

Curriculum for the award of the Degree of

# Master of Science in Physics

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# 1 General Remarks

This curriculum describes all regulations concerning the study of physics at the University of Fribourg. It is based on the regulations of the Faculty of Science and Medicine as defined in the *Règlement pour l'obtention des Bachelor of Science et des Master of Science de la Faculté des sciences et de médecine*, which entered into force on 2 February 2004 (hereafter called the *Regulation* for short). In case of discrepancies of translation, the French version will be considered authoritative.

## 1.1 Academic Titles and Study Programs

The Faculty of Science and Medicine 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 Physics**, subsequently called **BSc**.
- **Master of Science in Physics**, subsequently called **MSc**.

The **BSc study program** in Physics at the university level provides a basic scientific education in physics including both theoretical and experimental aspects. Its completion opens possibilities in many professional domains and provides a solid basis for life-long learning, an indispensable requirement for professional success. In addition, the BSc in Physics is the basis for advanced studies leading to the MSc in Physics. Anyone in possession of a federal general qualification for university entrance (*maturité fédérale / eidgenössisches Maturitätszeugnis*) or a document deemed equivalent (cf. Art. 6 of the Regulation) can be admitted to the BSc Physics degree programme.

The **MSc study program** in Physics provides the student with more advanced courses, and begins the process of specialization. Completion of the degree allows access to various professional activities in research, education, industry, commerce, and administration. Furthermore, the MSc is the entry requirement for doctoral studies. When accompanied by an additional subject like mathematics, the MSc allows one to enter a complementary education program leading to a qualification as a high-school teacher (*Diplôme d'enseignement pour les écoles de maturité (DEEM) / Lehrdiplom für Maturitätsschulen (LDM)*).

Candidates in possession of a Physics BSc from the University of Fribourg or any other Swiss university are admitted to the Physics MSc (Art. 7 of the Regulation). Candidates in possession of a BSc degree from abroad in a different subject or of equivalent degrees (e.g. a degree from an engineering school) can also be admitted to the MSc study program by a decision of the Faculty of Science and Medicine to be made in each individual case. Provisional admission can be granted and depends on the fulfilment of additional requirements set by the Faculty (cf. Section 3.5 of this document).

## 1.2 Course Structure

The course work leading to both the BSc and MSc degrees is subdivided into formal lectures, exercise classes, laboratory activities, seminars, specialized projects, and so on. These courses are measured in teaching units or “UE” (from “unité d'enseignement” or “Unterrichtseinheit”). To each UE, a number of **ECTS<sup>1</sup> points** is assigned, which, following successful completion of

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<sup>1</sup> ECTS stands for *European Credit Transfer System*. One ECTS point corresponds to approximately 30 hours of work. See also [https://ec.europa.eu/education/resources/european-credit-transfer-accumulation-system\\_en](https://ec.europa.eu/education/resources/european-credit-transfer-accumulation-system_en).

the course (e.g., exams) are converted into ECTS credits (see Section 1.3). The BSc degree course requires 180 ECTS credits (corresponding to six semesters of study), and the MSc degree requires an additional 90 ECTS credits (three semesters).

The purpose of the different UE types is as follows:

- **Lectures** give a formal introduction to the scientific methods in physics and advance thinking in a scientific way. They help in acquiring the basic knowledge and understanding the fundamental physics concepts.
- **Exercise classes** complement the lectures and provide essential help for the understanding and practical application of a lecture's content. Through them, the student will practice and apply the acquired principles and mathematical techniques.
- **Laboratory work**, be it experimental or theoretical, is the basis of scientific research. It provides a controlled environment for the hands-on realization of physical measurements. It is during this work that the student will encounter many of the instruments used in research, how such devices assist in making measurements, and the systematic and statistical limits of precision on the measurements made.
- **Seminar presentations** are used to expand the student's knowledge in specialized domains often neglected in the formal courses as well as to begin the development of oral presentation skills for scientific results.
- **Student projects** are a first step towards applying the skills learned in the lectures and exercise classes to real research problems.
- The preparation of the **Master thesis**, under the supervision of an experienced researcher, is the actual starting point of scientific research.

The BSc degree course is composed of a **major branch** made up of 150 ECTS, and a selectable **minor branch** counting for 30 ECTS. The major branch consists of the compulsory UEs in physics and mathematics, and a supplementary science chosen from chemistry, biology, or computer science (locally known as the "propaedeutic branch"). The UEs of the minor branch may not overlap with those of the major. Outside of that restriction, all other subjects taught at the University of Fribourg can potentially be selected as minors. Among the selective minors, mathematics is the obvious choice for physicists, although interdisciplinary study with another science is often attractive. If a student wishes to choose a different minor, she or he must consult with the student advisor in physics to establish a suitable curriculum.

The MSc degree program consists of a one full year of formal lectures, exercise classes, projects, seminars, and an MSc project lasting six months and terminating with the Master's thesis. Although examinations of the UEs of the BSc can be deferred for several semesters after the course, note carefully that the examinations of the MSc UEs are only possible after all requirements for the BSc have been completed (cf. 1.3). Frequently, lectures for both the master and third year of bachelor programs are given in common, with differences made in the associated exercises to reflect the different levels. Advanced classes for both MSc and PhD students are also sometimes offered.

### 1.3 Acquired Skills

The aim of the studies leading to the award of an MSc in Physics 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 study programme, 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 Course Assessment (UE) and Accreditation of ECTS Credits

Acquisition of ECTS credits occurs via three steps: assessment of individual UEs, grouping of UEs into a validation package, and awarding the respective ECTS credits for the completed package.

Exercises are assessed following written criteria given at the beginning of the course (e.g., number of submitted exercise papers, number of correctly solved exercises, etc.). Permission to sit the exam associated with a formal lecture can be subject to the successful completion of the lecture's corresponding exercise class.

**Assessment** of lectures is made by an oral and/or written exam, whose type and duration are specified in an appendix to this curriculum. Exams occur during the official exam sessions in spring, summer, or autumn, and are subject to a fee. Students register for each exam via the students' web portal MyUniFR (<https://my.unifr.ch>), within the stipulated delays according to the on-line procedure and using their university provided account and password. The marks range from 6 (highest mark) to 1 (lowest mark). An exam marked below 4 can be repeated, but only once, and at earliest during the next exam session.

A **Validation package** comprises multiple, separately assessed, UEs. Art. 18 of the Regulation determines the number of these packages 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 a UE, and
- the assessment criteria for UE not subject to formal examinations (practical work exercises seminars, etc.) are met.
- no mark is equal to 1.0.

After satisfying those conditions, a package is considered validated and the corresponding ECTS points are converted into ECTS credits and attributed to the student. Upon request, the Dean's office will issue confirmations in which exam results and awarded credits 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 depending on the choice of the instructor. Students are free to decide in which of the two languages they wish to express themselves. Courses for third year taught in common with MSc students are in English.

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

## 1.6 Ethics and Science

Ethical principles are an integral part of a scientific education. Accepted international conventions must be respected during research and while documenting all 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 physics at the University of Fribourg can be found in the documents referenced on the web page <http://www3.unifr.ch/scimed/en/plans> which can also be obtained from the Office of the Physics Department, Chemin du Musée 3, CH-1700 Fribourg.

## 2 Bachelor of Science (BSc)

See the French or the German versions of the curriculum for the BSc degree requirements.

## 3 Master of Science (MSc)

[Version 2018, validation packages: PV-SPH.0000006, PV-SPH.0000011]

The MSc program in Physics requires 90 ECTS credits to complete, and is expected to take 18 months. The first year (60 ECTS credits) consists primarily of courses, exercises, the weekly seminar, and the first part of the master's work, designed to strengthen and complete the student's existing physics knowledge. The lectures can be taken at Fribourg, or may be partially composed of courses offered under the BeNeFri agreement, or from the "Troisième Cycle Romand" courses of the Swiss-French universities. The MSc degree course is completed by a research project of 36 ECTS credits in total, which includes the writing of a Master's thesis.

UEs (Course Units) of the MSc can only be assessed and accredited after successful completion of the BSc.

### 3.1 MSc Course Units

The first year of MSc study has two semesters of compulsory courses counting for 24 ECTS credits. The compulsory courses vary between even and odd years as noted below.

#### 3.1.1 Program for Odd-Numbered Years

##### Semester 1 (autumn)

Code	Title of UE	tot. h.	ECTS
<b>Compulsory Courses</b>			
SPH.04102	Atomic physics (lecture)	28	2
SPH.04112	Atomic physics (exercises)	14	1.5
SPH.04301	Magnetism and quantum fluids (lecture)	28	2
SPH.04311	Magnetism and quantum fluids (exercises)	14	1.5
SPH.04501	Classical statistical mechanics (lecture)	28	2
SPH.04511	Classical statistical mechanics (exercises)	14	1.5
SPH.04004	Colloquia	14	0.5
SPH.04007	Proseminars	14	1
			<b>12</b>

##### Semester 2 (spring)

Code	Title of UE	tot. h.	ECTS
<b>Compulsory Courses</b>			
SPH.04201	Atomic spectroscopy (lecture)	28	2
SPH.04211	Atomic spectroscopy (exercises)	14	1.5
SPH.04401	Structure and dynamics of matter (lecture)	28	2
SPH.04411	Structure and dynamics of matter (exercises)	14	1.5
SPH.04605	Introduction to the many-body problem (lecture)	28	2
SPH.04615	Introduction to the many-body problem (exercises)	14	1.5
SPH.04008	Colloquia	14	0.5
SPH.04009	Proseminars	14	1
			<b>12</b>

3.1.1.1 Course Units distributed over three semesters:

Code	Title of UE	tot. h.	ECTS
<b>Compulsory Courses</b>			
SPH.04003	Project	–	5
SPH.04010	Project presentations <sup>1</sup>		1
<b>Elective Courses</b>			
SPH.04nnn	Specialized courses in Physics	–	15
	Other (English for Masters Students recommended)		9
			<b>30</b>

<sup>1</sup> To be chosen during the last semester of study

The student advisor will inform you about the choice and distribution of the UE.

**3.1.2 Program for Even-Numbered Years****Semester 1 (autumn)**

Code	Title of UE	tot. h.	ECTS
<b>Compulsory Courses</b>			
SPH.04103	Particle physics (lecture)	28	2
SPH.04113	Particle physics (exercises)	14	1.5
SPH.04302	Electrons in solids (lecture)	28	2
SPH.04312	Electrons in solids (exercises)	14	1.5
SPH.04502	Quantum statistical mechanics (lecture)	28	2
SPH.04512	Quantum statistical mechanics (exercises)	14	1.5
SPH.04004	Colloquia	14	0.5
SPH.04007	Proseminars	14	1
			<b>12</b>

**Semester 2 (spring)**

Code	Title of UE	tot. h.	ECTS
<b>Compulsory Courses</b>			
SPH.04202	Modern optics (lecture)	28	2
SPH.04212	Modern optics (exercises)	14	1.5
SPH.04403	Soft condensed matter physics (lecture)	28	2
SPH.04413	Soft condensed matter physics (exercises)	14	1.5
SPH.04602	Introduction to field theory (lecture)	28	2
SPH.04612	Introduction to field theory (exercises)	14	1.5
SPH.04008	Colloquia	14	0.5
SPH.04009	Proseminars	14	1
			<b>12</b>

3.1.2.1 Course Units distributed over three semesters:

Code	Title of UE	tot. h.	ECTS
<b>Compulsory Courses</b>			
SPH.04003	Project	–	5
SPH.04010	Project presentations <sup>1</sup>		1
<b>Elective Courses</b>			
SPH.04nnn	Specialized courses in Physics	–	15
	Other (English for Masters Students recommended)		9
			<b>30</b>

<sup>1</sup> To be chosen during the last semester of study

The student advisor will inform you about the choice and distribution of the UE.

## 3.2 Content of the MSc UE

### 3.2.1 Lectures

The obligatory courses are given in common with courses for students in the third year of the BSc, with additional content and exercises adapted to the higher level demanded of MSc students. The exams will also reflect the more stringent requirements.

In addition to the required lectures, the student will require at least 15 ECTS from lectures specializing in either experimental or theoretical physics. The choice of available lectures varies from year to year; at Fribourg we have offered the following topics:

- Selected chapters in Atomic Physics and Optics (e.g., Precision physics with spin polarized atoms)
- Selected chapters in Solid State Physics (e.g., Magnetism, Solid State Spectroscopy, and Superconductivity)
- Selected chapters in Soft Condensed Matter Physics (e.g., Light, X-ray, and neutron scattering in soft matter)
- Advanced Statistical Mechanics
- Many-body theory
- Critical Phenomena
- Electronics
- Computational Physics
- General Relativity
- Biological Physics
- Symmetries in Physics
- Optics of strongly scattering media

The specialized lectures may also be taken at other universities. The *Troisième Cycle* courses of the Swiss-French universities are also eligible. It is recommended that the student follows specialization courses in the same domain as the intended thesis work.

Other lectures are necessary to complete the ECTS requirements; these elective courses are at the discretion of the student.

### 3.2.2 Colloquia, Proseminars and Research Seminars

*Colloquia* (SPH.04004, SPH.04008): Each student will attend the weekly departmental colloquia given by visiting researchers (attendance list) and must provide a summary of 4 of them.

*Proseminars* (SPH.04007, SPH.04009): Each student will make a presentation based on recent research papers (one presentation either for SPH.04007 or SPH.04009) and attend to all other seminar presentations (attendance list).

*Project presentations* (SPH.04010): Each student must give a presentation in which the results of the Masters Project (SPH.04003) are presented.

### 3.2.3 Advanced Project

The advanced project, be it experimental or theoretical, consists of work performed within one of the research groups present at Fribourg. During the work, the student will become intimately familiar with the experimental techniques and/or theoretical methods applicable to the physical



problems on which the master's thesis will eventually be based. The results will be written in an extended, detailed report.

### 3.3 MSc Exams and Assessment

Assessment criteria for UEs are specified in the appendices to the curriculum in Physics and Mathematics.

The UEs of the first year of study are collectively assessed in the first validation package, and gives the student 54 ECTS, if successful.

### 3.4 Master's Thesis and Exam

The second validation package of the Master's program (36 ECTS) consists entirely of the UE dedicated to the *Master's thesis* itself (SPH.05001). This work is foreseen to last between six (6) to twelve (12) months. It will start during the 2<sup>nd</sup> semester of MSc studies and will extend over the entire 3<sup>rd</sup> semester. It is real research work which the student will do under the supervision of an active researcher in the field, and during which the student's aptitude for fundamental research will begin to develop. The work will be presented both as a formal written document, and as a 30 minutes oral presentation. The work will be judged on the same 1 (totally unacceptable) to 6 (excellent) scale as the exams are. This validation package will be validated only for marks of 4 and above. If a work is judged insufficient, a second master thesis may be undertaken on a different subject.

Successful completion of the two validation packages results in the right to the title **Master of Science in Physics, University of Fribourg (MSc)**.

### 3.5 Admission Regulations for the Master Programme

#### 3.5.1 Admission Procedure

Acceptance to a Master programme in Physics may be granted provided the following two conditions have been met by the applicant:

- Satisfying the University admission requirements as defined in the *Règlement concernant l'admission à l'Université de Fribourg* (<https://www3.unifr.ch/apps/legal/fr/document/274904>),
- The student possesses a Bachelor of Science in Physics from the University of Fribourg or an academic degree judged equivalent by the Faculty of Science and Medicine.

For candidates with degrees that are not judged equivalent by the Faculty of Science and Medicine, the Commission for Students' Requests will decide on eligibility (*Commission des requêtes des étudiant-e-s*, Dean's Office, Faculty of Science and Medicine, ch. du Musée 8, CH-1700 Fribourg, Switzerland).

Based on the candidate's academic qualification, the Commission for Students' Requests can accept the application on the condition that additional requirements are fulfilled, provided they are of a minor scope and can be completed simultaneously with the Master studies. Otherwise, access is denied or applicants can be admitted to a "pre-master programme" and can begin the Master programme only after having fulfilled the requirements initially set for the pre-master. Final acceptance to the Master programme for a qualifying student depends on the successful completion of the additional requirements.

### **3.5.2 Standard Transfers**

Under certain conditions, access to the Master's programme may be granted directly. This is of particular applicability for candidates holding a title of Bachelor HES. A detailed description of these conditions is available from the Dean's Office of the Faculty of Science and Medicine, or from the Studies Advisor in the Physics department.