UNIVERSITÀ
DEGLI STUDI
DI TRIESTE

ACADEMIC REGULATION of the MASTER'S DEGREE IN PHYSICS

ACADEMIC YEAR 2026-27

Ministerial class

LM-17

Approved by the Course Council on 27 November 2025.

Article 1 – Objectives and scope

1. Pursuant to Article 12(1) of Italian Ministerial Decree No 270/2004, the Regulation on Educational Activities of the Master's Degree in Physics defines the organisational aspects of this degree programme.

2. Pursuant to the provisions of the Regulation on Educational Activities of the University of Trieste, this regulation is approved by the competent bodies after obtaining the opinion of the Department's teacher-student joint committee in accordance with the degree programme outline. This is done in full respect of academic freedom and taking into consideration the rights and obligations of teachers and students.

3. For the purposes of this document, the following definitions apply.

- The 'University REA' is the Regulation on Educational Activities of the University of Trieste.
- The 'degree programme outline' is the programme outline (structure and organisation) of the Master's Degree in Physics annexed to the University REA.
- The 'Department' is the Department of Physics at the University of Trieste.
- The 'degree programme' is the Master's Degree in Physics.
- The 'Course Council' is the course council of the Master's Degree in Physics.
- The 'Education Committee' is the education committee of the Master's Degree in Physics.
- The 'Thesis Committee' is the evaluation committee for students' final theses at the Master's Degree in Physics.
- The 'Regulation on Educational Activities' is this present document, i.e. the regulation on educational activities of the Master's Degree in Physics.
- 'International mobility' means a mobility period when students carry out their studies, internship and/or research for their final thesis at a foreign academic or research institution. Mobility periods are regulated by relevant agreements or University calls for applications and their completion must be certified.
- The 'master's degree website' is the set of webpages dedicated to the Master's Degree in Physics within the University's website. The English version of the master's degree website is accessible from the following URL: https://lauree.units.it/en/0320107301800010 University 'credits' correspond to units within the European Credit Transfer and Accumulation System (ECTS);
- The 'discipline code' is the code by which the Italian Ministry of University and Research identifies each academic discipline.
- The 'type' of educational activity indicates the category within which all academic courses and other activities fall according to the provisions of the Italian Ministry of University and Research.

Article 2 – Contents

1. The Regulation lays down the rules for the application of the degree programme outline. In particular, they define the following elements:

   a) the list of courses and any other educational activities and their discipline code;
   a) the possible division of taught courses into modules;
   a) the educational objectives and credits of all degree taught courses and other educational activities;
   a) any prerequisite for taking a given course;
   a) the specific curricula and pathways offered to students;
   a) the rules for the submission of any individual study programme;
   a) the different course formats, including distance learning;
   a) the premises where educational activities are actually carried out;
   a) the types of examinations and other assessment tests;
   b) any provisions on attendance requirements;
   c) admission requirements and procedure.

Article 3 – Degree programme bodies

1. The degree programme has the following official bodies:

   a) the Course Council;
   b) the Coordinator of the Course Council;
   c) the Education Committee;
   d) the Thesis Committee;
   e) the Admission Committee.

2. The Course Council is composed of the following members:

   a) teachers entrusted with educational activities within the degree programme;
   b) contract teaching staff entrusted with educational activities within the degree programme or teachers of courses delivered as part of another degree programme;
   c) representatives of the students enrolled in the degree programme. The number of student representatives corresponds to 15 % of the members of the Council, rounded up to the nearest whole number.

The members referred to in point c) only participate in the formation of the quorum and majorities of the committee if they are present at the meeting.

The term of office for student representatives is one year. Representatives are elected between 1 October and 30 November by all the students enrolled in the degree programme. Each student may only vote one candidate. Failure to designate student representatives does not affect the functioning of the Course Council. In the event that a student representative steps down from office or is dismissed prematurely, they shall be replaced by the first of the non-elected candidates.

Meetings of the Course Council are valid also when held remotely.

3. The Course Council has the following functions:

a) planning and coordinating the educational activities required to obtain the final degree. The Committee submits the programme to the Departmental Council for approval;
b) deciding on matters related to the career of students (internal and external transfers, enrolment with credit recognition, etc.);
c) approving or rejecting individual study programmes;
d) organising and regulating student support and tutoring activities;
e) assigning theses as well as supervisor and co-supervisor(s) to graduating students;
f) defining and proposing the composition of thesis committees to the Head of the Department;
g) asking academic staff to cover the required courses, in full respect of their freedom of teaching and their competence, then proposing to the Departmental Council the official assignment of educational activities;
h) expressing opinions on the teaching activity of researchers within the degree programme;
i) proposing the regulation on educational activities and any amendments to the Departmental Council;
j) appointing the members of the committees referred to in Article 3(1)(c, d, e) and the staff member in charge of internships and type-F educational activities after hearing the proposal made by the Coordinator.

The Coordinator of the Course Council is elected from among full-time tenured academic staff within the bachelor's and master's degrees in Physics. The term of office is three academic years and the same person cannot be elected more than twice consecutively. The election takes place in accordance with Article 45 of the General Regulation of the University.

The Coordinator appoints a deputy from among the members of the Course Council referred to in Article 3(2)(a). The Deputy replaces the coordinator whenever necessary.

4. the Coordinator of the Course Council has the following functions:

a) representing the Degree Programme;

b) convening the meetings of the Committee at least one week in advance and chairing it;

c) implementing the deliberations of the Course Council, Education Committee and Thesis Committee.

5. The Education Committee is composed of the Coordinator, who chairs it, and of one teacher for each pathway that has been activated. These teachers are designated by the Course Council upon proposal of the Coordinator. Student representatives referred to in paragraph 2(c) of this Article shall take part in the meetings of the Education Committee in an advisory capacity.

6. The Education Committee has the following functions:

a) handling the procedures for the preparation of the degree programme outlines

b) formulating proposals and expressing opinions on the evaluation of teaching;

c) preparing the documentation on matters related to the students' academic records (internal and external transfers, enrolment with credit recognition, etc.);

d) proposing the schedule of educational activities;

e) proposing any prerequisites for taking other courses;

f) coordinating the annual schedule of written and practical examinations.

7. The Thesis Committee is composed of one teacher for each pathway that has been activated. It is designated by the Course Council upon proposal of the Coordinator. A teacher may be a member of both Thesis Committee and Education Committee.

1. The Thesis Committee has the following functions:

a) helping students choose their thesis' topic and periodically asking the academic staff about lists of possible subjects in order to make them known to students;

b) examining students' requests for a thesis supervisor, to be chosen from among the teachers of the degree programme of from among the teaching staff in the field of physics and proposing a co-examiner to be approved by the Course Council;

c) examining any student's request for an external supervisor submitted pursuant to Article 13(3). If the request is considered as valid, the thesis' subject is of interest to the Department and an academic staff member is available to act as internal contact, the Thesis Committee proposes the request as well as the names of the internal contact and co-supervisor to the Course Council for approval;

d) evaluating any request for the recognition of credits for study, research and drafting activities to be carried out abroad for the final thesis when there are no specific rules on these mobility periods. The request must be submitted together with the request for a

thesis' supervisor and must be signed by the proposed supervisor. The Thesis Committee proposes the whole request to the Course Council for approval;

e) proposing the number and dates of graduating sessions.

9. The Admission Committee is designated by the Course Council upon proposal of the Coordinator. It verifies that prospective students meet entry requirements. It is composed of three members of the permanent teaching staff of the degree programme. The term of office is two years and it may only be renewed once.

Article 4 – Structure and organisation

1. The degree programme is organised and regulated on the basis of the following documents:

a) the degree programme outline;
b) the list of taught courses and educational activities;
c) the annual study programme.

2. The degree programme outline defines the structure and organisation of the degree programme. It defines how to apply the criteria of the ministerial class to which the master's degree belongs.

1. The list of taught courses and educational activities defines the following elements for each curriculum and/or pathway:

a) the list of courses and any other educational activities and their discipline code;
b) the possible modules into which courses may be divided;
c) the credits students may obtain from each course or educational activity;
d) the educational objectives of all courses;
e) any prerequisite.

The list of taught courses and educational activities is set out in Annexes B1 and B2 of this Regulation.

4. The annual study programme defines the organisational structure of the degree programme, with particular regard to the distribution of educational activities across the two-year programme and within each year. The study programme is proposed by the Course Council, defined annually by the Department Council, in accordance with the degree programme

outline and the list of courses and educational activities, and approved by the competent University bodies in compliance with the Statute.

The annual study programme is published in the official outline, as well as on the master's degree website.

Article 5 – Admission to the degree programme and assessment of admission requirements

1. In order to be admitted to the degree programme, students must have an eligible three-year university degree obtained in Italy or abroad. Candidates must be able to demonstrate a level B2 in English on the CEFR scale. Language proficiency assessment is regulated by Article 11. Adequate knowledge of mathematics and physics is required. In particular, the following basic knowledge is deemed necessary:

   - Mathematical Analysis, Geometry, Linear Algebra, and Computer Science for a total of at least 15 ECTS;
   - Classical Physics (Mechanics, Thermodynamics, Electromagnetism, Acoustics, Optics), Quantum Mechanics, Special Relativity, Statistical Mechanics, Condensed Matter Physics, Nuclear and Subnuclear Physics, Physics Laboratory (experiments and statistical analysis of data) for a total of at least 30 ECTS.

2. The assessment of admission requirements is carried out by the Committee referred to in Article 3(9). Candidates meeting all requirements set out in paragraph 1 must send the following documents to the members of the Admission Committee, preferably via email: a CV including all of the educational activities completed, with the relevant ECTS, dates, marks and syllabi as well as the title of their bachelor's degree thesis and final mark. Documents will have to be sent following the procedure and deadlines published on the University's website in accordance with the calendar referred to in paragraph 4.

3. The assessment of adequate academic preparation is based on candidates' curriculum and, where appropriate, on an interview. Candidates who obtained an Italian bachelor's degree of ministerial class 25 (pursuant to Italian Ministerial Decree No 509/99) or L-30 (pursuant to Italian Ministerial Decree No 270/04) with a final mark of 90 out of 110 (or higher) will be admitted without any admission test. Other candidates who meet the requirements set out in paragraph 1 may be asked to undergo an interview to ensure they have the necessary foundation skills and knowledge.
4. Deadlines for the submission of applications and enrolment are set out by the Academic Calendar.

Article 6 – Obtaining the final degree

1. In order to obtain this master's degree, students must obtain 120 credits in accordance with the law in force in the academic year of enrolment.

2. Pursuant to Article 8 of Italian Ministerial Decree No 270/04, the normal duration of a master's degree is 2 years.

3. The final degree may also be obtained before the end of the two-year period, provided that the student has acquired the 120 credits set out in their study programme.

Article 7 – Type of educational activities

1. The degree programme includes educational activities divided into the types below, in accordance with Article 10 of Italian Ministerial Decree No 270/04.

   Type B: core disciplines;

   type C: related and integrative subjects;

   type D: elective subjects;

   type E: activity relating to the final examination;

   type F: educational activities aimed at developing additional language, ICT and/or interpersonal skills, and any other professionally relevant skills, as well as internships with external bodies.

1. The credits students must obtain in each type are set out in Annexes B1 and B2 to this Regulation, together with their educational objectives, academic discipline and schedule per year of course and term.

Article 8 – Curricula, pathways and study programmes

1. Taught courses and educational activities within the degree programme are scheduled so as to offer different pathways within the official curricula corresponding to different specialisations in the various branches of Physics. Curricula, pathways and their educational objectives and activities, as well as any prerequisites, are described in Annexes B1 and B2.

2. Students may submit individual study programmes. Individual study programmes must be drafted according to the degree programme outline and meet the criteria below.
   - At least 40 ECTS must be obtained in advanced concepts and skills.
   - At least 6 ECTS must be obtained in advanced concepts and skills in at least three of the following academic disciplines (pursuant to Italian Ministerial Decree No 1649 of 19th December 2023):
     - Experimental Physics and Applied Physics (including cultural heritage, environmental, biomedical applications);
     - Theoretical Physics, Mathematical Models and Methods;
     - Condensed Matter Physics and Physics of Fundamental Interactions;
     - Astronomy, Astrophysics and Cosmology, and Geophysics and Atmospheric Sciences.
   - Between 15 and 21 ECTS must be obtained in complementary subjects.
   - Between 9 and 12 ECTS must be obtained in elective subjects.
   - Between 5 and 8 ECTS must be obtained in type-F activities;
   - 40 ECTS must be dedicated to the final thesis.
   - They cannot include more than eleven taught courses, excluding elective subjects and extra-credit activities.

   Students without an Italian bachelor's degree of ministerial class 25 (pursuant to Italian Ministerial Decree No 509/99) or L-30 (pursuant to Italian Ministerial Decree No 270/04) [see Article 3(3)] need to submit an individual study programme. The rules for submitting and modifying individual study programmes are established at the University level. Individual study programmes must be approved by the Course Council. Standard study programmes are provided for students with an Italian bachelor's degree of ministerial class 25 (pursuant to Italian Ministerial Decree No 509/99) or L-30 (pursuant to Italian Ministerial Decree No 270/04). Standard study programmes are listed in Annex B1 and are automatically approved.

3. Students may submit individual study programmes with more than 120 ECTS. Limits and rules laid down in the Regulation on the Academic Career of Students apply. The final master's degree certificate shall indicate all the credits obtained by the student, including any extra credits.

4. Students wishing to adhere to international mobility programmes must establish the educational activities they will follow at the host institution together with the coordinator of the Erasmus mobility for their degree programme. These activities must be approved by the Course Council before the start of the mobility period. The Department of Physics has approved a mark conversion table, which is useful for activities with a final mark. Credits are registered by the University Academic Services at the end of the mobility period and on the basis of the transcript of records sent by the partner institution to certify the activities carried out by the student.

Article 9 – Formats of courses, examinations and other assessment tests, including remote formats;

1. Every University credit (ECTS) corresponds to an average of 25 hours spent by the student between classes and independent learning. The usual proportion is one third of the time spent in classes and two thirds devoted to independent study. For laboratory activities, the time is divided equally.

2. The following teaching formats are allowed:
   - lectures in the classroom, possibly with the use of multimedia tools;
   - computational or other exercises in classroom or computer room;
   - individual or group laboratory experiments;
   - lectures and/or experiments at research facilities outside the University or periods spent at other Italian or foreign universities in the framework of international agreements;
   - specific lectures may also be given in teleconference, according to the official outline.

3. Lectures can be held in Italian or English, at the choice of the teacher, who will clearly indicate their choice in the syllabus.

4. Internships aim at acquiring working skills that may be useful for the final thesis and are generally carried out under the guidance of the student's supervisor or of another staff member agreed with the Course Council. At the end of their internship, students present their work in a public seminar attended by the student's supervisor and the staff member in charge of internships. Further educational activities aimed at developing additional language, ICT skills and any other professionally relevant skills may be carried out under the guidance of supervisors designated by the Teaching Committee. The outcomes of these activities are assessed through the presentation of the results of an individual project. This may be done in writing, as a public seminar, or by creating a multimedia content or a software.

5. Pursuant to the University REA, all educational activities that allow for the acquisition of credits are assessed by a committee that includes the person in charge of the activity. The overall evaluation is expressed in marks out of 30, possibly with honours. Internships and type-F activities are simply evaluated as approved/not approved.

6. Examinations may include a written/practical test, an interview or both. A written report on the activity carried out may be required for laboratories. There are three examination periods in accordance with Article 26 of the Regulation on the Academic Career of Students.

Interviews and written tests for the same examination are generally carried out in the same examination period, unless the teacher in charge of the educational activity decides otherwise. Every year, the dates of examination rounds and periods are indicated in the programme's official outlines and published on the master's degree website. Students may withdraw from interviews, but in that case the board of examiners may decide that any related written test shall be repeated as well.

Article 10 – Credit recognition

Students may request the recognition of credits for professional skills and competences or for academic skills and competences acquired through higher-education activities designed and offered by the University of Trieste and any partners. Requests must be supported by appropriate certifications. The Educational Committee evaluates the activities carried out by the student and their equivalence and compatibility with the educational objectives of the degree programme. If necessary, the Committee will contact the student for further information. Requests are then discussed by the Course Council, which will accept or reject them.

Article 11 – English language proficiency assessment procedures and recognition of credits related to knowledge of any other EU language(s) or computer skills.

Students' English language proficiency will be assessed through both a written test and an interview. They shall demonstrate at least an English level B2 on the Common European Framework of Reference for Languages (CEFR) scale. This level of proficiency may be deduced from the student's academic records or from a certificate issued by a recognised institution. In all other cases, admission is subject to a language proficiency assessment carried out by the University.

Credits for the knowledge of other EU languages may be recognised on the basis of internationally recognised certificates up to the maximum number of ECTS allowed by the degree programme outline.

Credits for computer skills may be recognised on the basis of the documents submitted up to the maximum number of ECTS allowed by the degree programme outline.

Article 12 – Periodic evaluation of the credits acquired over ten years before

If some examinations were taken ten years or more before graduation and the relevant knowledge may have become obsolete, the Course Council may impose additional activities or request additional assessment interviews.

Article 13 – Final examination and obtaining the final degree

1. Students obtain their Master's Degree in Physics after discussing a thesis before a board of examiners composed of at least five members which is appointed by the competent educational structures.

2. The thesis is a written document presenting original results on a research topic within a specific field. The thesis must include an appropriate bibliography. The research can be experimental, theoretical or computational.

3. The research for the thesis is carried out under the guidance of a supervisor, who is usually a teacher of the degree programme or another academic staff member of the University working in the field of physics. The thesis supervisor is assigned by the Thesis Committee in accordance with the procedures laid down in Article 3(8)(b, c). The thesis can be written in Italian or in English. Even if the thesis is written in English, the title page, with the title of the thesis and the names of the supervisor and any co-supervisors, as well as an abstract of the thesis, must be written in Italian. Students must submit the project of their thesis together with the request for a thesis supervisor to the Thesis Committee at least 6 months before they plan to discuss their thesis. If a student wishes to prepare their thesis with an external supervisor, they must first request an interview with the Committee. If the thesis project is feasible, at least 8 months before they plan to discuss their thesis the student must submit the following documents to the Thesis Committee: a motivational letter, the thesis project (1-2 pages) with a short description of goals, techniques and expected results. The documents must be signed by the applicant and their prospective supervisor. The Commission then proceeds as described in Article 3(8)(c).

4. If part or all of the study, research and drafting activity for the thesis is carried out at a foreign institution, the student may apply for the recognition of the 5 F-type credits for the internship, and up to 30 E-type credits for the final examination, under ‘credits earned abroad’. The student must submit this request to the Thesis Committee together with the documentation referred to in point 3. In the absence of any specific indications on international mobility, the documentation attesting that these activities have been carried out will be evaluated for the recognition of credits by the Coordinator of the Course Council and a member of the Thesis Committee.

5. The final degree mark is based on the evaluation of the student’s records, the contents of their thesis, its presentation and on further elements aimed at encouraging students to pass all their examinations and concluding their studies within the time limits set by the degree programme outline. The overall final mark is determined as the sum of the following elements:

   a) the basis for the final mark is the average of the examination marks obtained during the two-year programme weighted by the relevant ECTS and expressed in marks out of 110;

   b) an additional 0.2 points will also be awarded for each examination passed with honours (*lode*), up to a maximum of 2 points;

c) the total amount is rounded up if the first decimal place is 5 or more, and down if the first decimal place is less than 5;

d) students who have passed all their examinations before the September examination period of their second year shall be awarded an additional ‘speed point’;

Students in line with their exam schedule, i.e. students graduating during their second-year graduation periods, shall be awarded an additional ‘in time point’;

f) students who have undertaken an international mobility period of at least 6 continuous weeks and have achieved at least 1 ECTS shall be awarded an additional “mobility point”;

g) during the final test, the counter-supervisor shall add 0, 1 or 2 points, respectively, if they consider the test to be below the average, at average levels or above the average;

h) during the final test, the board of examiners may award up to a maximum of an additional four points;

i) only students whose overall score is 111/110 or more may graduate with honours; in any case, this is only possible upon proposal of the supervisor and the unanimous agreement of the board of examiners;

l) graduates with honours whose overall score is 119/110 or more may be awarded a distinction. The distinction may only be awarded upon proposal of the supervisor and the unanimous agreement of the board of examiners.

Article 14 – Provisions on attendance requirements

1. Attendance of laboratory activities is mandatory.

2. The Education Committee shall establish the alternative activities that students in employment or students with disabilities will have to follow instead of courses with mandatory attendance. The Committee may also establish supplementary distance learning materials for non-regular students or part-time students.

Article 15 – Transfer of students from other degree programmes

1. Any requests for transfer to the Master’s Degree in Physics are proposed by the Education Committee and then discussed by the Course Council, which may accept or reject them, if necessary after hearing the candidate. The deadlines for the submission of transfer requests are set out by the Academic Calendar.

2. Students requesting transfer must also submit an individual study programme indicating the educational activities for which they request credit recognition.

3. Students may request the recognition of credits obtained in other degree programmes or at other universities as well as the recognition of credits for certified professional skills and competences. The Educational Committee evaluates the activities carried out by the student and their equivalence and compatibility with the educational objectives of the degree programme. Requests are then discussed by the Course Council, which will accept or reject them. The Committee may also conduct interviews to assess the students' initial proficiency. Whenever possible, the Course Council will recognise the largest number of credits possible. The reason for any rejection will be detailed.

Article 16 – Transitional and final provisions

Amendments to the Regulation related to the degree programme outline, Article 13(4, 5) of this Regulation or the list of courses on offer of types A, B and C shall apply only to students enrolled in the first cohort following the entry into force of this Regulation. Unless expressly stated otherwise, any other rule shall come into force for all enrolled students after approval by the Departmental Council.

Annex B1 (academic year 2026-2027)

Description of the educational pathway:

Curricula and study programmes

The educational offer of the Master's Degree in Physics includes six curricula with the relevant study programmes.
Here you will find:

1. The structure of the curricula included in the educational offer with the distribution of ECTS by type, academic area and discipline;
2. For each curriculum you will find:
    a. educational objectives;
    b. a table for presenting the standard study programmes, including the available elective course options and their distribution across the programme;
    c. additional information on standard study programmes and/or examples of study programmes.

Standard study programmes are automatically approved and are designed to provide students with a well-balanced and clearly structured educational pathway. The Department strives to ensure that class times for standard study programmes do not overlap.

Individual study programmes with advanced concepts and skills (type B) and complementary subjects (type C) other than those proposed in the standard study programmes are also possible. Individual study programmes will have to:

- meet the credit requirements established in the degree programme outline
- be adequately justified by the student
- be examined by the Education Committee for consistency and approved by the Course Council.

All study programmes must include at least 6 ECTS in at least three of the following academic disciplines (pursuant to Italian Ministerial Decree No 1649 of 19 December 2023):

- Experimental Physics and Applied Physics;
- Theoretical Physics, Mathematical Models and Methods;
- Condensed Matter Physics and Physics of Fundamental Interactions;
- Astronomy, Astrophysics and Cosmology, and Geophysics and Atmospheric Sciences.

- In accordance with the current regulations, the total number of ECTS/CFU credits required to obtain this degree is 120, distributed as follows: Between 40 and 60 credits must be obtained in type-B activities (advanced concepts and skills). Credits must be distributed as follows among the four above-mentioned disciplines: between 6 and 30 credits in experimental and applied physics; between 6 and 30 credits in theoretical physics, mathematical models and methods; between 0 and 30 credits in condensed matter physics and physics of fundamental interactions; between 0 and 30 credits in astronomy, astrophysics and cosmology, geophysics, and atmospheric sciences.
- Between 15 and 21 credits must be obtained in type-C activities (complementary subjects).
- Between 46 and 66 credits must be obtained in other activities (types D, E and F), distributed as follows: between 9 and 12 credits must be obtained from individual activities chosen by the student. Between 35 and 40 credits must be obtained from the final examination. Up to 3 credits can be obtained from the study of another foreign language. Up to 3 credits can be obtained from acquiring ICT skills.

Between 2 and 6 credits must be obtained from internships or traineeships. Up to 2 credits can be obtained from acquiring knowledge and skills that will be useful for entering the world of work.

1. Curriculum structure

The following table shows the distribution of ECTS across the different educational activities for each curriculum.

Educational activities are divided into different **types** (*tipologia di attività formativa* – TAF)

- **core disciplines** or type **B**
- **related and integrative subjects** or type **C**
- **elective subjects** or type **D**
- **activity relating to the final examination** or type **E**
- **educational activities aimed at developing additional language, ICT and/or interpersonal skills, and any other professionally relevant skills, as well as internships with external bodies** or type **F**

CONDENSED MATTER PHYSICS

Type	Field	Discipline Code	ECTS
B	Experimental and applied physics	PHYS-01/A PHYS-03/A PHYS-06/A	6
	Theoretical physics and foundations of physics	PHYS-02/A PHYS-04/A PHYS-06/B	6
	Condensed matter physics and physics of fundamental interactions	PHYS-01/A PHYS-02/A PHYS-03/A PHYS-04/A	30
	Astrophysics, geophysics, and atmospheric and space sciences	GEOS-04/A GEOS-04/C PHYS-05/A PHYS-05/B	0
C	Complementary subjects		18
D	Elective subjects		12
E	Final examination/Thesis		40
F	Internship		5
F	Computer tools for physics		3

NUCLEAR AND SUBNUCLEAR PHYSICS

Type	Field	Discipline Code	ECTS
B	Experimental and applied physics	PHYS-01/A PHYS-03/A PHYS-06/A	12
	Theoretical physics and foundations of physics	PHYS-02/A PHYS-04/A PHYS-06/B	6
	Condensed matter physics and physics of fundamental interactions	PHYS-01/A PHYS-02/A PHYS-03/A PHYS-04/A	21
	Astrophysics, geophysics, and atmospheric and space sciences	GEOS-04/A GEOS-04/C PHYS-05/A PHYS-05/B	6
C	**Complementary subjects**		18
D	Elective subjects		12
E	Final examination/Thesis		40
F	Internship		5

THEORETICAL PHYSICS

Type	Field	Discipline Code	ECTS
B	Experimental and applied physics	PHYS-01/A PHYS-03/A PHYS-06/A	6
	Theoretical physics and foundations of physics	PHYS-02/A PHYS-04/A PHYS-06/B	30
	Condensed matter physics and physics of fundamental interactions	PHYS-01/A PHYS-02/A PHYS-03/A PHYS-04/A	6
	Astrophysics, geophysics, and atmospheric and space sciences	GEOS-04/A GEOS-04/C PHYS-05/A PHYS-05/B	0
C	**Complementary subjects**		21
D	Elective subjects		12
E	Final examination/Thesis		40
F	Internship		5

PHYSICS OF COMPLEX SYSTEMS and CLIMATE AND FINANCE MODELLING

Type	Field	Discipline Code	ECTS
B	Experimental and applied physics	PHYS-01/A PHYS-03/A PHYS-06/A	6
	Theoretical physics and foundations of physics	PHYS-02/A PHYS-04/A PHYS-06/B	18
	Condensed matter physics and physics of fundamental interactions	PHYS-01/A PHYS-02/A PHYS-03/A PHYS-04/A	12
	Astrophysics, geophysics, and atmospheric and space sciences	GEOS-04/A GEOS-04/C PHYS-05/A PHYS-05/B	6
C	**Complementary subjects**		18
D	Elective subjects		12
E	Final examination/Thesis		40
F	Internship		5
F	Computer tools for physics		3

ASTROPHYSICS AND COSMOLOGY

Type	Field	Discipline Code	ECTS
B	Experimental and applied physics	PHYS-01/A PHYS-03/A PHYS-06/A	6
	Theoretical physics and foundations of physics	PHYS-02/A PHYS-04/A PHYS-06/B	6
	Condensed matter physics and physics of fundamental interactions	PHYS-01/A PHYS-02/A PHYS-03/A PHYS-04/A	0
	Astrophysics, geophysics, and atmospheric and space sciences	GEOS-04/A GEOS-04/C PHYS-05/A PHYS-05/B	30
C	**Complementary subjects**		18
D	Elective subjects		12
E	Final examination/Thesis		40
F	Internship		5
F	Computer tools for physics		3

QUANTUM SCIENCE AND TECHNOLOGY

Type	Field	Discipline Code	ECTS
B	Experimental and applied physics	PHYS-01/A PHYS-03/A PHYS-06/A	6
	Theoretical physics and foundations of physics	PHYS-02/A PHYS-04/A PHYS-06/B	24
	Condensed matter physics and physics of fundamental interactions	PHYS-01/A PHYS-02/A PHYS-03/A PHYS-04/A	6
	Astrophysics, geophysics, and atmospheric and space sciences	GEOS-04/A GEOS-04/C PHYS-05/A PHYS-05/B	6
C	**Complementary subjects**		21
D	Elective subjects		12
E	Final examination/Thesis		40
F	Internship		5

2. Curricula and study programmes

2.1 Curriculum in condensed matter physics

Educational objectives

The curriculum in condensed matter physics aims to train graduates with a solid background in experimental, theoretical and/or computational condensed matter physics. In general, this curriculum provides an overview of current problems in various areas of condensed matter physics, including classical disordered systems, topological materials, strongly correlated electronic models, low-temperature atomic and molecular systems, surface physics, and nanomaterials. Several standard study programmes are possible, focused on experimental techniques or on theoretical and computational methods, leading to expertise in the core disciplines of this field.

Study programmes based on **experimental** physics will provide:

- thorough knowledge of modern measuring instruments and data analysis techniques in condensed matter physics;
- experience with laboratory equipment and techniques;
- ability to use mathematical and computational tools for physics;

Study programmes based on **theoretical and computational** physics will provide:

- thorough knowledge of the state-of-the-art numerical techniques for treating classical and quantum systems in condensed matter physics;
- experience with high-performance computing;
- ability to apply the specific knowledge acquired to the modelling of complex physical systems;

Mixed study programmes will provide an overview of the two approaches described above and allow students to acquire both experimental as well as theoretical and computational techniques so as to obtain a broad understanding of the many aspects of condensed matter physics.

All standard study programmes foster a strong capacity for independent work and participation in national and international research collaborations. The training provided will allow graduates to continue their education through a PhD in Physics or related disciplines with a view to pursuing a career in research. Alternatively, graduates will be able to enter the technology or IT industry. In particular, the curriculum in condensed matter physics prepares students to contribute to scientific innovation, as well as to the management and design of technologies in fields related to the condensed matter physics. Graduates will have acquired all the necessary skills to produce both research and science communication texts, both in Italian and English.

Condensed Matter Physics – list of courses							
FIRST YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Fisica della materia condensata I **(condensed matter physics 1)**	PHYS-04/A	B	6	***Fisica della materia condensata II*** **(condensed matter physics 2)**	PHYS-04/A	B	6
Laboratorio di Fisica della materia condensata **(condensed matter physics laboratory)** *or* ***Laboratorio di fisica computazionale*** **(computational physics laboratory)**	PHYS-03/A	B	6	***Laboratorio di fisica dei nanomateriali*** **(nanoscale materials laboratory)** *or* ***Laboratorio computazionale di liquidi complessi*** **(complex fluids computational laboratory)**	PHYS-03/A PHYS-04/A	B	6
Teoria dei campi I **(quantum field theory 1)** *or* ***Meccanica statistica*** **(statistical mechanics)**	PHYS-02/A	B	6	***Transizioni di fase e fenomeni critici*** **(phase transitions and critical phenomena)** *or* ***Fondamenti di fisica delle superfici*** **(foundations of surface science)**	PHYS-04/A PHYS-03/A	B	6
Interazione radiazione-materia e luce di sincrotrone **(synchrotron light and interaction of radiation with matter)** *or* ***Atomi, molecole e fotoni*** **(atoms, molecules and photons)**	PHYS-03/A	B	6	**Related and integrative subject**		C	6
Strumenti informatici A **(computer tools A)** *or* ***Strumenti informatici B*** **(computer tools B)**	-	F	3	**Elective course**		D	6
Total number of 1st year credits							57
SECOND YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline**	**Type**	**ECTS**

					Code		
Related and integrative subject		C	6	**Thesis**		E	30
Related and integrative subject		C	6				
Elective course		D	6				
Internship		F	5				
Thesis		E	10				
Total number of 2nd year credits							63

Please note: the choice between Computer Tools A and B must be agreed with the teachers during the first joint lesson.

Related and integrative subjects – courses on offer within the curriculum

- *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems) (PHYS-04/A), 2nd term, 1st year
- *Nanostrutture* (nanostructures) (PHYS-03/A), 2nd term, 1st year
- *Fisica dei sistemi disordinati* (physics of disordered systems) (PHYS-04/A), 1st term, 2nd year
- *Fotonica* (photonics) (PHYS-03/A), 1st term, 2nd year
- *Metodi numerici per i sistemi quantistici a molti corpi* (numerical methods for quantum many-body systems) (PHYS-04/A), 1st term, 2nd year
- *Metodi numerici per la struttura elettronica* (numerical methods for electronic structure) (PHYS-04/A), 2nd term, 1st year
- *Piattaforme quantistiche* (quantum computing platforms) (PHYS-04/A), 1st term, 2nd year

Elective subjects – courses on offer within the curriculum

- *Biofisica sperimentale* (experimental biophysics) (PHYS-06/A), 1st term, 2nd year
- Any courses of type B or C that has not already been included in the study programme.

Elective subjects – courses on offer within other curricula

- *Dinamiche stocastiche* (stochastic dynamics), 2nd term, 1st year
- *Introduzione all'informazione quantistica* (introduction to quantum information), 2nd term, 1st year
- *Superconduttività e dispositivi quantistici* (superconducting quantum devices), 1st term, 2nd year
- *Computazione quantistica* (quantum computation), 1st term, 2nd year
- *Formazione ed analisi di immagini in fisica* (image formation and analysis in physics), 1st term, 2nd year

Standard study programmes which follow the choices indicated above are automatically approved. Students can also choose as 'elective activities' any advanced concepts and skills (type B) or Related and integrative subjects (type C) within this curriculum or other curricula that they have not already included in their study programme as well as courses offered by other degree programmes at the University. If a student chooses a course which is not listed above, the Education Committee will have to evaluate the feasibility and consistency of their study programme with the overall educational objectives. The study programme will then have to be approved by the Course Council.

2.2 Curriculum in nuclear and subnuclear physics

Educational objectives

The curriculum in nuclear and subnuclear physics aims to train graduates with the following skills and knowledge.

- a solid scientific background in nuclear and subnuclear theoretical and applied physics;
- a thorough knowledge of modern measuring instruments and data analysis techniques;
- a thorough knowledge of mathematical and computer tools for physics;
- extensive knowledge and experience of the curriculum's advanced concepts and skills;
- practical experience with laboratory equipment and techniques;
- the ability to fluently speak and write in English and possibly another European Union language in addition to Italian, including technical terminology;
- a strong ability to work independently as well as to participate in large national and international collaborative groups, including as project and unit leaders;
- ability to use the specific knowledge acquired to the modelling of complex physical systems and in areas of applied sciences;

Graduates in nuclear and subnuclear physics will be well prepared to carry out activities in the following fields: research and the promotion and development of technological innovation; technology management and design in areas related to nuclear and subnuclear physics, industry, environment, health, cultural heritage and public administration; dissemination of research results with particular reference to experimental and applied aspects of nuclear and subnuclear physics. They will also have excellent preparation for enrolling in a PhD both in Italy and abroad.

Nuclear and subnuclear physics – list of courses							
FIRST YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Teoria dei campi I **(quantum field theory 1)**	PHYS-02/A	B	6	***Astrofisica nucleare e subnucleare*** **(nuclear and subnuclear astrophysics)**	PHYS-05/A	B	6
Simmetrie e interazioni fondamentali **(fundamental interactions and symmetries)**	PHYS-02/A	B	6	***Caratteristiche generali dei rivelatori*** **(general principles of particle detectors)**	PHYS-01/A	B	6
Related and integrative subject 1		C	6	***Laboratorio acquisizione e controllo dati*** **(data acquisition and control laboratory)**	PHYS-01/A	B	6
Related and integrative subject 2		C	6	***Fisica Nucleare*** **(nuclear physics)**	PHYS-01/A	B	6
				Related and integrative subject 3		C	6
Elective course 1						D	6
Total number of 1st year ECTS							60
SECOND YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Laboratorio di fisica nucleare e subnucleare **(nuclear and subnuclear physics laboratory)**	PHYS-01/A	B	9	**Thesis**		E	30
Elective course 2		D	6				

Internship		F	5				
Thesis		E	10				
Total number of 2nd year ECTS							60

Related and integrative subjects – courses on offer within the curriculum

- *Fondamenti di fisica medica* (foundations of medical physics) (PHYS-06/A), 6 ECTS, 1st term, 1st year
- *Laboratorio di fisica medica* (medical physics laboratory) (PHYS-06/A), 6 ECTS, 2nd term, 1st year
- *Statistica avanzata per la fisica* (advanced statistics for physics) (PHYS-01/A), 6 ECTS, 1st term,
- *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics) (PHYS-01/A), 6 ECTS, 1st term,
- *Onde gravitazionali* (gravitational waves) (PHYS-01/A), 6 ECTS, 1st term,
- *Elettronica avanzata per la fisica sperimentale* (advanced electronics for experimental physics) (PHYS-01/A), 6 ECTS, 1st term, 2nd year
- *Rivelatori a semiconduttore e apparati per la fisica nucleare e subnucleare* (semiconductor detectors and instrumentation in nuclear and subnuclear physics) (PHYS-01/A), 6 ECTS, 1st term, 1st year
- *Formazione ed analisi di immagini in fisica* (image formation and analysis in physics) (PHYS-06/A), 6 ECTS, 1st term,

Related and integrative subjects – courses on offer within other curricula

- *Cosmologia I* (cosmology 1), 6 ECTS, 2nd term, 1st year
- *Modello standard delle interazioni fondamentali* (standard model of fundamental interactions), 6 ECTS, 2nd term, 1st year

Elective subjects – courses on offer within the curriculum

- *Introduzione alla fisica delle particelle* (introduction to particle physics) (PHYS-01/A), 6 ECTS, 1st term, 1st year
- *Fisica sperimentale delle particelle* (experimental particle physics) (PHYS-01/A), 6 ECTS, 1st term, 2nd year
- *Ottica avanzata* (advanced optics) (PHYS-01/A), 6 ECTS, 2nd term, 1st year

Elective subjects – courses on offer within other curricula:

- *Interazione radiazione-materia e luce di sincrotrone* (synchrotron light and interaction of radiation with matter), 6 ECTS, 1st term, 1st year
- *Relatività generale* (general relativity), 6 ECTS, 1st term,

Standard study programmes that will be automatically approved:

a – particle physics pathway

Complementary subject 1 *Statistica avanzata per la fisica* (advanced statistics for physics)
Complementary subject 2 *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics)
or Introduzione alla fisica delle particelle (introduction to particle physics)
Complementary subject 3 *Modello standard delle interazioni fondamentali* (standard model of fundamental interactions),
Choose two courses from the following:

- *Fisica sperimentale delle particelle* (experimental particle physics)
- *Rivelatori a semiconduttore e apparati per la fisica nucleare e subnucleare** (semiconductor detectors and tools in nuclear and subnuclear physics)

- *Elettronica avanzata per la fisica sperimentale** (advanced electronics for experimental physics)
- *Ottica avanzata** (advanced optics)
- *Teoria dei campi II*** (quantum field theory 2)

* = *experimental track*
** = *phenomenological track*

B – astroparticle physics pathway

Complementary subject 1 *Statistica avanzata per la fisica* (advanced statistics for physics)
Complementary subject 2 *Onde gravitazionali* (gravitational waves)
Complementary subject 3 *Cosmologia I* (cosmology 1)
Choose two courses from the following:

- *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics)
- *Ottica avanzata* (advanced optics)
- *Relatività generale* (general relativity)
- *Introduzione alla fisica delle particelle* (introduction to particle physics)
- *Modello standard delle interazioni fondamentali* (standard model of fundamental interactions)

Please note: Before taking Cosmology 1, you must have passed either General Relativity or Gravitational Waves (prerequisite)

C – medical physics pathway

Complementary subject 1 *Fondamenti di fisica medica* (foundations of medical physics)
Complementary subject 2 *Formazione ed analisi di immagini in fisica* (image formation and analysis in physics)
or Programmazione avanzata e tecniche di simulazione per la fisica (advanced programming and simulation techniques for physics)
or *Rivelatori a semiconduttore e apparati per la fisica nucleare e subnucleare* (semiconductor detectors and instrumentation in nuclear and subnuclear physics)
Complementary subject 3 *Laboratorio di fisica medica* (medical physics laboratory)
Choose two courses from the following:

- *Statistica avanzata per la fisica* (advanced statistics for physics)
- *Elettronica avanzata per la fisica sperimentale* (advanced electronics for experimental physics)
- *Interazione radiazione-materia e luce di sincrotrone* (synchrotron light and interaction of radiation with matter)
- *Ottica avanzata* (advanced optics)

Standard study programmes which follow the choices indicated above are automatically approved. Students can also choose as 'elective activities' any advanced concepts and skills (type B) or complementary subject (type C) within this curriculum or other curricula that they have not already included in their study programme, as well as courses offered by other degree programmes at the University. If a student chooses a course which is not listed above, the Education Committee will have to evaluate the feasibility and consistency of their study programme with the overall educational objectives. The study programme will then have to be approved by the Course Council.

2.3 Curriculum in theoretical physics

Educational objectives

The curriculum in theoretical physics aims to train graduates with the following skills and knowledge.

- an overview of current problems in various fields of research in theoretical physics, from elementary particle physics to the more formal aspects of quantum field theory, from the new frontiers of quantum physics to the latest developments in gravitational theories and in the study of complex systems;
- a strong ability to master abstract theoretical formulations and create physical systems models;
- extensive knowledge of advanced mathematical methods and tools for physics;
- an adequate knowledge of modern measuring instruments and data analysis techniques;
- the ability to fluently speak and write in English and possibly another European Union language in addition to Italian, including technical terminology;
- the ability to address new problems and propose solutions;
- a strong ability to work independently as well as to participate in large national and international cooperative groups;

Graduates in theoretical physics will be prepared for high-level activities such as research and development on topics ranging from fundamental physics to complex systems in the public and private sectors. They will also be able to find employment in the dissemination of research results and the transfer of advanced knowledge, two growing areas. They will also have solid foundations for enrolling in a PhD both in Italy and abroad.

Theoretical physics – list of courses							
FIRST YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Teoria dei campi I **(quantum field theory 1)**	PHYS-02/A	B	6	***Teoria dei campi II*** **(quantum field theory 2)**	PHYS-02/A	B	6
Relatività generale **(general relativity)**	PHYS-02/A	B	6	**Related and integrative subject 1**		C	6
Teoria dei gruppi **(group theory)**	PHYS-02/A	B	6	**Related and integrative subject 2**		C	6
Meccanica statistica **(statistical mechanics)**	PHYS-02/A	B	6				
Simmetrie e interazioni fondamentali **(fundamental interactions and symmetries) (1st term)** *or* ***Introduzione ai sistemi quantistici a molti corpi*** **(introduction to quantum many-body systems) (2nd term)**					PHYS-02/A PHYS-04/A	B	6
Elective course 1						D	6
Related and integrative subject 3						C	3
Total number of 1st year credits							57
SECOND YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Elective course 2						D	6
Laboratorio di fisica computazionale **(computational physics laboratory)** *or* ***Programmazione avanzata e tecniche di simulazione per la fisica*** **(advanced programming and simulation techniques in physics)**	PHYS-03/A PHYS-01/A	B	6	**Thesis**		E	27

Related and integrative subject 4		C	6				
Internship		F	5				
Thesis		E	13				
Total number of 2nd year credits							63

Related and integrative subjects (type C) – courses on offer within the curriculum

- *Teoria dei campi III* (quantum field theory 3) (PHYS-02/A), 1st term, 2nd year (6 ECTS)
- *Modello standard delle interazioni fondamentali* (standard model of fundamental interactions) (PHYS-02/A), 2nd term, 1st year (6 ECTS)
- *Fisica delle particelle e cosmologia* (particle physics and cosmology) (PHYS-02/A), 1st term, 2nd year (6 ECTS)
- *Meccanica quantistica e relatività speciale* (quantum mechanics and special relativity) (PHYS-02/A), 1st term, 1st year (3 ECTS)
- *Complementi di teoria dei campi* (advanced quantum field theory) (PHYS-02/A), 2nd term, 1st year (3 ECTS)
- *Teoria delle stringhe* (string theory) (PHYS-02/A), 1st term, 2nd year (6 ECTS)

Related and integrative subjects (type C) – courses on offer within other curricula

- *Computazione quantistica* (quantum computation), 1st term, (6 ECTS)
- *Introduzione all'informazione quantistica* (introduction to quantum information), 2nd term, (6 ECTS)
- *Onde gravitazionali* (gravitational waves) 1st term, (6 ECTS)
- *Statistica avanzata per la fisica* (advanced statistics for physics), 1st term, (6 ECTS)
- *Dinamiche stocastiche* (stochastic dynamics), 2nd term, 1st year (6 ECTS)
- *Complementi di meccanica statistica* (advanced statistical mechanics), 1st term, (6 ECTS)
- *Transizioni di fase e fenomeni critici* (phase transitions and critical phenomena), 2nd term, (6 ECTS)
- *Atomi, molecole e fotoni* (atoms, molecules and photons), 1st term, (6 ECTS)
- *Cosmologia I* (cosmology 1), 2nd term, (6 ECTS)
- *Dinamica del clima* (climate dynamics), 1st term, (6 ECTS)
- *Superconduttività e dispositivi quantistici* (superconductivity and quantum devices), 1st term, (6 ECTS)
- *Sistemi quantistici aperti* (open quantum systems), 1st term, (6 ECTS)
- *Algoritmi di calcolo quantistico* (quantum computing algorithms), 1st term, (6 ECTS)

Related and integrative subjects (type C) – courses on offer within other master's degree programmes (subject to actual activation)

- Advanced Mathematical Physics 1 (MATH-04/A), 1st term, (6 ECTS)
- Advanced Mathematical Physics 2 (MATH-04/A), 2nd term, (6 ECTS)
- Advanced Geometry 1 (MATH-02/B), 1st term, (6 ECTS)
- Topics in Advanced Mathematical Physics 1 (MATH-04/A), 2nd term, (6 ECTS)

Elective subjects (type D) – courses on offer within other curricula

- *Caratteristiche generali dei rivelatori* (general characteristics of particle detectors), 2nd term, 1st year (6 ECTS)
- *Metrologia quantistica* (quantum metrology), 2nd term, 1st year (6 ECTS)
- *Fisica dei sistemi disordinati* (physics of disordered systems), 1st term, (6 ECTS)
- *Cosmologia II* (cosmology 2), 1st term, 2nd year (6 ECTS)
- *Introduzione alla fisica delle particelle* (introduction to particle physics), (6 ECTS), 1st term, 1st year

Elective subjects (type D) – courses on offer within other master's degree programmes (subject to actual activation)

- Functional Analysis (MATH-03/A), 2nd term, (6 ECTS)
- Advanced Geometry 2 (MATH-02/B), 1st term, (6 ECTS)
- Advanced Geometry 3 (MATH-02/B), 2nd term, (9 ECTS)
- Introduction to Machine Learning (IINF-05/A), 1st term, (6 ECTS)
- *Relatività generale avanzata e fisica della gravità* (advanced general relativity and gravitational physics) (PHYS-02/A), 2nd term, (6 ECTS), offered within the Master's Degree in Mathematics at the University of Udine

The complementary subjects above can also be chosen as elective courses.

Standard study programmes which follow the choices indicated above are automatically approved. Students can also choose as 'elective activities' any advanced concepts and skills (type B) or complementary subject (type C) within this curriculum or other curricula that they have not already included in their study programme, as well as courses offered by other degree programmes at the University. If a student chooses a course which is not listed above, the Education Committee will have to evaluate the feasibility and consistency of their study programme with the overall educational objectives. The study programme will then have to be approved by the Course Council.

Examples of study programmes

a – quantum field theory

Advanced concepts and skills: *Teoria dei campi I* (quantum field theory 1), *Relatività generale* (general relativity), *Teoria dei Gruppi* (Group Theory), *Meccanica statistica* (statistical mechanics), *Teoria dei campi II* (quantum field theory 2), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Laboratorio di fisica computazionale* (computational physics laboratory) or *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics).
Complementary subject 1: *Modello standard delle interazioni fondamentali* (standard model of fundamental interactions).
Complementary subject 2: Topics in Advanced Mathematical Physics 1.
Complementary subject 3: *Complementi di teoria dei campi* (advanced quantum field theory).
Complementary subject 4: *Teoria dei campi III* (quantum field theory 3).
1st term elective subjects: *Simmetrie e interazioni fondamentali* (Fundamental Interactions and Symmetries), *Introduzione alla fisica delle particelle* (Introduction to Particle Physics), Advanced Geometry 1, Advanced Mathematical Physics 1, *Fisica delle particelle e cosmologia* (particle physics and cosmology), *Relatività generale avanzata e fisica della gravità* (advanced general relativity and gravitational physics), *Teoria delle stringhe* (string theory).
2nd term elective subjects: Advanced Mathematical Physics 2, *Cosmologia I* (cosmology 1), *Transizioni di fase e fenomeni critici* (phase transitions and critical phenomena).

b – fundamental particle physics

Advanced concepts and skills: *Teoria dei campi I* (quantum field theory 1), *Relatività generale* (general relativity), *Teoria dei gruppi* (group theory), *Meccanica statistica* (statistical mechanics), *Teoria dei campi II* (quantum field theory 2), *Simmetrie e interazioni fondamentali* (fundamental interactions and symmetries), *Laboratorio di fisica computazionale* (computational physics laboratory) or *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics).
Complementary subject 1: *Modello standard delle interazioni fondamentali* (standard model of fundamental interactions).
Complementary subject 2: *Cosmologia I* (cosmology 1).
Complementary subject 3: *Complementi di teoria dei campi* (advanced quantum field theory).
Complementary subject 4: *Fisica delle particelle e cosmologia* (particle physics and cosmology).
1st term elective subjects: Introduzione alla fisica delle particelle (introduction to particle physics), *Cosmologia II* (cosmology 2), *Teoria dei campi III* (quantum field theory 3), *Onde gravitazionali* (gravitational waves), *Statistica avanzata per la fisica* (advanced statistics for physics).
2nd term elective subjects: Transizioni di fase e fenomeni critici (phase transitions and critical phenomena).

c – quantum mechanics

Advanced concepts and skills: *Teoria dei campi I* (quantum field theory 1), *Relatività generale* (general relativity), *Teoria dei gruppi* (group theory), *Meccanica statistica* (statistical mechanics), *Teoria dei campi II* (quantum field theory 2), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Laboratorio di fisica computazionale* (computational physics laboratory) or *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics).

Complementary subjects 1 and 2: *Introduzione all'informazione quantistica* (introduction to quantum information), *Transizioni di fase e fenomeni critici* (phase transitions and critical phenomena), *Metrologia quantistica* (quantum metrology).

Complementary subject 3: *Meccanica quantistica e relatività speciale* (quantum mechanics and special relativity).

Complementary subject 4: *Computazione quantistica* (quantum computation), *Superconduttività e dispositivi quantistici* (superconductivity and quantum devices), *Atomi, molecole e fotoni* (atoms, molecules and photons)

Elective subjects 1 and 2: *Computazione quantistica* (quantum computation), *Atomi, molecole e fotoni* (atoms, molecules and photons), Introduction to Machine Learning, or one of the courses within the complementary subjects 1 and 2.

d – statistical physics

Advanced concepts and skills: *Teoria dei campi I* (quantum field theory 1), *Relatività generale* (general relativity), *Teoria dei gruppi* (group theory), *Meccanica statistica* (statistical mechanics), *Teoria dei campi II* (quantum field theory 2), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Laboratorio di fisica computazionale* (computational physics laboratory) or *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics).

Complementary subject 1: *Transizioni di fase e fenomeni critici* (phase transitions and critical phenomena).

Complementary subject 2: *Dinamiche stocastiche* (stochastic dynamics).

Complementary subject 3: *Meccanica quantistica e relatività speciale* (quantum mechanics and special relativity), *Complementi di teoria dei campi* (advanced quantum field theory)

Complementary subject 4: *Complementi di meccanica statistica* (advanced statistical mechanics)

Elective subject 1: *Introduzione all'informazione quantistica* (introduction to quantum information), *Metrologia quantistica* (quantum metrology).

Elective subject 2: *Fisica dei sistemi disordinati* (physics of disordered systems).

e – mathematical physics

Advanced concepts and skills: *Teoria dei campi I* (quantum field theory 1), *Relatività generale* (general relativity), *Teoria dei gruppi* (group theory), *Meccanica statistica* (statistical mechanics), *Teoria dei campi II* (quantum field theory 2), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Laboratorio di fisica computazionale* (computational physics laboratory) or *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques in physics).

Complementary subject 1: Advanced Mathematical Physics 2,

Complementary subject 2: Topics in Advanced Mathematical Physics 1

Complementary subject 3: *Meccanica quantistica e relatività speciale* (quantum mechanics and special relativity) or *Complementi di teoria dei campi* (advanced quantum field theory).

Complementary subject 4: Advanced Mathematical Physics 1,

1st term elective subjects: Advanced Geometry 3, Functional Analysis.

2nd term elective subjects: Advanced Geometry 1, Advanced Geometry 2, *Teoria dei campi III* (quantum field theory 3), *Teoria delle stringhe* (string theory).

2.4 Curriculum in physics of complex systems and climate and finance modelling

Educational objectives

The curriculum in physics of complex systems and climate and finance modelling aims to train graduates with the following skills and knowledge.

- a solid scientific background in statistical physics and in physics of complex systems;
- knowledge of advanced statistical and computational physics methods as well as mathematical methods and tools for physics;
- knowledge of modern data analysis techniques, including the use of artificial intelligence;
- specific knowledge for the modelling of complex physical systems and for applications in areas of applied science, with particular attention to climate and finance modelling;
- knowledge of innovative techniques for studying phenomena characterised by a high degree of unpredictability and complexity, in particular those relating to climate and environmental crises as well as economic and financial crises;
- the ability to fluently speak and write in English and possibly another European Union language in addition to Italian, including technical terminology; ability to address new problems and propose solutions;
- a strong ability to work independently as well as to participate in large national and international cooperative groups, including as project and unit leaders;

Graduates in physics of complex systems will be trained in working environments that require the assessment of confidence levels of numerical predictions, models and simulations. They will be able to respond to the urgent need to analyse phenomena characterised by a high degree of unpredictability and complexity in fields of major impact, including social impact, such as those relating to climate and environmental crises as well as economic and financial crises. Graduates in physics of complex systems and climate and finance modelling will be prepared for high-level activities such as research and development in the public and private sectors. They will be able to engage in high-level dissemination of research results, with particular reference to the experimental and applied aspects of the physics of the atmosphere, ocean and climate (e.g. natural risk management) and financial markets. They will also have excellent foundations for enrolling in a PhD both in Italy and abroad.

Physics of complex systems and climate and finance modelling – list of courses							
FIRST YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
***Meccanica statistica* (statistical mechanics)**	PHYS-02/A	B	6	***Fluidodinamica geofisica* (geophysical fluid dynamics)**	PHYS-05/B	B	6
Atomi, molecole e fotoni (atoms, molecules and photons) (1st term) or *Transizioni di fase e fenomeni critici* (phase transitions and critical phenomena) (2nd term)					PHYS-03/A PHYS-04/A	B	6
***Laboratorio di fisica computazionale* (computational physics laboratory)**	PHYS-03/A	B	6	***Dinamiche stocastiche* (stochastic dynamics)**	PHYS-02/A	B	6
***Strumenti informatici A* (computer tools A)** *or* ***Strumenti informatici B* (computer tools B)**		F	3	***Sistemi complessi avanzati* (advanced complex systems)**	PHYS-04/A	B	6
Related and integrative subject 1 ***Gravimetria e magnetometria* (gravimetry and magnetometry)** (offered within the Master's Degree in Geophysics and Geodata) *or* ***Fisica dei sistemi disordinati* (physics of disordered systems)**	GEOS-04/A PHYS-04/A	C	6	Related and integrative subject 2 Module block: *fisica dell'atmosfera* (atmospheric physics) **(*Dinamica e processi a larga scala* [large-scale dynamics] - *Termodinamica e processi alla mesoscala* [mesoscale thermodynamics and processes])** *or* ***Metodi quantitativi per la finanza* (quantitative analysis in finance)**	PHYS-05/B PHYS-06/A	C	6
Elective course 1						D	6
Total number of 1st year credits							57
SECOND YEAR							
1st term	**Discipline**	**Type**	**ECT**	**2nd term**	**Discipline**	**Type**	**ECT**

	Code		S		Code		S
Elective course 2						D	**6**
Complementi di meccanica statistica (advanced statistical mechanics)	PHYS-02/A	B	6	**Thesis**		E	27
Related and integrative subject 3 Dinamica del clima (climate dynamics)	PHYS-05/B	C	6				
Internship		F	5				
Thesis		E	13				
Total number of 2nd year credits							63

Please note: the choice between Computer Tools A and B must be agreed with the teachers during the first joint lesson.

Elective courses that will be automatically approved

Courses on offer within other curricula

- *Laboratorio di astrofisica spaziale* (space astrophysics laboratory), 1st term, (6 ECTS)
- *Meteorologia e climatologia dello spazio* (space weather and climate), 2nd term, (6 ECTS)
- *Biofisica sperimentale* (experimental biophysics), 1st term, (6 ECTS)
- *Fisica della materia condensata I* (condensed matter physics 1), 1st term, (6 ECTS)
- *Fisica nucleare* (nuclear physics), 2nd term, (6 ECTS)
- *Programmazione avanzata e tecniche di simulazione per la fisica* (advanced programming and simulation techniques for physics), 1st term, (6 ECTS)
- *Laboratorio computazionale di liquidi complessi* (complex fluids computational laboratory), 2nd term, (6 ECTS)
- *Statistica avanzata per la fisica* (advanced statistics for physics), 1st term, (6 ECTS)
- *Fisica dei sistemi disordinati* (physics of disordered systems), 1st term, (6 ECTS)

Courses on offer within other degree programmes (subject to actual activation)

- *Radioprotezione nel campo ambientale e lavorativo* (environmental and workplace radiation protection) (PHYS-06/A), 2nd term, (6 ECTS) (offered within the Bachelor's Degree in Physics)
- Seismology (GEOS-04/A), 2nd term, 1st year (6 ECTS) (offered within the Master's Degree in Geophysics and Geodata)
- Introduction to Machine Learning (IINF-05/A), 1st term, (6 ECTS) (offered within the Master's Degree in Electrical and Computer Engineering)
- Stochastic Modelling and Simulation (INFO-01/A) (offered within the Master's Degree in Scientific and Data-intensive Computing)
- Statistical Machine Learning (INFO-01/A) (offered within the Master's Degree in Scientific and Data-intensive Computing)

Standard study programmes which follow the choices indicated above are automatically approved. Students can also choose as 'elective activities' any advanced concepts and skills (type B) or complementary subject (type C) within this curriculum or other curricula that they have not already included in their study

programme, as well as courses offered by other degree programmes at the University. If a student chooses a course which is not listed above, the Education Committee will have to evaluate the feasibility and consistency of their study programme with the overall educational objectives. The study programme will then have to be approved by the Course Council.

2.5 Curriculum in astrophysics and cosmology

Educational objectives

The curriculum in astrophysics and cosmology aims to train graduates with the following skills and knowledge:

- mastery of the scientific method;
- a solid foundation in classical and modern physics;
- a thorough preparation in modern astrophysics and cosmology;
- advanced knowledge of modern data collection and measuring instruments as well as of data analysis techniques;
- a thorough knowledge of mathematical and computer tools for physics;
- Extensive knowledge and experience of the disciplines characterising this sector;
- the ability to fluently speak and write in English and possibly another European Union language in addition to Italian, including technical terminology;
- a considerable working autonomy, enabling graduates in astrophysics and cosmology also to act as project and unit leaders;
- ability to apply the specific knowledge acquired for the modelling of complex physical systems and in areas of applied science;

Graduates will be able to continue their education with a PhD in Physics, Astronomy or in similar disciplines to try and enter the world of basic research in academia or other research institutions. More generally, graduates will be able to enter the industrial and service sectors requiring high-level skills, a high degree of autonomy and coordination skills. Graduates in astrophysics and cosmology may especially serve the following functions:

- promotion and development of scientific and technological innovation in the field of astrophysics, cosmology and space, as well as management and design of related technologies;
- project design in areas related to astrophysical, cosmological and space-related disciplines in the fields of industry, environment, cultural heritage and public administration;
- high-level science communication in astronomy and astrophysics, as well as project organisation and management for the dissemination of research results.

Astrophysics and cosmology – list of courses							
FIRST YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Astrofisica delle galassie **(astrophysics of galaxies)**	PHYS-05/A	B	6	***Cosmologia I*** **(cosmology 1)**	PHYS-05/A	B	6
Relatività generale **(general relativity)**	PHYS-02/A	B	6	***Laboratorio di Tecnologie Astronomiche*** **(astronomical technologies laboratory)**	PHYS-05/A	B	6
Processi radiativi **(radiative processes)**	PHYS-05/A	B	6	**Related and integrative subject 1**	PHYS-05/A	C	6
Astrofisica stellare **(stellar astrophysics)**	PHYS-05/A	B	6	**Elective course 1**		D	6
Strumenti informatici A **(computer tools A)** *or* ***Strumenti informatici B*** **(computer tools B)**		F	3				
Elective course 2						D	6
Total number of 1st year credits							57
SECOND YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
Laboratorio di astrofisica spaziale **(space astrophysics laboratory)** *or* ***Laboratorio di programmazione avanzata per l'astrofisica*** **(advanced computational astrophysics laboratory)**	PHYS-01/A	B	6	**Thesis**		E	30

Related and integrative subject 2		C	6				
Related and integrative subject 3		C	6				
Internship		F	5				
Thesis		E	10				
Total number of 2nd year credits							63

Please note: Before taking Cosmology 1, you must have passed either General Relativity or Gravitational Waves (prerequisite).

Please note: the choice between Computer Tools A and B must be agreed with the teachers during the first joint lesson.

Standard study programmes that will be automatically approved:

Standard study programmes must meet the following criteria:

- Complementary subject 1 must be chosen from the courses on offer during the second term of the first year.
- Complementary subjects 2 and 3 must be chosen from the courses on offer during the first term of the second year.
  Elective subjects 1 and 2 must be chosen from the courses on offer within the curriculum, other curricula or other degree programmes (see 'Elective courses' below for more details). Elective subject 2 may also be taken during the first term.

Related and integrative subjects – courses offered during the second term of the first year (6 ECTS each)

Courses on offer within the curriculum:

- *Cosmologia osservativa* (observational cosmology) (PHYS-05/A)
- *Meteorologia e climatologia dello spazio* (space weather and climate) (PHYS-05/A)
- *Astrofisica nucleare e subnucleare* (nuclear and subnuclear astrophysics) (PHYS-05/A)

Related and integrative subjects – courses offered during the first term of the second year (6 ECTS each)

Courses on offer within the curriculum

- *Cosmologia II* (cosmology 2), (PHYS-05/A)
- *Pianeti e astrobiologia* (astrobiology and planetary science) (PHYS-05/A)

Courses on offer within other curricula

- *Onde gravitazionali* (gravitational waves)
- *Atomi, molecole e fotoni* (atoms, molecules and photons)
- *Teoria dei campi I* (quantum field theory 1)
- *Simmetrie e interazioni fondamentali* (fundamental interactions and symmetries)
- *Fisica delle particelle e cosmologia* (particle physics and cosmology)

Elective subjects

Courses on offer within the curriculum

- *Radioastronomia* (radio astronomy) (PHYS-05/A), 2nd term, 1st year (6 ECTS)

Courses on offer within other master's degree programmes (subject to actual activation)

- *Relatività generale avanzata e fisica della gravità* (advanced general relativity and gravitational physics) (PHYS-02/A), 2nd term, 1st year (6 ECTS), offered within the Master's Degree in Mathematics at the University of Udine

Students can choose as 'elective subjects' any advanced concepts and skills (type B) or Related and integrative subject (type C) within this curriculum or other curricula that they have not already included in their study programme or also courses offered by other degree programmes at the University. If a student chooses courses from any advanced concepts and skills (type B) or complementary subject (type C) offered within this curriculum, the study programme shall be automatically approved. If a student chooses a course which is not listed above, the Education Committee will have to evaluate the feasibility of their study programme and the consistency with the overall educational objectives.

Examples of study programmes

The study programmes below include all of the following advanced concepts and skills: *Astrofisica delle galassie* (galaxy formation and evolution), *Relatività generale* (general relativity), *Processi radiativi* (radiative processes), *Astrofisica stellare* (stellar astrophysics), *Cosmologia I* (cosmology 1), *Laboratorio di tecnologie astronomiche* (astronomical technology laboratory). They also include either Computer Tools A or Computer Tools B, to be chosen with the teachers during the first joint lesson.
Depending on how they are completed, they may have different areas of focus.

Stellar astrophysics

- *Laboratorio di astrofisica spaziale* (space astrophysics laboratory)
- *Astrofisica nucleare e subnucleare* (nuclear and subnuclear astrophysics), *Cosmologia osservativa* (observational cosmology), *Radioastronomia* (radio astronomy)
- *Pianeti e astrobiologia* (astrobiology and planetary science), one course chosen from among *Cosmologia II* (cosmology 2), *Atomi, molecole e fotoni* (atoms, molecules and photons) and *Onde gravitazionali* (gravitational waves)

Extragalactic astrophysics

- *Laboratorio di astrofisica spaziale* (space astrophysics laboratory)
- *Radioastronomia* (radio astronomy), *Cosmologia osservativa* (observational cosmology), *Fisica delle particelle e cosmologia* (particle physics and cosmology)
- *Cosmologia II* (cosmology 2), one course chosen from among *Onde gravitazionali* (gravitational waves) *Atomi, molecole e fotoni* (atoms, molecules and photons) and *Teoria dei campi I* (quantum field theory 1)

Theoretical cosmology

- *Laboratorio di programmazione avanzata per l'astrofisica* (advanced computational astrophysics laboratory)
- *Cosmologia osservativa* (observational cosmology), *Fisica delle particelle e cosmologia* (particle physics and cosmology), *Radioastronomia* (radio astronomy) or a course chosen from among those offered within the curriculum in theoretical physics
- *Cosmologia II* (cosmology 2), one course chosen between *Teoria dei campi I* (quantum field theory 1), *Onde gravitazionali* (gravitational waves) and *Relatività generale avanzata e fisica della gravità* (advanced general relativity and gravitational physics)

Multi-messenger astronomy

- *Laboratorio di astrofisica spaziale* (space astrophysics laboratory) or *Laboratorio di programmazione avanzata per l'astrofisica* (advanced computational astrophysics laboratory)
- *Astrofisica nucleare e subnucleare* (nuclear and subnuclear astrophysics), *Radioastronomia* (radio astronomy) and a course chosen from among those offered within the curriculum in nuclear and subnuclear physics – astroparticle physics pathway
- *Onde gravitazionali* (gravitational waves), *Cosmologia II* (cosmology 2),

Computational astrophysics

- *Laboratorio di programmazione avanzata per l'astrofisica* (advanced computational astrophysics laboratory)
- *Cosmologia osservativa* (observational cosmology), two courses chosen from among the computational subjects offered at the University of Trieste, two courses chosen from among: *Cosmologia II* (cosmology 2), *Pianeti e astrobiologia* (astrobiology and planetary science),
- *Onde gravitazionali* (gravitational waves)

Planetary science and space physics

- *Laboratorio di astrofisica spaziale* (space astrophysics laboratory)
- *Meteorologia e climatologia dello spazio* (space weather and climate), *Radioastronomia* (radio astronomy), *Astrofisica nucleare e subnucleare* (nuclear and subnuclear astrophysics)
- *Pianeti e astrobiologia* (astrobiology and planetary science), one course chosen from among: *Cosmologia II* (cosmology 2), *Onde gravitazionali* (gravitational waves), *Atomi, molecole e fotoni* (atoms, molecules and photons) and *Teoria dei campi I* (quantum field theory 1)

2.6 Curriculum in quantum science and technology

Educational objectives

The curriculum in quantum science and technology aims to train graduates with the following skills and knowledge:

- an overview of current challenges in information processing, metrology and simulation of classical and quantum systems;
- mastery of the use of quantum computing platforms in computation, machine learning, information and communication theory;
- sound knowledge of quantum information processing in metrology and simulation and of theoretical modelling applied to these systems;
- extensive knowledge of mathematical and computer tools for physics;
- extensive knowledge and experience of nuclear and subnuclear physics;
- adequate knowledge of modern measuring instruments and data analysis techniques;
- the ability to fluently speak and write in English and possibly another European Union language in addition to Italian, including technical terminology;
- a strong ability to address new problems and propose solutions;
- a strong ability to work independently, as well as to participate in large national and international cooperative groups;

Graduates in quantum science and technology will be prepared for high-level activities such as research and development on topics ranging from quantum computation to quantum information and communication in the public and private sectors. They will respond to the increasing demand for profiles with quantum skills that can fit into what is going to become the second industrial revolution. They will also have solid foundations for enrolling in a PhD both in Italy and abroad.

Quantum science and technology – List of courses							
FIRST YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
***Computazione quantistica* (quantum computation),**	PHYS-02/A	B	6	***Introduzione all'informazione quantistica* (introduction to quantum information)**	PHYS-02/A	B	6
***Atomi, molecole e fotoni* (atoms, molecules and photons)**	PHYS-03/A	B	6	***Metrologia quantistica* (quantum metrology)**	PHYS-02/A	B	6
Computational Physics Laboratory *or* ***Laboratorio di fisica della materia condensata* (condensed matter physics laboratory)**	PHYS-03/A	B	6				
***Meccanica quantistica e relatività speciale* (quantum mechanics and special relativity)**	PHYS-02/A	C	3				
Related and integrative subject 1						C	6
Related and integrative subject 2						C	6
Elective course 1						D	6
Elective course 2						D	6
Total number of 1st year credits							57
SECOND YEAR							
1st term	**Discipline Code**	**Type**	**ECTS**	**2nd term**	**Discipline Code**	**Type**	**ECTS**
***Gravimetria e magnetometria* (gravimetry and magnetometry)** (offered within the	GEOS-04/A	B	6	**Thesis**		E	30

Master's Degree in Geophysics and Geodata)							
***Algoritmi di calcolo quantistico* (quantum computing algorithms)**	PHYS-02/A	B	6				
Related and integrative subject 3						C	6
Internship		F	5				
Thesis		E	10				
Total number of 2nd year credits							63

Related and integrative subjects – courses on offer within the curriculum

- *Superconduttività e dispositivi quantistici* (superconductivity and quantum devices) (PHYS-02/A), 6 ECTS, 1st term,
- Quantum Machine Learning (INFO-01/A), 6 ECTS, 2nd term,
- *Sistemi quantistici aperti* (open quantum systems) (PHYS-02/A), 1st term, (6 ECTS)

Related and integrative subjects – courses on offer within other curricula

- *Fisica della materia condensata I* (condensed matter physics 1), 6 ECTS, 1st term, 1st year
- *Fotonica* (photonics), 6 ECTS, 1st term, 1st year
- *Metodi numerici per i sistemi quantistici a molti corpi* (numerical methods for quantum many-body systems), 6 ECTS, 1st term, 1st year
- *Piattaforme quantistiche* (quantum computing platforms), 6 ECTS, 1st term,
- *Teoria dei campi I* (quantum field theory 1), 6 ECTS, 1st term,
- *Dinamiche stocastiche* (stochastic dynamics), 6 ECTS, 2nd term,
- *Fisica della materia condensata II* (condensed matter physics 2), 6 ECTS, 2nd term, 1st year
- *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), 6 ECTS, 2nd term, 1st year
- *Laboratorio computazionale di liquidi complessi* (complex fluids computational laboratory), 6 ECTS, 2nd term, 1st year

Related and integrative subjects – courses on offer within other degree programmes (subject to actual activation)

- Introduction to Machine Learning (IINF-05/A), 6 ECTS, 1st term, 1st year
- *Algoritmi di ottimizzazione* (optimisation algorithms) (INFO-01/A), 6 ECTS, 2nd term, 1st year
- *Codici correttori d'errore* (error-correcting codes) (IINF-05/A), 6 ECTS, 2nd term,

Elective subjects – courses on offer within other curricula

Any courses chosen from among complementary subjects that have not already been chosen as type-C courses. In addition:

- *Elettronica avanzata per la fisica sperimentale* (advanced electronics for experimental physics), 6 ECTS, 1st term,
- *Formazione ed analisi di immagini in fisica* (image formation and analysis in physics), 1st term,
- *Meccanica statistica* (statistical mechanics), 6 ECTS, 1st term,
- *Statistica avanzata per la fisica* (advanced statistics for physics), 6 ECTS, 1st term
- *Teoria dei gruppi* (group theory), 6 ECTS, 1st term,
- *Nanostrutture* (nanostructures), 6 ECTS, 2nd term,
- *Ottica avanzata* (advanced optics), 6 ECTS, 2nd term,
- *Transizioni di fase e fenomeni critici* (phase transitions and critical phenomena), 6 ECTS, 2nd term,
- *Metodi numerici per la struttura elettronica* (numerical methods in electronic structure), 6 ECTS, 2nd term,
- *Laboratorio di fisica computazionale* (computational physics laboratory) (unless already chosen as a type-B course), 6 ECTS, 1st term,
- *Laboratorio di fisica della materia condensata* (condensed matter physics laboratory) (unless already chosen as a type-B course), 6 ECTS, 1st term,

Elective subjects – courses on offer within other degree programmes (subject to actual activation)
Any courses chosen from among complementary subjects that have not already been chosen as type-C courses. In addition:

- *Computabilità, complessità e logica* (computability, computational complexity and logic) (INFO-01/A), 9 ECTS, 1st term
- *Deep Learning* (INFO-01/A), 6 ECTS, 2nd term
- *Inferenza statistica* (statistical inference) (STAT-01/A), 12 ECTS, 1st term
- *High Performance and Cloud Computing* (IINF-05/A), 9 ECTS, 1st term

- *Sistemi dinamici* (dynamic systems) (IINF-04/A), 6 ECTS, 1st term
- *Statistica (corso progredito)* (advanced statistics) (STAT-01/A), 9 ECTS, 1st term
- *Introduzione a spettroscopie ottiche avanzate per materiali quantistici* (introduction to advanced optical spectroscopy for quantum materials) (PHYS-03/A), 6 ECTS, 2nd term
- *Quantum Chemistry* (CHEM-02/A), 6 ECTS, 2nd term
- *Fondamenti di ottica quantistica* (foundations of quantum optics) (PHYS-03/A), 6 ECTS, 2nd term
- *Reti logiche* (logical networks) (IINF-01/A), 6 ECTS, 2nd term
- *Stochastic Modelling and Simulation* (INFO-01/A), 6 ECTS, 2nd term

Please note: related and integrative subjects that have not already been included in a study programme as type-C complementary subject courses can be chosen as elective courses.

Examples of study programmes

a – quantum hardware

Complementary subjects 1, 2 and 3: Introduction to Machine Learning, *Superconduttività e dispositivi quantistici* (superconductivity and quantum devices), *Piattaforme quantistiche* (quantum computing platforms), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Fotonica* (photonics), *Sistemi quantistici aperti* (open quantum systems).

Elective subjects 1 and 2: *Laboratorio di fisica computazionale* (computational physics laboratory) or *Laboratorio di fisica della materia condensata* (condensed matter physics laboratory), *Fondamenti di ottica quantistica* (foundations of quantum optics), *Fisica della materia condensata II* (condensed matter physics 2), Quantum Machine Learning, *Formazione ed analisi di immagini in fisica* (image formation and analysis in physics), *Elettronica avanzata per la fisica sperimentale* (advanced electronics for experimental physics), *Metodi numerici per i sistemi quantistici a molti corpi* (numerical methods for quantum many-body systems), *Codici correttori d'errore* (error-correcting codes).

b – quantum information theory

Complementary subjects 1, 2 and 3: Introduction to Machine Learning, *Piattaforme quantistiche* (quantum computing platforms), Quantum Machine Learning, *Superconduttività e dispositivi quantistici* (superconductivity and quantum devices), *Sistemi quantistici aperti* (open quantum systems).

Elective subjects 1 and 2: *Computabilità, complessità e logica* (computability, computational complexity and logic), *Inferenza statistica* (statistical inference), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Fondamenti di ottica quantistica* (foundations of quantum optics), *Statistica (corso progredito)* (advanced statistics), Stochastic Modelling and Simulation.

c – quantum computing theory

Complementary subjects 1, 2 and 3: Introduction to Machine Learning, *Algoritmi di ottimizzazione* (optimisation algorithms), *Codici correttori d'errore* (error-correcting codes), *Piattaforme quantistiche* (quantum computing platforms), Quantum Machine Learning, *Superconduttività e dispositivi quantistici* (superconductivity and quantum devices).

Elective subjects 1 and 2: *Laboratorio di fisica computazionale* (computational physics laboratory) or *Laboratorio di fisica della materia condensata* (condensed matter physics laboratory), *Computabilità, complessità e logica* (computability, computational complexity and logic), *Introduzione ai sistemi quantistici a molti corpi* (introduction to quantum many-body systems), *Metodi numerici per i sistemi quantistici a molti corpi* (numerical methods for quantum many-body systems), *Fondamenti di ottica quantistica* (foundations of quantum optics).

Please note: students without prior knowledge of Python are recommended to also take Computer Tools A or B (Type-F course, 3 ECTS). The choice between Computer Tools A and B must be agreed with the teachers during the first joint lesson.

Standard study programmes which follow the choices indicated above are automatically approved. Students can also choose as ‘elective activities’ any advanced concepts and skills (type B) or complementary subject (type C) within this curriculum or other curricula that they have not already included in their study programme, as well as courses offered by other degree programmes at the University. If a student chooses a course which is not listed above, the Education Committee will have to evaluate the feasibility and consistency of their study programme with the overall educational objectives. The study programme will then have to be approved by the Course Council.

Approved by the Course Council on 19 March 2026