



UNIVERSITY OF FRIBOURG

FACULTY OF SCIENCE

Curriculum for the obtention of the Degree of

Master of Science in Physics

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1 General Remarks

This curriculum describes all the regulations concerning the course of studies in physics 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 certificats universitaires (« Bachelor of Science ») et des diplômes (« 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 Physics**, subsequently called **BSc**.
- **Master of Science in Physics**, subsequently called **MSc**.

The **programme of study of the BSc** in Physics represents a university course of studies, comprising a basic scientific education in physics 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 Physics forms the basis for advanced studies leading to the MSc in Physics. 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 Physics represents a scientific course of studies, allowing one to specialize in a specific subject. The MSc in Physics 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 like mathematics, the MSc allows one to enter a complementary didactics programme leading to a qualification as a high-school teacher (*Fähigkeitszeugnis für das Höhere Lehramt II*).

Persons in possession of a BSc in Physics of the University of Fribourg or any other Swiss university are admitted to the MSc course of studies in physics (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 a decision of the Faculty of Science to be made in each individual case. Provisional admission can be granted, which then depends on the fulfilment of additional requirements (cf. Section 3.5).

1.2 Course Structure

The degree courses leading to the BSc and MSc respectively are subdivided into **course (UE)** comprising lectures, exercise classes, laboratories, seminars, student projects, etc. To each UE, a number of **ECTS¹ points** is 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 (corres-

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

ponding 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).

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 physics and mathematics. The minor may not overlap with the major. Otherwise all subjects taught at the University of Fribourg can potentially be selected as minors. Among the selective minors, mathematics is the obvious minor for physicists. If a student wishes to choose a different minor, he/she must consult the student advisor of physics in order to work out a suitable curriculum.

The MSc degree programme consists of a one-year taught programme comprising lectures, exercise classes, and seminars, and a **MSc project** lasting 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. (cf. 1.3).

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

- **Lectures** give an introduction to the scientific methods in physics and advance thinking in a scientific way. They help acquiring the required knowledge and understanding the fundamental concepts.
- **Exercise classes** complement the lectures and provide essential help for working with and understanding a lecture's content. They give students the opportunity to practise and apply the acquired principles and the mathematical techniques.
- **Student projects** are a first step, towards concret, experimental or theoretical approach of problem solving.
- **Seminar presentations** are used for working on as well as presenting orally existing scientific results.

The preparation of the **Master thesis**, under the supervision of an experienced researcher, is the actual starting point of scientific research.

1.3 Assessment of Course (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.

Exercises are assessed following the criteria given at the beginning of the course (number of submitted exercise papers, number of correctly solved exercises, etc.). Admission to the exam corresponding to a lecture course can be subject to meeting the requirements of the corresponding exercise class. **Assessment** of lectures is made by an oral and/or written exam, whose type and duration are regulated in 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. 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 package 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 a UE.
- the assessment criteria of UE not examined (practical work, exercises, etc.) are met.

Under these prerequisites, validation package 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.

1.4 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 German, French, or English.

1.5 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.

1.6 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 [Réglement d'admission de l'Université de Fribourg / *Zulassungsreglement der Universität Freiburg*; (www.unifr.ch/rectorat/reglements)]
- Regulation of 2 February 2004 for the Obtainment of the Bachelor of Science and Master of Science
- Curriculum for the basic and subsidiary subjects of the Faculty of Science of the University of Fribourg
- Study guide of the University of Fribourg
- University calendar of the University of Fribourg

2 Bachelor of Science (BSc)

(See the French or the German versions of the curriculum for the obtention of the degree of Bachelor of Science in Physics)

3 Master of Science (MSc)

[Version 2004, validation packages: MSc1-PH.0007, MSc2-PH.0008]

The MSc program in Physics requires 90 ECTS to complete, and is expected to take 18 months. The first year (60 ECTS) consists primarily of courses, exercises, the weekly seminar, and the preparation toward the thesis work (literature survey), designed to strengthen and complete the students existing physics knowledge. The lectures can be followed at Fribourg, or may be partially composed of courses offered under the BeNeFri agreement, or from the "Troisième Cycle" courses of the Swiss-French universities. The MSc degree course is completed by a master research project of 30 ECTS in total which includes writing a master thesis.

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

3.1 Course Units of the MSc

Semester 1 (winter)

Code	Title	hours	ECTS
Required Courses			
PH.4100	Advanced condensed matter I	3	3
PH.4110	Exercises (Advanced condensed matter I)	1	1.5
PH.4300	Atoms and photons I	3	3
PH.4310	Exercises (Atoms and photons I)	1	1.5
PH.4500	Advanced quantum mechanics	2	2
PH.4510	Exercises (Advanced quantum mechanics)	2	3
PH.4001	Seminars and Colloquia	1	2
PH.4003	Project		5
Elective courses			
PH.xxxx	Specialized courses in Physics		3
–	Other (Scientific English recommended)		6
			30

Semester 2 (summer)

Code	Title	hours	ECTS
Required Courses			
PH.4200	Advanced condensed matter II	3	3
PH.4210	Exercises (Advanced condensed matter II)	1	1.5
PH.4400	Atoms and photons II	3	3
PH.4410	Exercises (Atoms and photons II)	1	1.5
PH.4002	Master's thesis preparation		9
Elective courses			
PH.xxxx	Specialized courses in Physics		9
–	Other		3
			30

3.2 Content of the UE of the MSc

Lectures

The core courses of *Atoms and photons* and *Advanced condensed matter* consolidate the students knowledge of two important domains of modern physics research. *Atoms and photons* treats in

more detail the ideas of atomic physics and modern optics developed in the undergraduate courses *Constituants de la matière I-III*. The course on *Advanced condensed matter* specializes on solid state, physics of liquids, and the boundary area of soft matter physics, again building on the material covered in *Matière condensée I-III* from the undergraduate syllabus. *Advanced quantum mechanics* develops the key ideas of scattering, relativistic quantum mechanics, and the quantum treatment of light (second quantization).

In addition to the required lectures (which are given every year), the student will require at least 12 ECTS from lectures specializing in 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
- Selected chapters in solid state physics
- Selected chapters in soft condensed matter physics
- Advanced statistical mechanics
- Many-body theory
- Critical phenomena
- Quantum field theory
- Electronics
- Computational physics

The specialized lectures may be taken at other universities; for example, the BeNeFri Advanced Materials course (12 ECTS). The *Troisième Cycle* courses of the Swiss-French universities are also eligible. It is recommended that the student follow 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.

Seminars and Colloquia

Each student will present a seminar based on recent research papers (cf. 2.2.3); attendance is expected for all other seminar presentations, as well as for the weekly department colloquia presented by visiting researchers.

Master's Project

The thesis 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 thesis is based. The results will be written in an extended, detailed report.

Preparation of the Master's thesis

Before beginning the thesis work, a literature review will be made. The work consists of collecting all recent and pertinent publications on the topic, and writing a summary analysis of the state of the field. In addition, progress to understanding the necessary experimental and/or theoretical techniques necessary for the final thesis work will begin.

3.3 MSc Exams and Assessment

The first year of study is collectively assessed under the name of validation package MSc1, and gives the student 60 ECTS, if successful. The evaluation of the weekly seminar, the project, and the literature survey preparation is made based on criteria announced at the beginning of the year. The course evaluations are made by the following exams:

1. Thirty-minute oral exam for each of the following:
 - *Advanced condensed matter I* (PH.4100)

- *Atoms and photons I* (PH.4300)
- *Advanced condensed matter II* (PH.4200)
- *Atoms and photons II* (PH.4400)
- *Advanced quantum mechanics* (PH.4500)

Evaluation criteria (written/oral exam, homework evaluation, etc) fixed in writing at the beginning of the course for:

2. Specialized courses in Physics;
3. Scientific English;
4. Elective courses.

3.4 Master's thesis and exam

The second validation package of the Master's program (MSc2) consists entirely of the *The Master's thesis* itself (PH.5000). Work can only officially begin when the MSc1 coursework has been completed.

The work, valued at 30 ECTS and occurring in the last six months of the program, will be research related, but of a relatively modest scope, undertaken by the student with the assistance of a person having solid research experience. This work will allow the student to develop his or her taste and aptitude for research. The final report of the work will be presented both as a written scientific text (dissertation) and by oral examination in the form of a 30 minutes conference. The thesis and dissertation are evaluated on a scale of 1 (totally unacceptable) to 6 (outstanding work). Successful validation of MSc2 occurs for values of 4 and above. If a work is judged insufficient, a second MSc2 project may be offered to the student.

Successful completion of the MSc1 and MSc2 course work results in the right to the title "Master of Science (MSc) in Physics".

3.5 Regulations of Admission to the Master Programme

3.5.1 Admission procedure

Admission to the Masters program 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*,
- The student possesses a Bachelor in Physics from the University of Fribourg or equivalent degree judged acceptable by the Faculty of Science.

The Faculty of Science establishes and maintains the list of equivalent degrees. Candidates holding a degree quoted in that list will be automatically accepted for a Master's program (provided the other requirement, i.e. (1), is satisfied). Candidates with degrees not on the list will be required to submit an application, in writing, to the Committee of Student Requests ("Commission des requetes des etudiant-es", care of: Office of the Dean, Faculty of Science, Musée 6a, CH-1700 Fribourg, Switzerland), which will decide on eligibility. In some cases, acceptance may be conditionally based on additional coursework requirements: these may be satisfied in parallel with the regular master's work, or the student may be required to enter as a qualifying student. Final acceptance in the Master's program for a qualifying student is contingent on the successful completion of the additional requirements.

3.5.2 Standard Transfers

Under certain conditions, access to the Master's program 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 Decanat of the Science Faculty, or from the Studies Adviser in the Physics department.