, Renningen, 2001 • J. Zarzycki (ed.), Materials Science and Technology. A Comprehensive Treatment. Vol. 9: • Glasses and Amorphous Materials, VCH, Cambridge, 1991
13	**Use of the module (in other study programmes)** M. Eng. Ceramic Science and Engineering
14	**Other information**

Module 20 - Structure of Substances 1

03CH2420

6 credit points (CP)
Compulsory elective module

Workload	semester	**Duration**
180 hrs.	1st term (recommended)	1 term

1

				Compulsory/ elective	**Contact time**	**Self-study**	**Planned Group size**	**LP**
Courses								
20.1	V	Modeling of crystalline and organic substances	3324201	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
20.2	V	Data analysis and interpretation	3324202	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2	**Learning outcomes / competences** **3324201 - Modeling of crystalline and organic substances (V)** The students • Are able to represent simple three-dimensional structures of crystalline or organic compounds using suitable software • Have an overview of various software solutions for modeling chemical and mineralogical structures • Have basic knowledge of transforming analytical information into chemical and mineralogical structures **3324201 - Data analysis and interpretation (V)** The students • Gain knowledge in the evaluation of different analytical measurement methods using practical examples • Gain insight and access to modern database-based evaluation software packages • Learn the handling and interpretation of measured data as well as the correct classification of the measured results into the scientific context Learn strategies for the correct assignment of specific phases in complex phase mixtures
3	**Contents** **3324201 - Modeling of crystalline and organic substances (V)** • Introduction to different software solutions for the visualization of chemical and mineralogical structures • Interpretation of X-ray spectra • Deepening with crystal structures / crystal lattices **3324201 - Data analysis and interpretation (V)** • Use of various software based systems for the evaluation of spectroscopic methodologies (UV-Vis, IR, Raman, NMR, MS) • Correct phase assignments from combining results of different measurement data Classification of the evaluated results in the scientific context
4	**Frequency of the offer** only in the winter semester **3324201 - Modeling of crystalline and organic substances (V)** only in the winter semester **3324202 - Data analysis and interpretation (V)** only in the winter semester
5	**Teaching language** **3324201 - Modeling of crystalline and organic substances (V)**

	English **3324202 - Data analysis and interpretation (V)** English
6	**Individual course requirements** none
7	**Type of examination** Partial module exam Modeling of crystalline and organic substances written exam (Klausur) (duration - 45 min.) Partial module exam Data analysis and interpretation written exam (Klausur) (duration - 45 min.)
8	**Requirements for the awarding of credit points** Passing the module examinations **3324201 - Modeling of crystalline and organic substance** successful passing of partial module exam **3324201 - Data analysis and interpretation (V)** successful passing of partial module exam
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Mrs. Dr. Vanessa Hopp
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3324201 - Modeling of crystalline and organic substance** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3324201 - Data analysis and interpretation (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)**

	M.Sc. Material Science (20242)
14	**Other information**

Module 21 - Structure of Substances 2

03CH2421

6 credit points (CP)
Compulsory elective module

Workload	**Semester**	**Duration**
180 hrs.	2nd term (recommended)	1 term

1 **Courses**

				Compul-sory/ elective	**Contact time**	**Self-study**	**Planned Group size**	**LP**
20.1	V	Experimental Design	3324211	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3
20.2	V	Computational Chemistry	3324212	Mandatory	2 SWS 30 hrs.	60 hrs.	30	3

2 **Learning outcomes / competences**

3324211 - Experimental Design (V)

The students

- are able to select their own forms of experimentation to answer specific research questions
- develop simple experimental designs with software support
- know the basics of good academic work
- have basic knowledge of the procedure for statistical experimental design
- know the importance of targeted experimental design for the quality of research results

3324211 - Computational Chemistry (V)

The students

- learn the basics and concepts of computational calculations of chemical structures (single-point energy, geometry optimization) based on different theoretical methods depending on structure sizes of the system (ab initio / DFT / MD / MC calculations)
- will learn to work with different software packages to perform small-size calculations on their own devices
- will be able to predict spectroscopic properties of phases based on structural data

3	**Contents** **3324211 - Experimental Design (V)** • Strategies for selecting suitable experiments and planning experiments • Introduction to the software for statistical design of experiments • Tutorials on experimental design using case studies **3324211 - Computational Chemistry (V)** • Concept of computational chemistry and computational materials engineering • First principle methods (ab initio) based on quantum mechanical concept • Density functional theory (DFT) for larger systems • Molecular dynamics (MD) calculations based on classical mechanism for atomic movements • Monte Carlo (MC) simulations based on statistical mechanisms
4	**Frequency of the offer** only in the summer semester **3324211 - Experimental Design (V)** only in the summer semester **3324211 - Computational Chemistry (V)** only in the summer semester
5	**Teaching language** **3324211 - Experimental Design (V)** English **3324211 - Computational Chemistry (V)** English
6	**Individual course requirements** none
7	**Type of examination** Partial module exam Experimental Design written exam (Klausur) (duration - 45 min.) Partial module exam Computational Chemistry written exam (Klausur) (duration - 45 min.)
8	**Requirements for the awarding of credit points** Passing the module examinations **3324211 - Experimental Design (V)** successful passing of partial module exam **3324211 - Computational Chemistry (V)**

	successful passing of partial module exam
9	**Importance of the grade for the final grade** 6/120
10	**Module coordinator** Dr. Ali Masoudi Alavi
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3324211 - Experimental Design (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry **3324211 - Computational Chemistry (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Chemistry
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 22 - Mobility Module

5-30 credit points (LP)
Compulsory elective module

03XX2422

As part of the mobility module, courses or modules from external accredited study programmes amounting to 5-30 ECTS-LP can be included after prior consultation with the study programme coordinators.

Workload	**Semester**	**Duration**
150-900 hrs.	3rd-4th term (recommended)	1-2 terms

1	**Courses**	**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**

	22.1	V	Applied Natural Sciences mobility module	3924221	Duty to vote	--	--	--	--
	22.2	V	Mobility Module Material Science	3924222	Duty to vote	--	--	--	--

2 **Learning outcomes / competences**

3924221 - Mobility Module Applied Natural Sciences (V)

Students gain an insight into an area of current research at foreign institutions.

3924222 - Mobility Module Material Science (V)

The students gain an insight into an area of current research at recognized institutions.

3 **Contents**

3924221 - Mobility Module Applied Natural Sciences (V)

- As part of the mobility module, courses or modules from external accredited study programmes amounting to 5-30 ECTS-LP can be included after prior consultation with the study programme coordinators.

3924222 - Mobility Module Material Science (V)

- Within the framework of the mobility module, courses or modules from externally accredited degree programmes amounting to 5-30 ECTS-LP can be included after prior consultation with the programme directors.

4 **Frequency of the offer**

Every term

3924221 - Mobility Module Applied Natural Sciences (V)

Every term

3924222 - Mobility Module Material Science (V)

Every term

5 **Teaching language**

3924221 - Mobility Module Applied Natural Sciences (V)

German

3924222 - Mobility Module Material Science (V)

German or English

6 **Individual course requirements**

	None
7	**Forms of examination** in accordance with the external examination regulations
8	**Requirements for the awarding of credit points** in accordance with the external examination regulations
9	**Importance of the grade for the final grade** 5-30/120
10	**Module coordinator** Prof. Dr. Simone Mascotto
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences **3924221 - Mobility Module Applied Natural Sciences (V)** Faculty 3 - Mathematics / Natural Sciences **3924222 - Mobility Module Material Science (V)** Faculty 3 - Mathematics / Natural Sciences
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 23 - Language and Soft Skills for Material Science

1-3 credit points (LP)
Compulsory elective module

The module concludes without a module exam in accordance with of the examination regulations.

Workload	**Semester**	**Duration**
30-90 hrs.	1st-5th term (recommended)	1-5 terms

1

Courses		**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
53.1	Selection from the Skills Academy range	Elective	Varies depending on the course		20	1-3

2 **Learning outcomes / competences**

The students

- hone or further develop their individual study profile by choosing university or practical courses that make sense for them;
- take responsibility for their own learning and development processes and align their professional development with their future professional field by using the key competence and language course offerings.

3 **Contents**

Interdisciplinary Career and Study Centre (Interdisziplinäres Karriere- und Studienzentrum, IKaruS) offers various modules as part of the Skills Academy, e.g. in the areas of Digital Skills, Language Skills, Professional Skills, Social Skills and Study Skills.

Within the modules, three components (workshops or self-study courses) must be taken, which together provide 1 ECTS-LP. If a language course is taken during the semester, 2 (language courses that are not German as a foreign language) or 3 (only German as a foreign language) ECTS-LP can be earned.

4 **Frequency of the offer**

Every term

5 **Teaching language**

see description of the Interdisciplinary Career and Study Centre (Interdisziplinäres Karriere- und Studienzentrum, IKaruS)

6 **Individual course requirements**

None

7 **Forms of examination**

The module concludes without a module exam.

8 **Requirements for the awarding of credit points**

The generally group-based methodological-practical and professional field-oriented orientation of the workshops (2.) may require attendance (cf. the examination regulations).

9	**Importance of the grade for the final grade** In accordance with the examination regulations, the grade of the final module examination is not weighted in the education of the overall grade.
10	**Module coordinator** Interdisciplinary Career and Study Centre (Interdisziplinäres Karriere- und Studienzentrum, IKaruS)
11	**Responsible institution** Interdisciplinary Career and Study Centre (Interdisziplinäres Karriere- und Studienzentrum, IKaruS)
12	**Literature** The relevant literature and any other media used will be announced in the context of the respective course.
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242) In principle, the Interdisciplinary Career and Study Centre (Interdisziplinäres Karriere- und Studienzentrum, IKaruS) is open to all study programmes at the university.
14	**Other information** The courses do not necessarily all have to be completed in one semester, as the modules are offered every term, sometimes with different topics, sometimes with recurring and changing topics. However, it is recommended to complete a module in two terms if possible.

Module 24 - Special Topics and Methods in Computational Sciences

03IN2424

3-9 credit points (CP)
Compulsory elective module

Courses or modules from external accredited study programs amounting to 3-9 ECTS-LP can be included in the module after prior consultation with the study programme coordinators.

Workload	**Semester**	**Duration**
90-270 hrs.	4th/5th term (recommended)	1-2 terms

1

Courses				**Compulsory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**
24.1	V	Special topics and methodological approaches in computer science	4514491	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3
24.2	V	Special topics and methodological approaches in computer science	4514491	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3
24.3	V	Special Topics and Methods in Computational Sciences	4514491	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3

2	**Learning outcomes / competences** **4514491 - Special Topics and Methods in Computer Science (V)** The students • gain insight into an area of current research in computer science **4514492 - Special Topics and Methods in Computational Sciences (V)** The students • have in-depth knowledge of computational sciences
3	**Contents** **4514491 - Special Topics and Methods in Computer Science (V)** • Insight into an area of current research in computer science **4514492 - Special Topics and Methods in Computational Sciences (V)** • In-depth knowledge of computational sciences • English specialized terminology of Computational Sciences
4	**Frequency of the offer** every term **4514491 - Special Topics and Methods in Computer Science (V)** every term **4514492 - Special Topics and Methods in Computational Sciences (V)** every term
5	**Teaching language** **4514491 - Special Topics and Methods in Computer Science (V)** German **4514492 - Special Topics and Methods in Computational Sciences (V)** English
6	**Individual course requirements** None
7	**Forms of examination** Module exam Special Topics and Methods in Computational Sciences as exam (Klausur) (written - 90 min.)

8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 3-9/120
10	**Module coordinator** N.N.
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **4514491 - Special Topics and Methodologies in Computer Science (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **4514492 - Special Topics and Methodologies in Computational Sciences (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 25 - Special Topics and Methods in Material Sciences 2

3-6 credit points (CP)
Compulsory elective module

03PH2425

a) Courses or modules from external accredited study programmes amounting to 3-6 ECTS-LP can be included in the module after prior consultation with the study programme coordinators.

Workload	**Semester**	**Duration**
90-180 hrs.	1st/2nd term (recommended)	1-2 terms

1	**Courses**	**Compul-sory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**LP**

	25.1	V	Special topics and methods of materials science	3524251	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3
	25.2	V	Special Topics and Methods in Material Sciences	3524252	Duty to vote	2 SWS 30 hrs.	60 hrs.	30	3

2	**Learning outcomes / competences** **3524251 - Special Topics and Methods in Materials Science (V)** The students • gain an insight into a field of current research in materials science **3524252 - Special Topics and Methods in Material Sciences (V)** The students • have in-depth knowledge in material sciences
3	**Contents** **3524251 - Special Topics and Methods in Materials Science (V)** • Insight into an area of current research in materials science **3524252 - Special Topics and Methods in Material Sciences (V)** • In-depth specialist knowledge in material sciences • English specialized terminology in material sciences
4	**Frequency of the offer** every term **3524251 - Special Topics and Methods in Materials Science (V)** every term **3524252 - Special Topics and Methods in Material Sciences (V)** every term
5	**Teaching language** **3524251 - Special Topics and Methods in Materials Science (V)** German **3524252 - Special Topics and Methods in Material Sciences (V)** English
6	**Individual course requirements**

	None
7	**Forms of examination** Module exam Special Topics and Methods in Material Sciences as exam (Klausur) (written - 90 min.)
8	**Requirements for the awarding of credit points** Passing the module exam
9	**Importance of the grade for the final grade** 3-6/120
10	**Module coordinator** Frau Prof. Dr. Silke Rathgeber
11	**Responsible institution** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3524251 - Special Topics and Methodologies in Materials Science (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3524252 - Special Topics and Methodologies in Material Sciences (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature** Will be announced in the respective courses
13	**Use of the module (in other study programmes)** M.Sc. Material Science (20242)
14	**Other information**

Module 26 - Nuclear medicine, computed tomography and X-ray diagnostics 03PH2413		5 credit points (CP) Compulsory elective module
Workload 150 hrs.	term 2nd term (summer term)	**Duration** 1 term

1	**Courses**				**Compul-sory/ elective**	**Contact time**	**Self-study**	**Planned Group size**	**CP**
	13.1	V+P	Nuclear medicine, computer tomography and X-ray diagnostics	3524131	Compulsory	2 SWS 30 hrs. +2 SWS 30 hrs.	90 hrs.	30	5

2 **Learning outcomes / competences**

3524131 - Nuclear medicine, computed tomography and X-ray diagnostics (V+P)

Students are able to transfer theoretical knowledge of physics to a specific application and medical problem. Students expand and consolidate their knowledge and understanding of medical physics in the field of nuclear medicine and X-ray diagnostics and further deepen their knowledge of computed tomography. They will be able to explain how multimodal devices (SPECT/CT, PET/CT, PET/MRI) work and evaluate their advantages and disadvantages. They learn the practical implementation of 3D image reconstruction procedures in computed tomography. Students will be familiar with the IT systems used in nuclear medicine and X-ray diagnostics as well as the basics of clinic management.

3 **Contents**

3524131 - Nuclear medicine, computed tomography and X-ray diagnostics (V+P)

- Different detector types and different approaches to spatially resolved photon detection for nuclear medicine imaging and for X-ray imaging; physics and technology of the gamma camera, single photon emission computed tomography (SPECT), positron emission tomography (PET); reconstruction and correction methods of PET and SPECT; computed tomography: image reconstruction for fan beam geometry; spiral CT; DVT; dual energy CT; multimodal devices (e.g. SPECT/CT, PET/CT); interventional radiology and other special procedures; teleradiology; the most important applications of nuclear medical imaging, computed tomography and X-ray diagnostics; methods and procedures for dosimetry for nuclear medical therapy and diagnostics, for X-ray imaging and computed tomography; Fundamentals of radiation protection, standardization, other recommendations for X-ray diagnostics, computed tomography and nuclear medicine; radiation protection for patients; diagnostic reference values; official procedures and inspections, reporting obligations. In-depth: IT systems, image archiving and data exchange in nuclear medicine and X-ray diagnostics: storage obligations; international standards and data formats (DICOM, HL7); clinic management: PACS, HIS, RIS and electronic patient records (EPR). Guest lectures by medical specialists and scientists/researchers are also planned.

Internship: Micro CT and X-ray imaging for material science; various tasks

4	**Frequency of the course** Summer semester; Hybrid (online) **3524131 - Nuclear medicine, computed tomography and X-ray diagnostics (V+P)** Summer semester; Hybrid (online)
5	**Teaching language** 3524131 - Nuclear medicine, computed tomography and X-ray diagnostics (V+P) German
6	**Individual course requirements** None
7	**Examination forms** Assignments (courseworkStudienleistung) Internship: Anestate for the respective experiment; duration 15-30 minutes Module exam Nuclear Medicine, Computed Tomography and X-ray Diagnostics as exam (Klausur) (written - 90 min.)
8	**Requirements for the awarding of credit points** Passing the module exam Passing the assignments (coursework) Internship - Antestate
9	**Weighting of the grade for the final grade** 5/120
10	**Module coordinator** Prof. Dr. Vesna Prokic
11	**Responsible organization** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics **3524131 - Special Topics and Methodologies in Materials Science (V)** Faculty 3 - Mathematics / Natural Sciences -> Institute of Integrated Natural Sciences -> Physics
12	**Literature**

	Will be announced in the respective courses
13	**Use of the module (in other degree programs)** M.Sc. Material Science (20242) M.Sc. Applied Physics
14	**Other information** The lecture is offered hybrid (online and face-to-face)