Master of Science

Molecular Systems Science and Engineering

(MSSE)

Description of the course modules (Modulhandbuch)

Heidelberg University

Faculty of Engineering Sciences

Key Information

Name of university	Heidelberg University
Name of department / Name of the Faculty	Institute for Molecular Systems Engineering and Advanced Materials (IMSEAM) / Faculty of Engineering Sciences
Degree program	Master of Molecular Systems Science and Engineering
Type of degree course	Consecutive
Acronym	MSSE
Formats of studies	Full time or part time
Standard period of study	2 years, i.e. 4 semesters
Total number of credit points	120
Location of studies	Heidelberg
Number of places in the program	28
Target group	Holders of Bachelor of Science, Magister, Staatsexamen, Diploma or equivalent final degree of a relevant program with a nominal study load of at least 6 semesters (full-time). Relevant studies are Physics, Chemistry, Materials Science, Molecular Biotechnology, Biochemistry, and related fields.
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1 Qualification objectives, profile and particularities of the degree program

1.1 Preamble – Qualification objectives of Heidelberg University

In keeping with Heidelberg University's mission statement and constitution, degree programs are designed to provide a comprehensive academic education, incorporating subject-specific, cross-disciplinary, and career-related objectives that prepare students for their future professional careers. The resulting skills profile is included in the course description for all university disciplines and is implemented in each degree program's specific qualification objectives, curricula, and modules.
The main points of the competence profile are:

- Development of subject-specific skills, with a particular emphasis on research,
- Development of the skills required for trans-disciplinary dialogue,
- Development of practical problem-solving skills,
- Development of personal and social skills,
- Promotion of students' willingness to assume social responsibility based on the skills acquired.

1.2 Profile of the MSSE

The research-oriented Master's program in Molecular Systems Science and Engineering (MSSE) at Heidelberg University is offered by the Institute of Molecular Systems Engineering and Advanced Materials (IMSEAM) in collaboration with the Faculty of Engineering Sciences. Its primary objective is to deepen and broaden the expertise of students while preparing them for research- or development-oriented professional careers in the field of Molecular Systems Science and Engineering. Additionally, it serves as a foundation for pursuing a PhD.

As part of this program, students develop a comprehensive understanding of relevant theoretical approaches and experimental methods, enabling them to evaluate their advantages and limitations to devise the best solutions for specific problems. They acquire the ability to identify inadequate or suboptimal solutions and the skills to develop innovative strategies or improve existing ones. The MSSE program emphasizes practical skills, training students to work with advanced tools from molecular systems and materials research. They learn to apply these skills to efficiently solve application-oriented problems.
Throughout the program, students select modules in five core subjects: Energy Conversion, Molecular Design, Biomaterials, Nanosystems, and Philosophy and Ethics in the Engineering Sciences. These areas represent subfields of 'Molecular Systems Science and Engineering.' Each subject includes a combination of foundational lectures and advanced modules, covering the field comprehensively. Over the course of their studies, students create individualized academic profiles, equipping them to become highly competitive researchers in their chosen areas of interest.

The program culminates in a research phase during the second year, which includes a seminar, research projects in the student's area of specialization (lab rotations), and the completion of a Master's thesis. This phase emphasizes independent research, teaching students to document and publish their work. Additionally, students refine their knowledge of scientific methods, laboratory skills, creativity, entrepreneurship and interdisciplinary systems thinking. Students gather experience applying their knowledge, and they learn to work in teams and to effectively communicate.

1.3 Subject-specific qualification objectives

The MSSE program provides students with the opportunity to create a personalized academic profile based on their research interests. As a result, the skills and knowledge they acquire may vary depending on their choice of modules. Detailed information is provided in the module descriptions in sections 2.2, 2.3, and 3.

The MSSE program emphasizes advanced research and prepares the students accordingly. Graduates gain proficiency in various methods from chemistry, physics, biology, and engineering, with a focus on their practical application. The program fosters independent research, problem-solving, and effective project management, culminating in the completion of a thesis.
MSSE graduates are trained in both written and oral scientific communication to effectively present their research findings. They are taught how to learn independently and how to consistently expand their knowledge and skills. The graduates have been trained to efficiently gather, analyze, and interpret information. Their ability to make informed decisions and articulate well-reasoned viewpoints will distinguish them academically and professionally.

1.4 Generic qualification objectives

Graduates of the MSSE program possess the skills to work independently with a variety of specialized tools for diverse applications and can select the most appropriate ones to solve specific problems in the field. They can work in a structured manner and they can professionally organize complex projects. Furthermore, they have first insides into the legal and financial aspects of establishing and managing a company.
MSSE graduates are adept at formulating subject-specific perspectives and developing problem-solving strategies in molecular systems science and engineering. They excel at articulating complex issues to both experts and non-specialists, defending their research findings, and contributing effectively to interdisciplinary teams. Graduates also demonstrate strong leadership skills, inspire their peers, and collaborate with individuals from diverse backgrounds to enhance team performance.

1.5 Employment Opportunities

Graduates of the MSSE program are well-equipped to tackle challenges in fields such as energy harvesting, biomaterials, nano science and technology, and molecular engineering. The program's broad course offerings make graduates highly desirable

for a wide range of industries, including the chemical sector, energy technology, medical engineering, and soft robotics, to name a few. Their interdisciplinary training enhances their appeal to employers, as they are proficient in navigating diverse subject-specific cultures and terminologies, even extending to areas like philosophy and ethics.
Potential employers range from large corporations to specialized startups within the field. Additionally, due to courses in entrepreneurship and intellectual property (IP), graduates are well-prepared to contribute to or even establish ventures in these areas.

1.6 Particularities of the Degree Program

1.6.1 Reason for cumulative examinations

The requirement for two examination components within a single module arises from the inclusion of courses from diverse disciplines. The competencies to be acquired in these courses vary significantly and cannot be adequately assessed through a single examination.
Different examination formats are utilized in some modules (e.g., oral examinations or presentations combined with written assignments) to evaluate a variety of skills. Additionally, the curriculum offers significant flexibility in selecting seminar topics, allowing acquired competencies to be assessed through multiple examinations. Even when the format is the same – such as two written assignments – these assessments focus on different topics. Lecturers typically have considerable freedom in deciding how to assess their modules.
Given the highly varied and specialized nature of the competencies covered in the modules, it is recommended that these competencies be evaluated through specific individual examinations rather than a single final module exam.

1.6.2 Teaching forms and assessment

The following teaching and learning formats are predominantly used in the courses of the MSSE program:

- **Lecture:** A traditional lecture delivered by the lecturer, with students engaging in preparation and follow-up through self-study.
- **Inverted classroom lectures:** Students conduct self-study and then consolidate and apply the material with guidance from the lecturer during classroom sessions.
- **Seminar:** Students present topics to their peers and the lecturer.
- **Exercise/tutorial:** Activities include self-study, solving exercise sheets, and engaging in active discussions and questions based on the lecture content.
- **Practical course/lab rotation:** These activities are based on lecture content and/or coordination with lab supervisors. Students conduct and evaluate laboratory experiments and prepare experimental protocols.

Different teaching formats are assessed using a variety of methods:

- **Theoretical course formats (e.g., lectures):** These are usually assessed through written or oral exams. Written exams typically last 90–180 minutes,

while oral exams are limited to 60 minutes. Essays and project proposals may also be used as alternative assessment formats.

- **Seminars:** Assessment is based on the student's presentation, active participation in discussions, and preparation and review of assigned materials.
- **Practicals:** Assessment is typically based on written protocols styled as scientific publications, demonstrated practical skills, preparation and review of provided materials, and, if applicable, a presentation of results. The specific examination methods may vary depending on the preferences of the supervisors, and not all methods may be required in every course.

The specific examination format for each course will be announced during the first session of the semester. Timely submission of written protocols, presentations, and other required materials is mandatory.

1.6.3 Requirements for the assignment of credits

The final grade for the Research Subject MSSE I, II, and III sections is determined by considering the weight of all required compulsory elective modules, based on their associated credit points (CP).
Composition of the final grade for the compulsory elective modules:
The final grade is calculated by considering the weight of all courses, which is determined by their associated credit points (CP).

2 Structure of the MSSE

2.1 Credit points (CP) and module types

The MSSE program contains two main module categories: compulsory modules and compulsory elective modules. For each module, a certain number of Credit Points (CP) are awarded upon completion, in accordance with the rules of the European Credit Transfer and Accumulation System (ECTS). A total of 120 CP are required for graduation.
The number of CP assigned to each module reflects the average student workload, with 1 CP corresponding to approximately 30 hours of student work. This includes both participation in courses and the time needed for preparation and follow-up in self-study.
The number of CP assigned to each module is specified in the respective module description. Students receive credits once the modules have been successfully completed, regardless of the grading of their performance. These points reflect the quantity of work completed, while grades are assigned for qualitative assessment.
In this program, a distinction is made between a module and a course. Modules are self-contained teaching units that must be completed to graduate. Some compulsory elective modules contain elective courses that students can choose from. The term "courses" is a catch-all term and can refer to lectures, seminars, or lab practicals. All modules are listed below, whereas the specific courses for the MSSE-II and MSSE-III modules are provided in heiCO.

2.2 Compulsory modules (84 CP)

All compulsory modules must be successfully completed in order to graduate. Students must not have forfeited their claim to be examined (Prüfungsanspruch) in any of the compulsory modules.
These modules aim to provide students with the necessary knowledge to work in a research environment on their own projects under supervision.

The MSSE program includes the following compulsory modules:

Compulsory modules	**84 CP**
Data and Project Management	6 CP
Creative Science Lab	12 CP
Technology Transfer	6 CP
Scientific Specialization	15 CP
Methods and Project Planning	15 CP
Master Thesis (including Colloquium)	30 CP

2.2.1 Data and Project Management

The "Data and Project Management" compulsory module covers three main topics: Project Management, Data Management, and Numerical Methods and Computation. Successful participation in and completion of this module are prerequisites for graduation.

Students will develop a comprehensive understanding of project management principles, with an emphasis on strategies relevant to research projects.
Data management has become a critical component in both academic and industrial research, especially within interdisciplinary laboratories. Students will gain knowledge and hands-on experience in managing data, including data storage, metadata management, and the use of electronic laboratory documentation software.
In addition, they will acquire skills in numerical methods and computational techniques, particularly those that are essential within the context of the MSSE program.

2.2.2 Creative Science Lab (12 CP):

The **“Creative Science Lab”** compulsory module spans fifteen weeks and consists of multiple components. Successful participation and completion of this module are prerequisites for graduation. The primary objective is to equip students with valuable skills for conducting rigorous research and fostering independence in a laboratory environment. Additionally, the module provides a strong foundation in various analytical, practical, and theoretical methods relevant to Molecular Systems Science and Engineering.
In the first part of the module, students are divided into groups and attend pre-defined lab courses hosted by different IMSEAM research groups. These courses cover a range of subjects, including but not limited to biomechanics and cell cultures, 3D printing and technical design, microfluidics, electrical measurements, and spectroscopy. Following the lab courses, students will have a study week before taking a written exam. This initial phase is designed to provide them with essential laboratory skills, enabling them to work independently during the second part of the module and later in their rotations and thesis research.
In the second part, students will have full autonomy in the lab, working in small groups to investigate open research questions. They will develop their ability to design experiments that address scientific inquiries within the field of molecular systems science and engineering. At the conclusion of the module, students will present their findings in a talk and a practical demonstration to their peers and professors as part of an oral examination.

2.2.3 Technology Transfer (6 CP)

The **"Technology Transfer"** compulsory module encompasses four main topics: Intellectual Property, Start-Ups, Entrepreneurship, as well as transfer of scientific ideas, concepts and progress into broader society including Science Communication. Successful participation in and completion of this module are prerequisites for graduation.

In this module, students will acquire a comprehensive understanding of patenting strategies, including the principles, processes, and intricacies involved in protecting intellectual property. They will not only be able to analyze but also critically evaluate the prerequisites necessary for securing and managing intellectual property rights effectively. Additionally, students will gain a thorough understanding of the fundamental principles involved in establishing a successful startup business. This includes the core principles of entrepreneurship as well as an understanding of business fundamentals. Students will learn the basics of how to patent their innovations and how to launch a startup venture, as well are get familiarized with the university resources that are available to them. Students will have the opportunity to propose their own ideas, prepare a business plan, and pitch their concepts. Lastly, students can take on the role of experts in society by designing and implementing a science communication project of their choosing—whether through social media content, school presentations, or public outreach events in collaboration with local organizations.

2.2.4 Scientific Specialization (15 CP):

The **"Scientific Specialization"** compulsory module encompasses a up to twelve-week, hands-on laboratory practical and a seminar component. Successful participation and completion of this module are prerequisites for admission to the Master Thesis and graduation.

Throughout this module, students will delve deeper into their chosen research subject, ideally equipping them with the knowledge and methodological experience needed for their Master thesis. Additionally, they will acquire further expertise in conducting research, including experiment development and evaluation, and gaining skills in communicating their research during regular lab meetings with their peers and members of their host lab. The exact content of this module is defined together with the supervisor.

2.2.5 Methods and Project Planning (15 CP):

The **"Methods and Project Planning"** compulsory module encompasses an up to twelve-week, hands-on laboratory practical and a seminar component. Successful participation and completion of this module are prerequisites for admission to the Master Thesis and graduation.

Throughout this module, students will delve deeper into their chosen research subject, ideally equipping them with the knowledge and methodological experience needed for their Master thesis. Additionally, they will acquire further expertise in conducting research, including experiment development and evaluation, and honing their skills in communicating their research findings during regular lab meetings with their colleagues in their host lab. The exact content of this module is defined together with the supervisor.

2.2.6 Master Thesis (30 CP, including Colloquium)

The **"Master Thesis"** compulsory module is scheduled for the fourth semester and consists of a six-month, hands-on laboratory project in which students work independently on their own research projects under the guidance of a supervisor.

To start the Master Thesis, students must have successfully completed the modules "Scientific Specialization" and "Methods and Project Planning."

The primary objective of the Master Thesis is to immerse students in a research environment and equip them with the skills necessary for a successful career in academia or industry.

2.3 Compulsory elective modules (36 CP)

The MSSE program includes three sections of compulsory elective modules called ***Research Subject Molecular Systems Science and Engineering I, II, and III***. Each section requires the successful completion of a specified number of compulsory elective modules in order to graduate.
The goal of these modules is to equip students with essential knowledge, providing a solid foundation for becoming proficient and productive researchers. This knowledge is crucial for both conducting their research projects and collaborating effectively with peers from diverse fields within Molecular Systems Science and Engineering. While the primary objective is to deepen their expertise in chosen areas of interest, these modules also offer opportunities to broaden their perspectives by exploring subjects beyond their core focus, all within the overarching framework of the field.

Section 1: Compulsory elective modules in Research Subject Molecular Systems Science and Engineering I	**18 CP**
Energy Conversion	6 CP
Molecular Engineering	6 CP
Biomaterials	6 CP
Nanosystems	6 CP
Philosophy and Ethics in the Engineering Science	6 CP

Three of the **five** offered compulsory elective modules must be successfully completed in order to complete the section *Research Subject Molecular Systems Science and Engineering I*.

Section 2: Compulsory elective modules in Research Subject Molecular Systems Science and Engineering II	6 CP
Specialization (Macro)Molecular Engineering	6 CP
Specialization Life-inspired Molecular Systems	6 CP
Specialization Physics of Functional Materials	6 CP
Specialization Physical and Biological Principles of Sensing	6 CP

One of the **four** offered compulsory elective modules must be successfully completed in order to complete the section *Research Subject Molecular Systems Science and Engineering II.*

Section 3: Compulsory elective modules in Research Subject Molecular Systems Science and Engineering I	12 CP
Functional Organic Materials	6 CP
Synthetic Biosystems	6 CP
Advanced Macromolecular Chemistry	6 CP
Physics of Molecular Systems Science and Engineering	6 CP

Two of the **four** offered compulsory elective modules must be successfully completed in order to complete the section *Research Subject Molecular Systems Science and Engineering III.*

2.3.1 Section: Research Subject Molecular Systems Science and Engineering I

The section ***Research Subject Molecular Systems Science and Engineering I*** includes five compulsory elective modules. Students must successfully complete **three** of the **five** offered modules. Completion of this section is a prerequisite for graduation.
Students have the opportunity to select one or both of the remaining lectures (without the exercise) as part of their MSSE_Core-II container for 3 CP.

The five compulsory elective modules in this section are:

- **Energy Conversion**
- **Molecular Engineering**
- **Biomaterials**
- **Nanosystems**
- **Philosophy and Ethics in the Engineering Sciences**

Energy Conversion: Students will develop an understanding of the core principles and regulations governing energy conversion. They will learn to apply these principles in practical calculations and gain insight into the operational mechanisms of specific energy conversion tools and systems. Additionally, students will acquire the skills to quantitatively assess the performance characteristics of these tools and systems. They will also understand and critically evaluate the material requirements for energy conversion. By the end of the course, students will be equipped to apply these concepts to novel technological challenges and in their respective societal context.

Molecular Engineering: Students will gain an understanding of the general principles of molecular engineering, including an overview of typical reactions and common organic chemistry synthesis methods. They will also become familiar with molecular characterization techniques. By the end of the course, students will be equipped to apply these concepts to novel technological challenges and in their respective societal context.
Biomaterials: Students will develop a comprehensive understanding of the principles of biomaterials. They will gain knowledge of the molecular basis of biomaterials, their interactions with biological systems, and their applications in various fields. Furthermore, students will explore material design, biocompatibility, and synthesis techniques. By the end of the course, students will be equipped to apply these concepts to novel technological challenges and in their respective societal context.
Nanosystems: Students will learn the fundamentals underlying chemical, physical and biological nanosystems. They will also be exposed to nanofabrication processes. They will develop skills to evaluate nanosystem characterization methods and select appropriate strategies for their analysis. Additionally, students will gain practical knowledge of nanosystem applications and functionalities. By the end of the course, students will be equipped to apply these concepts to novel technological and research challenges and in their respective societal context.
Philosophy and Ethics in the Engineering Sciences: Students will develop the ability to critically discuss key questions and principles from philosophy, including philosophy of science and ethics. They will also acquire skills to identify and address ethical issues in the field of Molecular Systems Science and Engineering. By the end of the course, students will be equipped to apply these concepts to novel technological challenges and in their respective societal context.

2.3.2 Section: Research Subject Molecular Systems Science and Engineering II

The section *Research Subject Molecular Systems Science and Engineering II* encompasses four separate compulsory elective modules, each offering a wide selection of courses (lectures, seminars, exercises, and practicals). Students must successfully complete one of the four offered modules. Completion of this section is a prerequisite for graduation.

The four compulsory elective modules in this section are:

- **Specialization Physics of Functional Materials**
- **Specialization (Macro)Molecular Engineering**
- **Specialization Life-Inspired Molecular Systems**
- **Specialization Physical and Biological Principles of Sensing**

Specialization Physics of Functional Materials: Students will acquire advanced knowledge and understanding of functional and engineering materials, as well as the physical principles that underlie them. They will apply principles from physics, chemistry, and materials science to describe and analyze the characteristics of these materials. Additionally, they will be introduced to several of the latest innovations and breakthroughs in the field of advanced engineering and functional materials.

Specialization (Macro)Molecular Engineering: Students will gain an understanding of the fundamental principles of macromolecules and polymers. They will learn advanced synthesis techniques, explore properties, and become proficient in characterization methods related to macromolecules. Additionally, they will become familiar with the latest advancements in polymeric materials and their diverse applications.
Specialization Life Inspired Molecular Systems: Students will develop expertise in various biomaterial classes and their associated properties. They will learn to analyze the mechanics of biomaterial systems and select appropriate testing methodologies. Furthermore, they will acquire the ability to integrate knowledge from disciplines such as biomedicine, biophysics, and biostatistics, leveraging this multidisciplinary insight to solve complex problems effectively.
Specialization Physical and Biological Principles of Sensing: Students will develop advanced expertise in the field of sensing and sensor development. The students will gain insight into computational modeling and how information is processed, enabling them to comprehend and model molecular systems effectively. Moreover, they will integrate knowledge from disciplines such as mathematics, numerical modeling, chemistry, physics and biology to conduct innovative research in the field of molecular systems, particularly with respect to developing novel experimental approaches and instrumentation.

2.3.3 Section: Research Subject Molecular Systems Science and Engineering III

The section *Research Subject Molecular Systems Science and Engineering III* encompasses four separate compulsory elective modules, each offering a wide selection of courses (lectures, seminars, exercises, and lab practicals). Students must successfully complete two of the four offered modules. Completion of this section is a prerequisite for graduation.

The four compulsory elective modules in this section are:

- **Functional Organic Materials**
- **Advanced Macromolecular Chemistry**
- **Synthetic Biosystems**
- **Physics of Molecular Systems Science and Engineering**

Functional Organic Materials: Students will develop a strong understanding of the fundamental concepts underlying the optoelectronic properties of organic (semi)conductors. They will learn the operational mechanisms of common organic electronic devices and gain familiarity with recent experimental and theoretical advancements, along with the methodologies used to achieve these findings. Additionally, students will acquire the skills to apply these concepts in numerical experiments and analyze real experimental data.
Advanced Macromolecular Chemistry: Students will gain a thorough understanding of the chemical principles necessary for designing, synthesizing, and developing macromolecules for practical applications. They will acquire knowledge of polymer synthesis and characterization processes, including reaction mechanisms. Furthermore, students will achieve a qualitative understanding of the structures of macromolecules and will develop proficiency in determining their properties.

Synthetic Biosystems: Students will be able to articulate and compare various topics within synthetic biology. They will also develop the ability to critically analyze experiments and theoretical concepts in this field, enabling them to evaluate and contribute to advancements in synthetic biosystems effectively.
Physics of Molecular Systems Science and Engineering: Students will acquire advanced knowledge of the physical principles governing molecular systems. They will deepen their understanding of the physical characterization methods and fabrication techniques for molecular systems. Additionally, students will explore various applications of molecular systems in the physical sciences, equipping them with the skills to apply these concepts in innovative contexts.

2.4 Summary

In summary, the following modules must be completed successfully in order to reach the required 120 CP:

6/6 Compulsory Modules: Data and Project Management Creative Science Lab Technology Transfer Scientific Specialization Methods and Project Planning Master Thesis	**84 CP**
3/5 Compulsory Elective Modules in the section Research subject MSSE I Energy conversion Molecular Engineering Biomaterials Nanosystems Philosophy and Ethics in the Engineering Science	**18 CP**
1/4 Compulsory Elective Modules in the section Research subject MSSE II Specialization (Macro)Molecular Engineering Specialization Life Inspired Molecular Systems Specialization Physics of Functional Materials Specialization Physical and Biological Principles of Sensing	**6 CP**
2/4 Compulsory Elective Modules in the section Research subject MSSE III Functional Organic Materials Synthetic Biosystems Advanced Macromolecular Chemistry Physics of Molecular Systems Science and Engineering	**12 CP**
Sum	**120 CP**

2.5 Mobility Window

Students have the opportunity to participate in modules and internships at other universities in Germany and abroad, particularly as part of the Lab Rotations (*Scientific Specialization and Methods and Project Planning*). In exceptional cases, this may also be possible for their master's thesis. Such arrangements require prior approval from the study coordinator. The third semester is the most suitable time for these endeavors.

2.6 Overview of the master degree program

The following table lists all compulsory modules and compulsory elective modules of the MSSE. Compulsory modules and sections are written in bold, compulsory elective modules are written in *italics*. The same module/course must not be counted twice.

CODE	Course Title	Recommended term	CP
MSSE_Core-I	**Section: Research subject Molecular Systems Science and Engineering I**	**1**	**18**
MSSE_EnCon	*Energy Conversion*	1	6
MSSE_MolEn	*Molecular Engineering*	1	6
MSSE_BioMat	*Biomaterials*	1	6
MSSE_NanoSys	*Nanosystems*	1	6
MSSE_PEES	*Philosophy and Ethics in the Engineering Science*	1	6
MSSE_DPMan	**Data and Project Management**	**1**	**6**
MSSE_Core-II	**Section: Research subject Molecular Systems Science and Engineering II**	**1**	**6**
MSSE_SpecMME	*Specialization (Macro)Molecular Engineering*	1	6
MSSE_SpecLIMS	*Specialization Life Inspired Molecular Systems*	1	6
MSSE_SpecPFMat	*Specialization Physics of Functional Materials*	1	6
MSSE_SpecPBPD	*Specialization Physical and Biological Principles of Sensing*	1	6
MSSE_CSLab	**Creative Science Lab**	**2**	**12**
MSSE_TechTrans	**Technology Transfer**	**2**	**6**
MSSE_Core-III	**Section: Research subject Molecular Systems Science and Engineering III**	**2**	**12**
MSSE_FOMat	*Functional Organic Materials*	2	6
MSSE_SBS	*Synthetic Biosystems*	2	6
MSSE_AdMaChem	*Advanced Macromolecular Chemistry*	2	6
MSSE_PMSSE	*Physics of Molecular Systems Science and Engineering*	2	6
MSSE_SciSpec	**Scientific Specialization**	**3**	**15**

MSSE_MPP	**Methods and Project Planning**	**3**	**15**
MSSE_MTC	**Master Thesis (including colloquium)**	**4**	**30**

3 Module descriptions

The following pages contain descriptions of all primary MSSE modules.

All compulsory modules and compulsory elective modules are offered and organized by the **I**nstitute for **M**olecular **S**ystems **E**ngineering and **A**dvanced **M**aterials (**IMSEAM**) (Im Neuenheimer Feld 225, 69120 Heidelberg).

MSSE modules are open to non-MSSE students, as long as sufficient instructor capacity, and infrastructure (e.g., lab space) are available. In seminars, the number of participants is limited by the time available for presentations. MSSE students are accepted with priority. Free slots are available for non-MSSE students. The lab practicals (Creative Science Lab, Scientific Specialization, Methods and Project Planning) and the Master Thesis are only intended for students of the MSSE.

An optional inclusion of modules in other study programs is left to these programs after consultation with the MSSE program coordinator.

In the following module descriptions

- 'ST' is summer term ('Sommersemester'); lectures start mid-April,
- 'WT' is winter term ('Wintersemester'); lectures start mid-October.

3.1 Research subject Molecular Systems Science and Engineering I

CODE: MSSE_Core-I	TITLE: **Research subject Molecular Systems Science and Engineering I**
Type	Section with associated compulsory elective modules comprised of lectures and exercises.
Credit Points	18
Workload	540 hours
Term	WT
Section parts and teaching methods	• 3 out of 5 possible compulsory elective modules must be completed (student's choice) • 3 lectures • 3 practical exercises with homework
Application of the section	Molecular Systems Science Engineering (Master of Science)

The section *Research subject Molecular Systems Science and Engineering I* consists of five compulsory elective modules. These are:

1. Energy Conversion
2. Molecular Engineering
3. Biomaterials
4. Nanosystems
5. Philosophy and Ethics in the Engineering Science

Three of the **five** compulsory elective modules in the section *Research subject Molecular Systems Science and Engineering I* must be completed successfully. Students can select one or both of the remaining lectures (without the exercise) as part of their MSSE_Core-II container for 3 CP.

3.1.1 Energy Conversion

CODE: MSSE_EnCon	TITLE: Energy Conversion
Type	• Compulsory elective module of the section MSSE_Core-I • Lecture with exercise
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Lecture • Practical exercise with homework
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will … … understand the fundamental concepts and laws for energy conversion and can apply these in calculations. … understand the working mechanisms of selected energy conversion devices and systems and can quantitatively evaluate their performance characteristics. … understand and evaluate/discuss the demands on the materials used in energy conversion. … be able to apply the concepts in novel technological and societal situations.
Content	• Types of energy • Thermodynamics • Energy in matter • Thermal energy conversion • Phase-change energy conversion • Solar energy and solar cells • Thermoelectric generators • Biological energy • Energy efficiency • Energy storage and batteries
Prerequisites	None
Recommended knowledge	Introductory courses to Physics/Chemistry
Requirements of the assignment of credits	• Written exam at the end of the semester. • Active participation in the exercises

3.1.2 Molecular Engineering

CODE: MSSE_MolEn	TITLE: Molecular Engineering
Type	• Compulsory elective module of the section MSSE_Core-I • Lecture with exercise
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Lecture • Practical exercise with homework
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … understand general principles in molecular engineering. … understand typical reactions, common organic chemistry, and synthesis methods. … understand molecular characterization methods. … apply their knowledge for independent solution of problems.
Content	• Introduction to molecular systems • Structure and reactivity: functional groups • Reaction mechanisms • Stereochemistry • Methods for molecular characterization • Applications
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	• Written exam at the end of the semester. • Active participation in the exercises

3.1.3 Biomaterials

CODE: MSSE_BioMat	TITLE: Biomaterials
Type	• Compulsory elective module of the section MSSE_Core-I • Lecture with exercise
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Lecture • Practical exercise with homework
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … describe biomaterial classes and properties. … analyze biomaterial mechanics systems and are able to choose a proper strategy. … discuss and review applications of biomaterials, particularly in the field of medicine. … discuss and review most recent inventions and developments in the field of biomaterials and their applications. … discuss and review advances in the research area of biomaterials in their respective societal context and approach ethical questions with the necessary nuance.
Content	• Introduction to living systems • Biomaterial classification • Material mechanics • Biocompatibility • Commercialization procedure of biomaterials • Applications of biomaterials (implants, biosensors, engineered systems) • Dynamic aspects in biomaterials science • Imaging methods • Engineered living materials • Basics of 3D printing • Ethical questions concerning (advances in) biomaterials
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	• Written exam at the end of the semester. • Active participation in the exercises

3.1.4 Nanosystems

CODE: MSSE_NanoSys	TITLE: Nanosystems
Type	• Compulsory elective module of the section MSSE_Core-I • Lecture with exercise
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Lecture • Lab practicals • Seminar with homework
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … understand, evaluate and discuss properties of fluids at small scales. … understand, evaluate and discuss the nucleation and growth of nanostructures. … understand, evaluate and discuss non-equilibrium active systems, both chemical and biological motors. … understand, evaluate and discuss optical properties of nanostructures. … understand, evaluate and discuss nanofabrication techniques, nanomaterials, DNA nanotechnology, self-assembly, nanomedicine and applications.
Content	• Properties of fluids at small scales: hydrodynamics, viscosity, Reynolds number, reciprocity, microfluidics, Brownian diffusion. • Non-equilibrium active systems: chemical motors, protein motors, active matter. • Optical properties of nanostructures: scattering, plasmonics, nanophotonics, synthesis of nanoparticles and quantum dots, characterization, and imaging methods. • Nanoscience: nanofabrication techniques, including solution based growth, nanomaterials, DNA nanotechnology, nanomedicine, and applications
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	• Written exam at the end of the semester. • Successful participation in the exercises

3.1.5 Philosophy and Ethics in the Engineering Sciences

CODE: MSSE_PEES	TITLE: **Philosophy and Ethics in the Engineering Sciences**
Type	• Compulsory elective module of the section MSSE_Core-I • Lecture with exercise
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Lecture • Seminar
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … master basic questions and topics in philosophy. … use philosophical skills like argument and critical thinking. … identify and discuss ethical and societal concerns about Molecular Systems Science and Engineering.
Content	• Introduction to terms, concepts and methods of philosophy, including logic, philosophy of science, epistemology, and ethics (metaethics, normative and applied ethics) • Insights into related topics from current philosophical research • Training in philosophical skills
Prerequisites	N/A
Recommended knowledge	Curiosity and willingness to engage in philosophy
Requirements of the assignment of credits	• Written exam at the end of the semester • Successful participation in the exercises

3.2 Data and Project Management

CODE: MSSE_DPMan	TITLE: Data and Project Management
Type	Compulsory Module
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	Comprised of a mix of lectures, seminars, and self-studying modules
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to... … understand typical processes and methods of selected project management methods, as well as the underlying concepts. … demonstrate and evaluate basic skills in project planning, execution, and evaluation. … demonstrate and evaluate methods for conflict avoidance and mitigation in project management. … compare and identify advantages and drawbacks of various project management methods, including agile ones. … demonstrate advanced knowledge of research data management. … demonstrate and apply competencies on Metadata management. … demonstrate good practices when handling research data. … demonstrate advanced knowledge of numerical methods. … Demonstrate and evaluate basic programming strategies.
Content	• Terminology of project management • Processes, process models, agile and classical methods of project management, phase model • Project planning, execution, and evaluation • Conflict management, personality types and team roles • Findability, accessibility, interoperability, and reusability of data, metadata • Current principles of numerical methods • Programming and modelling software and principles
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	The exact type of examination will be announced at the beginning of the module by the lecturer(s).

3.3 Research subject Molecular Systems Science and Engineering II

CODE: MSSE_Core-II	TITLE: **Research subject Molecular Systems Science and Engineering II**
Type	• Section with associated compulsory elective modules • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	WT
Section parts and teaching methods	• Choice between four compulsory elective modules and accompanying courses • Lectures, seminars, and lab practicals
Application of the section	Molecular Systems Science Engineering (Master of Science)

The section *Research subject Molecular Systems Science and Engineering II* consists of four compulsory elective modules. These are:

1. Specialization Physics of Functional Materials
2. Specialization (Macro)Molecular Engineering
3. Specialization Life-inspired Molecular Systems
4. Specialization Physical and Biological Principles of Sensing

One of the four compulsory elective modules from the section *Research subject Molecular Systems Science and Engineering II* must be completed successfully.

3.3.1 Specialization Physics of Functional Materials

CODE: MSSE_SpecPFMat	TITLE: Specialization Physics of Functional Materials
Type	• Compulsory elective module of the section MSSE_Core-II • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … demonstrate advanced knowledge and understanding of advanced and functional engineering materials. … utilize concepts from physics, chemistry and materials science to describe advanced and functional engineering materials. … demonstrate familiarity with the most recent developments in the field of advanced and functional engineering materials.
Content	• Physical, chemical and biological materials, devices and systems • Mathematical concepts and modeling • Properties, tuning and applications of specific materials
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.3.2 Specialization (Macro)Molecular Engineering

CODE: MSSE_SpecMME	TITLE: Specialization (Macro)Molecular Engineering
Type	• Compulsory elective module of the section MSSE_Core-II • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … understand the principles of macromolecules /polymers. … understand, evaluate and discuss advanced synthesis methods for macromolecules, properties and characterization. … understand, evaluate and discuss the most recent developments in the field of polymeric materials.
Content	• Introduction to macromolecules • Macromolecular synthesis • Characterization of macromolecules • Organic polymers • 3D printing of polymers
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.3.3 Specialization Life-inspired Molecular Systems

CODE: MSSE_SpecLIMS	TITLE: Specialization Life Inspired Molecular Systems
Type	• Compulsory elective module of the section MSSE_Core-II • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … demonstrate advanced knowledge of biomaterial classes and properties. … analyze biomaterial mechanics systems and are able to choose a proper testing strategy. … understand and utilize knowledge from biomedicine, biophysics, biostatistics. … view advances in the research areas covered by life-inspired molecular systems in their respective societal context and approach ethical questions with the necessary nuance.
Content	• Biological, physical, and chemical systems and networks • Bioinformatics • Modeling and machine learning • Ethical questions concerning (advances in) life-inspired molecular systems
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.3.4 Specialization Physical and Biological Principles of Sensing

CODE: MSSE_SpecPBPD	TITLE: **Specialization Physical and Biological Principles of Sensing**
Type	• Compulsory elective module of the section MSSE_Core-II • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	WT
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the compulsory elective module, the students will be able to… … demonstrate advanced knowledge of sensing principles and detection limits of natural and physical sensors: Biosensing, chemical sensing and physical sensors. … identify the underlying principles and determine the detection sensitivities. … understand utilize knowledge from mathematics, modelling, chemistry, physics and biology to analyze, design and quantify various sensors.
Content	• Senses in the natural world • Physics, chemistry of artificial sensors • Biosensors, physical sensors • Experimental principles
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.4 Creative Science Lab

CODE: MSSE_CSLab	TITLE: **Creative Science Lab**
Type	• Compulsory module • 9-week lab practical
Credit Points	12
Workload	360 hours
Term	ST
Module parts and teaching methods	The creative science lab consists of two distinct phases. • In the first phase, students will attend guided lab-practicals, supervised by members of different IMSEAM research groups. The first phase will be evaluated with a written exam. • In the second phase, students will work in small groups on their own research projects. The second phase will be evaluated through oral presentations and a practical demonstration by the different groups.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the first phase of this module, the students will be able to… … plan and perform proper research. … work in a research lab. … use the tools and conventions of science. … use scientific equipment correctly and safely. At the end of the second phase of this module, the students will be able to… … design and carry out well-defined scientific experiments. … perform different practical and theoretical methods relevant to molecular systems science and engineering. … choose the right methodologies for their respective scientific problems. … compare and rate different strategies to approach scientific questions. … communicate their research precisely and accurately to their peers and professors.
Content	First phase: • laboratory safety and etiquette • use of scientific equipment • laboratory skills in biomechanics, cell culture, 3D printing, technical design, microfluidics, electrical measurements, spectroscopy, and more Second phase: • development of a scientific project and hypothesis

	• design and implementation of experiments
Prerequisites	None
Recommended knowledge	Introductory courses in physics/chemistry
Requirements of the assignment of credits	• First phase: Written examination • Second phase: Oral examination and practical demonstration (presentation in front of peers and professors)

3.5 Technology Transfer

CODE: MSSE_TechTrans	TITLE: Technology Transfer
Type	• Compulsory module • Lecture and seminar
Credit Points	6
Workload	180 hours
Term	ST
Module parts and teaching methods	Comprised of a lecture, seminar, and self-studying aspects
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … understand the principles of patenting strategies. … analyze and judge prerequisites for intellectual property. … understand the principles of creating a Start-Up business. … understand business fundamentals. … understand the pipeline from patent to Start-Up. … understand the principles of entrepreneurship. … understand the principles of science communication. … communicate scientific ideas, concepts and advancements into broader society.
Content	• Introduction to intellectual property and patenting • Introduction to business basics • Introduction to Start-Up creation process • Introduction to Science Communication
Prerequisites	None
Recommended knowledge	N/A
Requirements of the assignment of credits	• Seminar presentation of a topic • Participation in discussion • Written report/business plan proposal

3.6 Research subject Molecular Systems Science and Engineering III

CODE: MSSE_Core-III	TITLE: **Research subject Molecular Systems Science and Engineering III**
Type	• Section with associated compulsory elective modules • Dependent on student's course selection
Credit Points	12
Workload	360 hours
Term	ST
Section parts and teaching methods	• Choice between four compulsory elective modules and accompanying courses • Lectures, seminars, and lab practicals
Application of the section	Molecular Systems Science Engineering (Master of Science)

The section *Research subject Molecular Systems Science and Engineering III* consists of four compulsory elective modules. These are:

1. Functional Organic Materials
2. Advanced Macromolecular Chemistry
3. Synthetic Biosystems
4. Physics of Molecular Systems Science and Engineering

Two of the **four** compulsory elective modules from the section *Research subject Molecular Systems Science and Engineering III* must be completed successfully.

3.6.1 Functional Organic Materials

CODE: MSSE_FOMat	TITLE: **Functional Organic Materials**
Type	• Compulsory elective module of the section MSSE_Core-III • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	ST
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … understand the key concepts underlying the mechanical, electrical and optical properties of functional organic materials and their molecular basis. … demonstrate familiarity with the most relevant fabrication techniques. … understand the working mechanisms of typical devices based on functional organic materials. … demonstrate familiarity with recent experimental and theoretical results and the techniques used to obtain them.
Content	• Organic electronics • Synthesis, fabrication, 3D printing • Properties and applications of functional organic polymers and molecules
Prerequisites	None
Recommended knowledge	Introductory course to Solid State Physics
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.6.2 Advanced Macromolecular Chemistry

CODE: MSSE_AdMaChem	TITLE: Advanced Macromolecular Chemistry
Type	• Compulsory elective module of the section MSSE_Core-III • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	ST
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … understand advanced methods for the synthesis of macromolecules. … understand the intricacies of advanced macromolecular characterization techniques. … demonstrate a broad understanding of the different applications of functional polymers.
Content	• Advanced macromolecular synthesis • Advanced characterization of macromolecules • Functional organic polymers • Applications
Prerequisites	None
Recommended knowledge	• Introductory courses to Chemistry • Attendance of the compulsory elective module *Specialization (Macro)Molecular Engineering*
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.6.3 Synthetic Biosystems

CODE: MSSE_SBS	TITLE: **Synthetic Biosystems**
Type	• Compulsory elective module of the section MSSE_Core-III • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	ST
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … describe and compare recent and advanced topics in synthetic biosystems. … analyze experiments and theoretical concepts in synthetic biosystems.
Content	• Introduction to synthetic biosystems • Experimental and theoretical methods in synthetic biosystems science • Fabrication methods to generate synthetic biosystems
Prerequisites	None
Recommended knowledge	Introductory courses to physics/chemistry and (ideally) biology/biomaterials
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.6.4 Physics of Molecular Systems Science and Engineering

CODE: MSSE_PMSSE	TITLE: **Physics of Molecular Systems Science and Engineering**
Type	• Compulsory elective module of the section MSSE_Core-III • Dependent on student's course selection
Credit Points	6
Workload	180 hours
Term	ST
Module parts and teaching methods	• Students select lectures, seminars, and lab practicals to a total of 6 CP according to their preferences and availability.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … understand advanced physical principles of molecular systems. … demonstrate insight into the physical characterization of molecular systems and their fabrication. … demonstrate insight into the applications of molecular systems in the physical sciences.
Content	• Advanced methods in micro- and nanotechnology, and/or computation and/or spectroscopy • Physics of Molecular Systems • Applications
Prerequisites	None
Recommended knowledge	Introductory courses to physics
Requirements of the assignment of credits	General Guidelines: • For lectures: Written exam at the end of the semester • For seminars: Presentation of a topic + participation in discussion • For lab practicals: Written lab report The type of examination will be announced at the beginning of the module by the lecturer(s).

3.7 Scientific Specialization

CODE: MSSE_SciSpec	TITLE: **Scientific Specialization**
Type	• Compulsory module • up to 12-week lab practical (lab rotation)
Credit Points	15
Workload	450 hours
Term	WT, ST
Module parts and teaching methods	Lab rotation in preparation for the Master Thesis
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … demonstrate advanced knowledge in the research field of the planned master thesis. … work on a project in a research laboratory under supervision.
Content	• The content of the module is defined together with the supervisor and will vary depending on the chosen research field in which the master thesis is planned. • In addition to the work within the research group may comprise specified lectures, seminars, or journal clubs as well as a substantial part of self-study.

Prerequisites	• Successful completion of the following modules and sections:
	  ○ MSSE_Core-I
	  ○ MSSE_Core-II
	  ○ MSSE_CSLab
	• Overall, 42 CP must have been acquired to enroll in this module.

Recommended knowledge	Suggested by supervisor
Requirements of the assignment of credits	• Oral examination on the content of the module • Written lab report

3.8 Methods and Project Planning

CODE: MSSE_MPP	TITLE: **Methods and Project Planning**
Type	• Compulsory module • up to 12-week lab practical (lab rotation)
Credit Points	15
Workload	450 hours
Term	WT
Module parts and teaching methods	• Work within a research group under supervision of the group leader • To pass this module, the student has to be part of a research group. • Upon completion of this course, the student is well prepared for the master thesis.
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … demonstrate advanced knowledge in the research field of the planned master thesis. … work on a project in a research laboratory under supervision.
Content	• The content of the module is defined together with the supervisor and will vary depending on the chosen research field in which the master thesis is planned. • In addition to the work within the research group may comprise specified lectures, seminars, or journal clubs as well as a substantial part of self-study.

Prerequisites	• Successful completion of the following modules and sections:
	  ○ MSSE_Core-I
	  ○ MSSE_Core-II
	  ○ CSLab
	• Overall, 42 CP must have been acquired to enroll in this module.

Recommended knowledge	Suggested by supervisor
Requirements of the assignment of credits	• Oral examination on the content of the module • Written lab report

3.9 Master Thesis (including colloquium)

CODE: MSSE_MTC	TITLE: **Master Thesis (including colloquium)**
Type	• Compulsory module • 6-month lab practical
Credit Points	30
Workload	900 hours
Term	WT, ST
Duration	The Master Thesis must be completed within 6 months. A one month extension can be granted in exceptional cases upon request.
Module parts and teaching methods	Master thesis and oral examination (colloquium)
Application of the module	Molecular Systems Science Engineering (Master of Science)
Objectives	At the end of the module, the students will be able to… … develop a hypothesis. … plan and analyze the necessary experiments to test their hypothesis. … perform scientific research in a research laboratory. … present their data and research results to other scientists in written (thesis) and oral (colloquium) form. … discuss their data and research results in the greater context of the research area molecular systems science and engineering. … pursue a successful career in academia or industry.
Content	• Research work on a specific MSSE-related topic. • Work within a research group under supervision of the group leader and group members.
Prerequisites	• advanced knowledge in the research area of the master thesis • MSSE_SciSpec compulsory module must be completed • MSSE_MPP compulsory module must be completed
Recommended knowledge	Suggested by supervisor
Requirements of the assignment of credits	• Written master thesis. • Colloquium: The results of the Master's thesis must be presented and defended in an oral examination (colloquium). The colloquium is held in front of two examiners. It lasts approximately 40-60 minutes.