

Curriculum for the award of the Degree of

# Master of Science in Chemistry

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# 1 General Remarks

This curriculum describes all the regulations concerning the course of studies in chemistry at the University of Fribourg. It is based on the regulations of the Faculty of Science as defined in the *Règlement pour l'obtention des Bachelor of Science et des Master of Science de la Faculté des sciences [Regulation of 2 February 2004 for the Obtainment of the Bachelor of Science and Master of Science]* (subsequently called *the Regulation* for short).

## 1.1 Academic Titles and Programme of Study

The Faculty of Science of the University of Fribourg awards the following official academic titles to students who have successfully completed their respective course of studies:

- **Bachelor of Science in Chemistry**, subsequently called **BSc**.
- **Master of Science in Chemistry**, subsequently called **MSc**.

The **programme of study of the BSc** in Chemistry represents a university course of studies, comprising a basic scientific education in chemistry by its method- and problem-oriented nature. It enables one to enter a wide professional area. At the same time it provides the basis for life-long learning, an indispensable requirement for professional success. In addition, the BSc in Chemistry forms the basis for advanced studies leading to the MSc in Chemistry. Every person who is in possession of a federal general qualification for university entrance (*maturité fédérale / Eidgenössisches Maturitätszeugnis*) or any equivalent document (cf. Art. 6 of the Regulation) will be admitted to the BSc degree programme.

The **programme of study of the MSc** in Chemistry represents a scientific course of studies, allowing one to specialize in a specific subject. The MSc in Chemistry gives access to various professional activities in research, education, industry, commerce, and administration. The MSc is furthermore the entry requirement for the scientific work and deepened scientific education leading to a doctorate. When accompanied by a subsidiary subject (biology, geography, informatics, mathematics, or physics), the MSc allows one to enter a complementary didactics programme leading to a qualification as a high-school teacher [*Diplôme d'enseignement pour les écoles de maturité (DEEM, ex-DAES II) / Lehrdiplom für Maturitätsschulen (LDM, ex-LDS II)*].

Persons in possession of a BSc in Chemistry of the University of Fribourg or any other Swiss university are admitted to the MSc course of studies (Art. 7 of the Regulation). Persons in possession of a BSc degree in a different subject or equivalent degrees (e.g. after graduating from an engineering school) can also be admitted to the MSc study programme by analogy. Provisional admission can be granted, which then depends on the fulfilment of additional requirements (cf. Section 2.5).

## 1.2 Course Structure

The degree courses leading to the BSc and MSc respectively are subdivided into **course units (UE)** comprising lectures, exercise classes, laboratories, seminars, student projects, etc. To each UE, a number of **ECTS<sup>1</sup> points** are assigned, which by assessment (e.g. successful exams) is converted into ECTS credits (see Section 1.3). The BSc degree course requires 180 ECTS credits (corresponding to a length of study of 6 semesters), and the MSc degree an additional 90 ECTS credits (corresponding to a length of study of 3 semesters).

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<sup>1</sup> ECTS stands for *European Credit Transfer System*. One ECTS point corresponds to an amount of work of approximately 30 hours.

The BSc degree course is composed of a **major** of 150 ECTS, and a selectable **minor** of 30 ECTS. The major consists of the compulsory UE in chemistry and basic mathematics, physics, and biology (or biology/biochemistry). The minor may not overlap with the major. Otherwise all subjects taught at the University of Fribourg can potentially be selected as minors. Corresponding curricula exist for all branches of the Faculty of Science (mathematics, physics, biology, biochemistry, etc.), for industrial chemistry (at the Fribourg engineering school) and some other popular subjects (economics, law, psychology, etc.). If a student wishes to choose a different minor, he/she must consult the student advisor of chemistry in order to work out a suitable curriculum.

The MSc degree programme consists of a one-year taught programme comprising lectures, lab work, and seminars, and the **MSc project** lasting 4-6 months leading to the **MSc thesis**. Examinations of the UE of the MSc are only possible after all the requirements for the BSc have been completed. (c.f. 1.3).

The purpose of the different forms of UE is as follows:

- **Lectures** give an introduction to the scientific methods in chemistry and advance thinking in a scientific way. They help acquiring the required knowledge and understanding the fundamental concepts, and introduce the formalisms used in data processing.
- **Lab work** complements the lectures and provides essential help for working with and understanding a lecture's content. They give students the opportunity to practise and apply the acquired principles, techniques, and models.
- **Research report** is preparing the students for acquiring knowledge in a specific field and disseminating the learned in a written form.
- The preparation of the **Master thesis**, under the supervision of an experienced researcher, is the actual starting point of scientific research.

### 1.3 Acquired skills

The aim of the studies leading to the award of an MSc in Chemistry is to deepen knowledge and perfect competence in the chosen field and at the same time develop skills in scientific English. Thus, at the end of the course, a student will have shown that he/she can apply their knowledge to accomplish a research project and will have learned how to work independently or how to integrate into an interdisciplinary research team. The award of the degree requires creative and self-critical talents as well as the ability to communicate ideas and work both in English and their native language.

### 1.4 Assessment of Course Units (UE) and Acquisition of ECTS Credits

Acquisition of ECTS credits occurs in three steps: assessment of the UE, grouping of UE into validation package, and awarding the respective credits.

Lab work is assessed following the criteria given at the beginning of the course. Admission to the exam corresponding to a lecture course can be subject to meeting the requirements of the corresponding lab work section. **Assessment** of lectures is made by an oral and/or written exam, whose type and duration are regulated in an appendix to this curriculum. Exams take place during the official exam periods (sessions) in spring, summer, and autumn. Students register in GESTENS within the stipulated delays for each exam according to the on-line procedure (<http://www.unifr.ch/science/gestens>). The marks range from 6 (highest mark) to 1 (lowest mark). An exam marked below 4 can be repeated once at the next exam session at the earliest.

**Validation packages** comprise multiple, separately assessed UE. Art. 18 of the Regulation determines the number of these package whereas this curriculum determines their content.

ECTS points are credited according to art. 19 of the Regulation if

- the weighted average of the exam marks of a validation package is at least 4. The weighting is given by the number of ECTS points assigned to an UE.
- the assessment criteria of UE not examined (lab work, seminars, etc.) are met.
- no mark is equal to 1.0.

Under these prerequisites, validation packages are validated and the corresponding ECTS points are converted into ECTS credits. By request, the Dean's office issues confirmations in which exam results and credits awarded are acknowledged (Art. 22 of the Regulation), provided the exam fee has been paid.

## 1.5 Teaching Languages

Each course of the BSc is taught in either German or French. Students can decide, in which of the two languages they want to express themselves. Occasionally, courses may be taught in English.

MSc courses are taught in English, German or French. For exams and written work (project reports, MSc thesis, etc.) students can choose between English, German or French.

## 1.6 Ethics and Science

Ethical principles are an integral part of a scientific education. Accepted international conventions must be respected during research and upon the writing up of any scientific work whether it be a project, a lecture, a thesis or a report. In particular, every external source of information (articles, lectures, web pages, etc.) must be correctly cited.

## 1.7 Regulations and Additional Information

Detailed information about studying computer science can be found in the following documents, which can be obtained from the Office of the Department of Computer Science, chemin du Musée 3, CH-1700 Fribourg:

- Regulation concerning the admission to the University of Fribourg [Règlement d'admission de l'Université de Fribourg / Zulassungsreglement der Universität Freiburg; (<http://www.unifr.ch/rectorat/reglements>)]
- Regulation of 2 February 2004 governing the granting of the titles of Bachelor of Science and Master of Science (<http://www.unifr.ch/science/plans/e>)
- Curriculum for major and minor branches in the Faculty of Science of the University of Fribourg (<http://www.unifr.ch/science/plans/e>)
- Study programme of the University of Fribourg (<http://studies.unifr.ch/en>)
- Course Programme of the University of Fribourg (<http://admin.unifr.ch/timetable>)
- UE database (<http://gestens.unifr.ch/>)
- The current examination session calendar of the University of Fribourg (<http://www.unifr.ch/science/gestens?page=10501>)

Finally, each student obtains a personal and secure space that can be reached using an individual university e-mail password. This space can be reached by the link "Connexion étudiant-es" on web page <http://www.unifr.ch/science/gestens> and allows inscription to courses and exams, access to exam results, the initiation of the process of attestation, etc.

## 2 Master of Science (MSc)

[Version 2014, validation packages: MSc1-CH.1009, MSc2-CH.1004]

The programme of study of the MSc in Chemistry spans one and a half years, corresponding to 90 ECTS credits. The courses (UE) of the MSc correspond to 60 ECTS in total. They consist of 6 modules, and a mandatory 7<sup>th</sup> Research module consisting of two laboratory courses and an extended research report.

The students must choose 5 modules among the thematic modules, as well as the mandatory *Research module* MO.CH.4900 consisting of 2 laboratory projects – to be carried out in two research groups of the Department of Chemistry, each project being the equivalent of 3 full-time weeks – and one written report (bibliography). These three parts have to be carried out in a field of a module followed by the student.

All modules have to be chosen within the programme of the Department of Chemistry of the University of Fribourg (one module can be taken at the EIF, see below). The study advisor can allow exceptions.

Some modules are not recommended for students who have done only the *BSc in Chemistry, Option Teaching* (120 ECTS in Chemistry), unless they have also completed the 30-ECTS minor programme *Chemistry for chemists* during their Bachelor studies.

The mandatory modules for students with a 120 ECTS bachelor in chemistry are

*MO-CH.4010 Advanced organic chemistry module*

*MO-CH.4400 Analytical chemistry module*

*MO-CH.4700 Materials module*

*MO-CH.4800 Polymers module*

*MO-CH.4900 Research module*

These modules have to be complemented by 9 ECTS points of courses on bachelor or master level taken within the Faculty of Sciences of the University of Fribourg in the domain of their bachelor minor. The choice has to be approved by the study advisor.

The MSc degree programme is completed by a 6 month master research project of 30 ECTS in total, which includes writing a master thesis and its oral defence.

UE of the MSc can only be assessed and recognized after successful completion of the BSc.

## 2.1 Course Units of the MSc

### 1<sup>st</sup> and 2<sup>nd</sup> Semester (Winter and/or Summer)<sup>2</sup>

Code	Course Unit	tot. h.	ECTS
<b>Elective at the Chemistry Department</b> <sup>3</sup>			
<i>MO-CH.4011</i>	<i>Advanced organic chemistry module, consisting of:</i>		
CH.4011	Bioorganic chemistry (lectures)	28	3
CH.4012	Physical organic chemistry (lectures)	28	3
CH.4013	Selected topics in organic chemistry (lectures)	28	3
<i>MO-CH.4106</i>	<i>Analytical chemistry module, consisting of:</i>		
CH.4116	Analytical chemistry I (lectures)	42	4
CH.4126	Analytical chemistry II (lectures)	42	4
CH.4135	Selected topics in analytical chemistry (seminar)	14	1
<i>MO-CH.4206</i>	<i>Advanced synthetic tools module, consisting of:</i>		
CH.4213	Synthesis of complex molecules (lectures)	28	3
CH.4243	Organometallic chemistry (lectures)	28	3
CH.4223	The chemistry of unpaired electrons (lectures)	28	3
<i>MO-CH.4301</i>	<i>Advanced inorganic chemistry module, consisting of:</i>		
CH.4301	Supramolecular chemistry (lectures)	28	3
CH.4302	Electronic structure of complexes (lectures)	28	3
CH.4303	Molecular magnetism (lectures)	14	1.5
CH.4304	Bioinorganic chemistry (lectures)	14	1.5
<i>MO-CH.4701</i>	<i>Materials module, consisting of:</i>		
CH.4701	Nanomaterials (lecture)	28	3
CH.4705	Crystallography and crystal growth and technology (lecture)	28	3
CH.4706	Solid state chemistry (lecture)	28	3
<i>MO-CH.4801</i>	<i>Polymers module, consisting of:</i>		
CH.4801	Polymer science I (lectures)	56	6
CH.4802	Polymer science II (lectures)	28	3
<i>MO-CH.4850</i>	<i>Physical chemistry module, consisting of:</i>		
CH.4851	Physical chemistry I (lecture)	28	3
CH.4852	Physical chemistry II (lecture)	28	3
CH.4853	Selected topics in physical chemistry (lecture)	28	3
<i>MO-CH.4900</i>	<i>Research module, consisting of:</i>		
CH.4901	Bibliographical work (project)	56	3
CH.4902	Laboratory project I (practical course) <sup>1</sup>	112	6
CH.4903	Laboratory project II (practical course) <sup>1</sup>	112	6
			<b>60</b>

### 3rd Semester

Code	Course Unit	tot. h.	ECTS
<b>Compulsory</b>			
CH.5014	Master project / Thesis	-	30
			<b>30</b>

<sup>1</sup> To be carried out in two different research groups

<sup>2</sup> An additional module in Physical Chemistry will be offered for the spring semester 2015.

<sup>3</sup> Grouped units constitute a Master module, which can only be chosen as a whole.

## 2.2 Content of the UE of the MSc

### Lectures

All modules comprise thematically focused lectures and seminars given by several professors. Some lectures may be presented by teachers from the Fribourg engineering school and professors from Neuchâtel and Berne. The following thematic is covered:

- Advanced organic chemistry (In depth presentation of subjects from organic chemistry);
- Analytical chemistry (Statistics, sample preparation, analytical methods, analytics in industry, validation);
- Advanced synthetic tools (Asymmetric synthesis of complex molecules, transition metals in synthesis, chemistry of unpaired electrons, supramolecular and biopolymer chemistry).
- Advanced inorganic chemistry (In depth presentation of subjects from inorganic chemistry);
- Materials (Nanoparticles, properties and applications; Solid state chemistry, soft matter, oxide materials, superconductors, surface coating; typical methods for solid state analysis);
- Physical chemistry module (advanced spectroscopy, electrochemistry, femtosecond chemistry, modeling, and simulation).
- Polymers (Polymer synthesis, analysis and properties; biopolymers, hybrid materials);

### Lab work

Lab work is an integral part of chemistry. Students are exposed to the research performed in the Department of Chemistry of the University of Fribourg and exercise themselves in a field closely related to a lecture thematic.

## 2.3 MSc Exams and Assessment

Assessment criteria for courses are specified in the appendix to the curriculum in Chemistry.

All of the 1<sup>st</sup> year UE of the MSc, i.e., the sum of the 4 chosen modules, form the **validation package MSc1**, enabling one to obtain 60 ECTS credits.

## 2.4 Master Project / Thesis and Assessment

The master thesis (CH.5014) forms the **validation package MSc2**. As a matter of principle, work on the master thesis can only be started after at least half of the modules of the validation package MSc1 has been evaluated.

The master project, a thesis of 30 ECTS points and duration of 4-6 months, introduces the students to scientific research. Normally, students will work on it during the third semester, and it represents the summit of the course of studies. It is a research work of a considerable volume under the supervision of an experienced researcher. During the master project and thesis, students can test their interest and ability to do research. They produce a thesis in the form of a scientific report and give an oral presentation of 30 minutes.

The master thesis is assessed by two examiners with a mark ranging from 6 (best mark) to 1 (worst mark). One of the examiners establishes a written report. A pass is accorded if the mark is at least 4. A failed master thesis can be repeated once on a different subject.

The successful completion of validation packages MSc1 and MSc2 awards the right to title **Master of Science in Chemistry, University of Fribourg (MSc)**.



## 2.5 Regulations of Admission to the Master Programme

### 2.5.1 Admission Procedure

Admission to the Master degree programme in chemistry is linked to two requirements: fulfilment of the admission requirements of the University – defined in the Regulations for the Admission to the University of Fribourg [*Règlement d'admission à l'Université de Fribourg / Reglement über die Zulassung an der Universität Freiburg*] – and possession of a Bachelor degree in chemistry from the University of Fribourg or an academic degree considered equivalent by the Faculty of Science.

The faculty possesses a list of academic titles that it recognizes as equivalent. Persons in possession of such a title will be admitted automatically. Persons in possession of an academic qualification not in the list can send the Faculty of science an application letter, on which the *Commission for student requests* – appointed by the faculty board – will make a decision.

Depending on the academic qualification, the Commission for student requests can make its acceptance dependent on the fulfilment of additional requirements, provided they are of a minor scope and can be completed in parallel to the master degree programme. Otherwise, applicants can be admitted to a “pre-master programme” and can start with the master degree programme only after fulfilling the requirements initially laid down for the pre-master.

### 2.5.2 Standard Transfers

Particular admission transfers to the master are regularly used, especially by candidates in possession of a Bachelor HES in Chemistry. Detailed descriptions of these standard transfers represent an appendix to this curriculum and can be obtained from the Dean's Office of the Faculty of Science or the Office of the Department of Chemistry.

### **3. Additional module programmes**

One module of 9 ECTS credits, the “Industrial Chemistry”, can be chosen from the Master program of the HES Fribourg, provided that the courses in “Industrial Chemistry” have been followed during the Bachelor studies.

#### **3.2 Content of the teaching units of the MSc**

For the description of the content and the learning outcomes, please refer to GestEns (<http://www.unifr.ch/science/gestens>).

#### **3.3 Exams of MSc and validation**

The chosen module will be examined under the responsibility of the corresponding department which offers it. Refer to the appendix specific to the domain.