



Study Plan Guide

Master's Degree in Physics

A.Y. 2025/2026

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Choosing the exams for the Master's Degree (LM) in Physics represents a first step towards the disciplinary field in which you will conduct your research or pursue your career. The purpose of this guide is to clarify the possible options offered by the Physics Degree Program and the steps required to implement your choice.

1 Glossary and formal steps

As a first step, when enrolling in the Master's Degree (LM) program, you will be required to formally choose — via the Alice portal — one out of five broad research areas, referred to hereafter as “curricula,” or alternatively a general curriculum. This choice provides an initial selection of the exams required to obtain the LM degree. However, the precise exam schedule will later be determined by the **Individual Study Plan (PdSI)**, which is usually selected at a later stage, once you are more familiar with the courses and all the educational opportunities offered by the program.¹

How to create your PdSI. The educational offer is organized into a set of recommended Study Plans (PdS), which guide you in the creation of your PdSI. These help not only in following the formal requirements for a Master's Degree in Physics, but also in building a coherent and culturally rich path in the subject area you wish to explore.

Each recommended PdS includes “mandatory” courses and often several “recommended elective” courses, selected for their thematic consistency with the PdS. Every course is associated with a label: FIS/xx. The first three letters indicate the scientific discipline—FIS for physics—while the numbers denote the subfield, with the following associations:

- FIS/01 - Experimental physics;
- FIS/02 - Theoretical physics, models and mathematical methods;
- FIS/03 - Physics of matter;
- FIS/04 - Nuclear and subnuclear physics;
- FIS/05 - Astronomy and astrophysics;
- FIS/06 - Earth physics;
- FIS/07 - Applied physics;
- FIS/08 - Didactics and history of physics.

Alcuni esami proposti potrebbero non fare parte di alcun settore scientifico FIS, ma semmai appartenere ad altri settori come ad esempio scienze dell'informazione (INF) o matematica (MAT).

Elective courses. In the study plan, 12 ECTS credits (CFU) may be freely chosen not only within the Physics Degree Program, but also among those offered by other degree programs, or by the Scuola Normale Superiore or the Scuola Sant'Anna. Elective credits must in any case be coherent with your Individual Study Plan (PdSI), thus it is strongly recommended to first consult the list of “Recommended Elective Courses”. Note that the Physics Degree Program also includes general courses that are not tied to a specific Study Plan; a short list of these can be found in Section [3](#).

Final recommendation. Once your study plan has been chosen, it must be submitted for approval through the CAPS portal (Assisted Compilation of Study Plans) at caps.df.unipi.it. The PdSI can be submitted or modified at any time during the year, but only the most recently approved version will be considered valid. If none of the recommended Study Plans meets your educational needs or interests, you may submit a “custom” PdSI for evaluation. However, it must comply with the minimum requirements listed in the relevant section and must be carefully justified in CAPS. Approval of a PdSI is neither automatic nor guaranteed — particularly in the case of a custom PdSI — so it is important to submit your plan via CAPS before beginning to take the exams.

¹ If you are receiving a scholarship that depends on the number of mandatory exams to be taken, it is strongly recommended that you contact the academic office to verify which exams are required for your scholarship to be confirmed.



2 List of the Recommended Study Plans

The list is arranged in alphabetical order, with the custom (free) PdSI appearing at the end. At the end of each brief description of the Study Plan, the corresponding curriculum is indicated.

Astronomy and Astrophysics The study plan addresses investigative methods related to astrophysical and space-related topics, and explores the links between fundamental physics and observational evidence in astrophysics. (Curriculum Astronomia e Astrofisica)

Complex Systems An interdisciplinary program providing skills to study complex systems—those composed of many interacting components, often exhibiting unpredictable and emergent behavior. (Curriculum Generale)

Data Analysis in Experimental Physics An educational program focused on advanced data analysis techniques, with applications to experimental physics. (Curriculum Generale)

Fundamental Interactions The study plan provides knowledge in nuclear and subnuclear particle physics, gravitational waves, and cosmic-origin particles. (Curriculum Interazioni Fondamentali)

Medical Physics The study plan focuses on the application of physical principles and methods to the prevention, diagnosis, and treatment of human diseases. (Curriculum Fisica Medica)

Phenomenology of Fundamental Interactions The study plan covers both theoretical and experimental aspects of fundamental interactions in physics, positioned between theoretical physics and experimental particle physics. (Curriculum Generale)

Physics for Cultural Heritage This study plan aims to train physicists capable of effectively collaborating with art historians, restorers, and archaeologists to address complex issues through the use of tools and methods typical of physical research, within a multidisciplinary context. (Curriculum Generale)

Physics of Biosystems A program that explores the intersection between condensed matter physics, complex systems, and life sciences. (Curriculum Fisica della Materia)

Physics of Geofluids Dynamics and Solid Earth The plan provides theoretical and applied foundations for studying key processes in geophysical fluids and the solid Earth, with applications in seismology, volcanology, and environmental physics. (Curriculum Generale)

Physics of Matter Focused on the theoretical and experimental study of states of matter, both classical and quantum, and their interactions with electromagnetic fields. (Curriculum Fisica della Materia)

Physics of the Universe The program equips students to study cosmic phenomena using an interdisciplinary theoretical and experimental approach, including the observation of gravitational waves, electromagnetic radiation, and astroparticles. The program benefits from proximity to the European Gravitational Observatory (EGO) and research conducted with the Advanced VIRGO gravitational wave detector. (Curriculum generale)

Plasma Physics The program covers the fundamentals and basic physical processes in plasmas, with further study of space plasmas and nuclear fusion. (Curriculum Fisica della Materia)

Quantum Computing and Technologies The study plan provides both theoretical and experimental training in the field of quantum computing and related technologies. (Curriculum Generale)

Theoretical Physics The study plan covers a wide range of topics in theoretical physics, including quantum field theory, the phenomenology of fundamental interactions, gravitation theory, statistical and condensed matter physics, and nuclear interactions. (Curriculum Fisica Teorica)

Theory of Quantum Materials The program focuses on theoretical and computational methods for the study of novel materials. (Curriculum Generale)

Piano di Studi Libero In cases where educational needs are not met by any of the recommended study plans, students may build a fully individualized study plan that does not fall under any of the categories above.

3 Elective courses not specific to any particular Study Plan

S1	[408BB] PHYSICS OF SOUND	FIS/07	06 CFU
S1	[092BB] PHYSICS OF SURFACES AND INTERFACES	FIS/03	03 CFU
S2	[357BB] LASER-PLASMA ACCELERATORS	FIS/03	06 CFU
S2	[428BB] NUCLEAR WEAPONS, DISARMAMENT AND NUCLEAR PROLIFERATION	FIS/04	06 CFU
S1	[407BB] CURRENT TRENDS IN QUANTUM MATTER	FIS/03	03 CFU
S1	[0039B] THE PHYSICS OF EVERY DAY LIFE	FIS/01	06 CFU

4 Details of the Recommended Study Plans

Please note that newly activated courses may not yet have working links on the Course Catalogue. To address this, temporary course descriptions have been created to briefly outline the content of such courses, pending their official inclusion in the catalogues. In all the recommended Study Plans listed below, please pay close attention to the following aspects:

- **Prerequisites.** When selecting the exams that will form your Individual Study Plan (PdSI), it is recommended that you consult the syllabi and prerequisite information for each course on the program website, using the links provided.
- **Courses also offered in the Bachelor's program.** Some courses are also offered at the undergraduate level. To include them in your PdSI, you must attach a transcript of records or, if applicable, declare that you come from another university. The courses subject to this rule are:
 - ⇒ [368BB] ASTROFISICA GENERALE,
 - ⇒ [0024B] FLUIDODINAMICA
- **Course with non-standard semesters.** Courses shared with or borrowed from the PhD program, as well as courses from the Scuola Normale Superiore (SNS), may be held outside the regular first and second semester schedule. It is advised to contact the instructors for more information. Be aware of the timing of these courses, as they often do not fall neatly into either semester. UniPi courses with this characteristic include:
 - ⇒ [404BB] NONPERTURBATIVE APPROACHES TO QUANTUM FIELD THEORIES S,
 - ⇒ [358BB] NONPERTURBATIVE APPROACHES TO QUANTUM FIELD THEORIES,
 - ⇒ [382BB] QUANTUM LIQUIDS,
 - ⇒ [0041B] STATISTICAL ANALYSIS LABORATORY.
- **Non-FIS courses.** In most Study Plans this is not a major issue, but it is never permitted to include more than 24 ECTS of courses from scientific areas other than FIS/xx. In the Study Plans where this limit is relevant, the rule will be explicitly stated.
- **Now many credits.** Each PdSI must include at least 75 ECTS credits of coursework. Together with the 45 credits from the final thesis, this brings the total to the required 120 ECTS for graduation. Study Plans that significantly exceed 120 ECTS will be discouraged and, if accepted, all listed courses must be completed.
- **Suggested paths.** Given the variety of available courses, many course sheets include examples of effective study paths, typically based on past student submissions, to guide your selection.
- **Modifying your PdSI.** Although you may update your PdSI at any time, it is strongly recommended to finalize your direction as early as possible. It is expected that you will pass all the exams listed in your most recently approved PdSI.

Details of the recommended Study Plans can be found in the following pages. For any doubts, difficulties in using this guide, or to report missing information (please note that it is normal for some syllabi to be unavailable or incomplete until around the end of August), do not hesitate to contact the Teaching Office (segr.dida@unipi.it) or the Course Coordinator (stefano.rodaro@unipi.it).

**ASTRONOMY AND ASTROPHYSICS**

(Curriculum ASTRONOMIA E ASTROFISICA)

Insegnamenti vincolati del PdS

minimo

57 CFU

Gruppo obbligatori*(tutti i seguenti)*

S1	[226BB] ASTROPHYSICAL PROCESSES	FIS/05	09 CFU
A	[0010B] ASTROPHYSICS AND MULTIMESSENGER LABORATORY	FIS/01	12 CFU
S2	[369BB] EXTRAGALACTIC ASTROPHYSICS AND COSMOLOGY	FIS/05	09 CFU
S2	[211BB] STELLAR PHYSICS	FIS/05	09 CFU

Gruppo fisica teorica*(almeno uno dei seguenti)*

S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo microfisica e struttura della materia*(almeno uno dei seguenti)*

S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU

Insegnamenti a scelta consigliati

massimo

18 CFU

(almeno 6CFU dai seguenti o dai vincolati non scelti)

S1	[0013B] ADVANCED TECHNOLOGIES FOR GROUND-BASED ASTROPHYSICS: FROM MICROWAVES TO VISIBLE LIGHT	FIS/05	06 CFU
S1	[306BB] EXPERIMENTAL METHODS FOR ASTROPARTICLE PHYSICS	FIS/01	09 CFU
S1	[307BB] EXPERIMENTAL METHODS FOR ASTROPARTICLE PHYSICS S	FIS/01	06 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S1	[0011B] MULTIMESSENGER AND HIGH-ENERGY ASTROPHYSICS	FIS/05	06 CFU
S1	[0012B] PHYSICS OF STAR FORMATION	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[192BB] ASTROPARTICLE PHYSICS	FIS/05	09 CFU
S2	[063BB] ASTROPARTICLE PHYSICS S	FIS/05	06 CFU
S2	[274BB] COSMOLOGY OF THE EARLY UNIVERSE	FIS/02	09 CFU
S2	[275BB] COSMOLOGY OF THE EARLY UNIVERSE S	FIS/05	06 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[170BB] EXOPLANETARY SYSTEMS	FIS/05	06 CFU
S2	[251BB] GRAVITATION THEORY	FIS/02	09 CFU
S2	[140BB] GRAVITATION THEORY S	FIS/02	06 CFU
S2	[0046B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES	FIS/07	09 CFU
S2	[0047B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES S	FIS/07	06 CFU
S2	[0016B] THEORY OF NUCLEAR INTERACTION S	FIS/02	06 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU

Note aggiuntive

Among the possible thematic paths within "Astronomy and Astrophysics", the following elective courses are suggested:

Path STELLAR PHYSICS:

- [0012B] Physics of star formation (6 CFU)
- [091BB] Compact Star S (6 CFU)

Path GALACTIC ASTROPHYSICS and COSMOLOGY:

- [0012B] Physics of star formation (6 CFU)
- [257BB] Cosmology of the early universe S (6 CFU)
- [228BB] General relativity (9 CFU)

Path GRAVITATIONAL WAVES and COMPACT OBJECTS:

- [256BB] Physics of gravitational waves S (6 CFU)
- [228BB] General relativity (9 CFU)

Path PLANETARY PHYSICS:

- [0012B] Physics of star formation (6 CFU)
- [170BB] Exoplanetary systems (6 CFU)

Path OBSERVATIONAL ASTRONOMY:

- [0013B] Advanced technologies for ground-based astrophysics (6 CFU)
- [0011B] Multimessenger and high-energy astrophysics (6 CFU)

COMPLEX SYSTEMS

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

33 CFU

Gruppo obbligatori

(tutti i seguenti)

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo fisica sperimentale

(almeno uno dei seguenti)

A	[403BB] BIO-SYSTEMS LAB	FIS/01	15 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU

Gruppo astrofisica

(almeno uno dei seguenti)

S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[211BB] STELLAR PHYSICS	FIS/05	09 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

42 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[178EE] BIOINFORMATICS	INF/01	03 CFU
S1	[878II] DATA MINING AND MACHINE LEARNING	ING-INF/05	12 CFU
S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S1	[783AA] GEOSPATIAL ANALYTICS	INF/01	06 CFU
S1	[389BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU
S1	[654AA] MACHINE LEARNING	INF/01	09 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU
S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[0005B] 3D AND 4D NANOMATERIALS AND DEVICES	FIS/03	09 CFU
S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[513LL] COMPUTATIONAL LINGUISTICS II	L-LIN/01	06 CFU
S2	[674AA] COMPUTATIONAL NEUROSCIENCE	INF/01	06 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[288DD] EARTHQUAKE SEISMOLOGY	GEO/10	06 CFU
S2	[211AA] GAME THEORY	MAT/09	06 CFU
S2	[375BB] LARGE SCALE PHYSICAL OCEANOGRAPHY	FIS/03	09 CFU
S2	[279BB] COMPLEX SYSTEMS - NEURAL DYNAMICS	FIS/03	09 CFU
S2	[699AA] DATA ANALYSIS	MAT/06	06 CFU
S2	[0021B] MICROBIOROBOTICS	FIS/03	06 CFU
S2	[0020B] NEUROENGINEERING	FIS/03	06 CFU
S2	[322BB] NONLINEAR DYNAMICS	FIS/03	09 CFU
S2	[0028B] PHYSICS OF THE ATMOSPHERE AND PRINCIPLES OF METEOROLOGY	FIS/07	06 CFU
S2	[0019B] QUANTUM MACHINE LEARNING	FIS/03	03 CFU
S2	[425BB] QUANTUM THERMODYNAMICS	FIS/03	06 CFU
S2	[668AA] SOCIAL NETWORK ANALYSIS	INF/01	06 CFU
S2	[628PP] STATISTICS FOR DATA SCIENCE	SECS-S/01	09 CFU
S1	[420AA] DATA MINING	INF/01	12 CFU
S1	[676AA] DATA MINING: FUNDAMENTALS	INF/01	06 CFU
A	[SNS-MMQF] MATHEMATICAL MODELS FOR QUANTITATIVE FINANCE	FIS/03	06 CFU
A	[SNS-QF] QUANTITATIVE FINANCE	FIS/03	06 CFU
A	[SNS-SMLM] STATISTICAL AND MACHINE LEARNING MODELS FOR TIME SERIES ANALYSIS	FIS/03	09 CFU

Note aggiuntive

- At least 18 CFU out of the elective 42 CFU must come from the FIS sector;
- The course [878II] DATA MINING AND MACHINE LEARNING is in non-negligible overlap with [676AA] DATA MINING: FUNDAMENTALS and [420AA] DATA MINING, it is thus very important to agree on how many total CFU will be included in the Study Plan when you plan to attend more than one of these courses;
- In particular, the course [676AA] DATA MINING: FUNDAMENTALS is the first module of [420AA] DATA MINING, and thus cannot be both included in your plan;
- The course [676AA] DATA MINING: FUNDAMENTALS is part of a LM with planned attendance: the possibility of attending the course is subject to availability and must be agreed upon with the instructor at the beginning of the course.
- Within the "Fisica Sperimentale", it is possible to choose "Computing methods for experimental physics and data analysis S" (6 CFU) + "Metodi numerici per la fisica S" (6 CFU). In this case, both courses must be attended.



Based on the past study plans submitted by students that have chosen to an educational path with in the complex system ambit, we report here which exams were typically inserted in the plan:

Path FINANCE:

- [SNS-MTT] Markets, trading and technologies
- [SNS-MMQF] Mathematical models for quantitative finance: market microstructure, networks, and systemic risk
- [SNS-QF] Quantitative finance
- [SNS-SMLM] Statistical and machine learning models for time series analysis
- [668A] Social network analysis

Path NEURONS and BRAIN:

- [279BB] Complex systems - neural dynamics
- [674AA] Computational neuroscience
- [326BB] Computational physics laboratory (inclusendo modulo Metodi della fisica non lineare e delle neuroscienze)
- [0020B] Neuroengineering
- [322BB] Nonlinear dynamics
- [420AA] Data mining

Path ACTIVE MATTER:

- [309BB] Disordered systems out of equilibrium
- [0021B] Microbiorobotics
- [273BB] Biophysical modelling of complex systems
- [0024B] Fluid dynamics
- [399BB] Introduction to molecular biophysics
- [375BB] Large scale physical oceanography
- [387BB] Physics of biosystems

Path EARTH SYSTEM:

- [0024B] Fluid dynamics
- [375BB] Large scale physical oceanography
- [0028B] Physics of the atmosphere and principles of meteorology
- [288DD] Earthquake seismology
- [353BB] Plasma physics

Path CHAOS and DYNAMICAL SYSTEMS:

- [PHD-DCS] Dynamics of complex systems
- [326BB] Computational physics laboratory (inclusendo modulo Metodi della fisica non lineare e delle neuroscienze)
- [322BB] Nonlinear dynamics
- [425BB] Quantum thermodynamics

Path COMPLEXITY and NETWORKS:

- [420AA] Data mining
- [783AA] Geospatial analytics
- [654AA] Machine learning
- [668AA] Social network analysis

**DATA ANALYSIS IN EXPERIMENTAL PHYSICS**

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

48 CFU

Gruppo obbligatori*(tutti i seguenti)*

A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU

Gruppo fisica sperimentale*(almeno uno dei seguenti)*

S2	[380BB] INSTRUMENTATION FOR FUNDAMENTAL INTERACTIONS PHYSICS	FIS/01	09 CFU
S1	[414BB] FUNDAMENTAL INTERACTIONS LABORATORY S	FIS/01	09 CFU
S2	[0047B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES S	FIS/07	06 CFU
S2	[0007B] QUANTUM TECHNOLOGIES FOR FUNDAMENTAL INTERACTION PHYSICS	FIS/01	09 CFU

Gruppo fisica teorica*(almeno uno dei seguenti)*

S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo microfisica e struttura della materia*(almeno uno dei seguenti)*

S2	[217BB] ACCELERATOR PHYSICS	FIS/04	09 CFU
S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S2	[063BB] ASTROPARTICLE PHYSICS S	FIS/05	06 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[274BB] COSMOLOGY OF THE EARLY UNIVERSE	FIS/02	09 CFU
S2	[369BB] EXTRAGALACTIC ASTROPHYSICS AND COSMOLOGY	FIS/05	09 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

27 CFU

(almeno 9CFU dai seguenti o dai vincolati non scelti)

S1	[878II] DATA MINING AND MACHINE LEARNING	ING-INF/05	12 CFU
S1	[676AA] DATA MINING: FUNDAMENTALS	INF/01	06 CFU
S1	[654AA] MACHINE LEARNING	INF/01	09 CFU
S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[338BB] SIGNAL PROCESSING FOR PHYSICS	FIS/01	06 CFU
S2	[699AA] DATA ANALYSIS	MAT/06	06 CFU
S2	[185BB] MONTECARLO METHODS IN EXPERIMENTAL PHYSICS	FIS/01	06 CFU
S2	[668AA] SOCIAL NETWORK ANALYSIS	INF/01	06 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
A	[420AA] DATA MINING	INF/01	12 CFU

Note aggiuntive

- The course [878II] DATA MINING AND MACHINE LEARNING is in non-negligible overlap with [676AA] DATA MINING: FUNDAMENTALS and [420AA] DATA MINING, it is thus very important to agree on how many total CFU will be included in the Study Plan when you plan to attend more than one of these courses;
- In particular, the course [676AA] DATA MINING: FUNDAMENTALS is the first module of [420AA] DATA MINING, and thus cannot be both included in your plan;
- The course [676AA] DATA MINING: FUNDAMENTALS is part of a LM with planned attendance: the possibility of attending the course is subject to availability and must be agreed upon with the instructor at the beginning of the course.

**FUNDAMENTAL INTERACTIONS**

(Curriculum INTERAZIONI FONDAMENTALI)

Insegnamenti vincolati del PdS

minimo

54 CFU

Gruppo obbligatori

(tutti i seguenti)

S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[413BB] FUNDAMENTAL INTERACTIONS LABORATORY	FIS/01	15 CFU

Gruppo fisica sperimentale, nucleare e subnucleare (gruppo 1)

(almeno uno dei seguenti)

S2	[373BB] PARTICLE PHYSICS S	FIS/04	06 CFU
S2	[0047B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES S	FIS/07	06 CFU
S2	[0007B] QUANTUM TECHNOLOGIES FOR FUNDAMENTAL INTERACTION PHYSICS	FIS/01	09 CFU

Gruppo fisica sperimentale, nucleare e subnucleare (gruppo 2)

(almeno uno dei seguenti)

S2	[217BB] ACCELERATOR PHYSICS	FIS/04	09 CFU
A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU
S2	[380BB] INSTRUMENTATION FOR FUNDAMENTAL INTERACTIONS PHYSICS	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU

Gruppo fisica teorica

(almeno uno dei seguenti)

S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU

Gruppo astrofisica

(almeno uno dei seguenti)

S2	[063BB] ASTROPARTICLE PHYSICS S	FIS/05	06 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[275BB] COSMOLOGY OF THE EARLY UNIVERSE S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

21 CFU

(almeno 9CFU dai seguenti o dai vincolati non scelti)

S1	[306BB] EXPERIMENTAL METHODS FOR ASTROPARTICLE PHYSICS	FIS/01	09 CFU
S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[385BB] INTRODUCTION TO NEUTRINO PHYSICS	FIS/04	03 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[427BB] PARTICLE DARK MATTER	FIS/01	06 CFU
S1	[1095I] RADIATION PROTECTION	ING-IND/20	06 CFU
S1	[338BB] SIGNAL PROCESSING FOR PHYSICS	FIS/01	06 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU
S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[0008B] BIOPHYSICS FOR EFLASH THERAPY	FIS/07	09 CFU
S2	[0035B] DESIGN OF DIGITAL SYSTEMS FOR RADIATION DETECTION	FIS/07	06 CFU
S2	[308BB] DISCRETE SYMMETRIES	FIS/04	06 CFU
S2	[198BB] DOSIMETRY	FIS/07	06 CFU
S2	[080BB] ELECTRONICS AND SENSORS	FIS/07	06 CFU
S2	[0004B] FLEXIBLE AND NANO-ELECTRONICS	FIS/03	09 CFU
S2	[201BB] HADRON COLLIDER PHYSICS	FIS/04	09 CFU
S2	[371BB] HADRON COLLIDER PHYSICS S	FIS/04	06 CFU
S2	[185BB] MONTECARLO METHODS IN EXPERIMENTAL PHYSICS	FIS/01	06 CFU
S2	[302BB] PARTICLE PHYSICS	FIS/04	09 CFU
S2	[0046B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES	FIS/07	09 CFU
A	[SNS-SMB] STANDARD MODEL AND BEYOND	FIS/02	06 CFU

Note aggiuntive

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**MEDICAL PHYSICS**

(Curriculum FISICA MEDICA)

Insegnamenti vincolati del PdS

minimo

51 CFU

Gruppo obbligatori*(tutti i seguenti)*

S1	[205BB] MEDICAL PHYSICS	FIS/07	09 CFU
A	[281BB] MEDICAL PHYSICS LABORATORY B	FIS/01	15 CFU
S2	[0037B] MOLECULAR IMAGING	FIS/07	06 CFU

Gruppo fisica teorica*(almeno uno dei seguenti)*

S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo microfisica e struttura della materia*(almeno uno dei seguenti)*

S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[399BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S2	[063BB] ASTROPARTICLE PHYSICS S	FIS/05	06 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

24 CFU

(almeno 9CFU dai seguenti o dai vincolati non scelti)

S1	[478EE] ELEMENTS OF PHYSIOLOGY, PHYSIOPATHOLOGY AND DIAGNOSTICS	BIO/09	06 CFU
S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[389BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU
S1	[338BB] SIGNAL PROCESSING FOR PHYSICS	FIS/01	06 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU
S2	[217BB] ACCELERATOR PHYSICS	FIS/04	09 CFU
S2	[107BB] ACCELERATOR PHYSICS S	FIS/01	06 CFU
S2	[0008B] BIOPHYSICS FOR EFLASH THERAPY	FIS/07	09 CFU
S2	[0039E] CELL BIOPHYSICS	BIO/10	03 CFU
S2	[0035B] DESIGN OF DIGITAL SYSTEMS FOR RADIATION DETECTION	FIS/07	06 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[198BB] DOSIMETRY	FIS/07	06 CFU
S2	[0004B] FLEXIBLE AND NANO-ELECTRONICS	FIS/03	09 CFU
S2	[0021B] MICROBIOROBOTICS	FIS/03	06 CFU
S2	[185BB] MONTECARLO METHODS IN EXPERIMENTAL PHYSICS	FIS/01	06 CFU
S2	[0020B] NEUROENGINEERING	FIS/03	06 CFU
S2	[124BB] NUCLEAR MAGNETIC RESONANCE	FIS/07	06 CFU
S2	[0040B] QUANTUM BIOLOGY	FIS/03	09 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU
A	[365BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS S	FIS/01	06 CFU

Note aggiuntive

As a further guidance to choose your exams, check the following possible thematic paths

Path MEDICAL PHYSICS. Plan suggested to students interested in the physics methods oriented to medicine, to pursue a possible career as medical physics specialist.*(from the "Gruppo microfisica")*

[206BB] Nuclear physics (FIS/04) 9 CFU

(from the "Insegnamenti a scelta")

[360BB] Computing methods for experimental physics and data analysis (FIS/01) 9 CFU

[198BB] Dosimetry (FIS/07) 6 CFU

[124BB] Nuclear magnetic resonance (FIS/07) 6 CFU.

Path FLASH RT. Plan suggested to students interested in acquiring a detailed knowledge of the physics and radio-biological mechanisms behind FLASH radiotherapy, including pertinent computational and experimental skills.



(from "Gruppo microfisica")

[399BB] Introduction to molecular biophysics (FIS/03) 6 CFU

(from "Insegnamenti a scelta")

[0008B] Biophysics for eflash therapy (FIS/07) 9 CFU

[360BB] Computing methods for experimental physics and data analysis (FIS/01) 9 CFU

[185BB] Montecarlo methods in experimental physics (FIS/01) 6 CFU

Path BIOMEDICAL IMAGING. *Plan suggested to students interested in developing a profound expertise in the physical principle and technologies used in the generations and analysis of biological imaging on different length scales.*

(from "Gruppo microfisica")

[399BB] Introduction to molecular biophysics (FIS/03) 6 CFU

(from "Insegnamenti a scelta")

[360BB] Computing methods for experimental physics and data analysis (FIS/01) 9 CFU

[124BB] Nuclear magnetic resonance (FIS/07) 6 CFU

[387BB] Physics of biosystems (FIS/03) 9 CFU

Path INSTRUMENTATION FOR MEDICAL PHYSICS. *Plan suggested to students interested in the biomedical imaging and radiotherapy technologies, with a particular focus on the instrumental, computational and physical aspects relevant to the development and optimization of data acquisition systems, in dosimetry and imaging.*

(from "Gruppo microfisica")

[206BB] Nuclear Physics (FIS/04) 9 CFU

(from "Insegnamenti a scelta")

[107BB] Accelerator physics S (FIS/04) 6 CFU

[360BB] Computing methods for experimental physics and data analysis (FIS/01) 9 CFU

[0035B] Design of digital systems for radiation detection (FIS/07) 6 CFU

**PHENOMENOLOGY OF FUNDAMENTAL INTERACTIONS**

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

66 CFU

Gruppo obbligatori*(tutti i seguenti)*

S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[192BB] ASTROPARTICLE PHYSICS	FIS/05	09 CFU
S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU

Gruppo fisica teorica, nucleare e subnucleare*(almeno uno dei seguenti)*

A	[SNS-EFT] EFFECTIVE FIELD THEORIES I AND II	FIS/02	06 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S2	[197BB] QUANTUM CHROMODYNAMICS	FIS/02	09 CFU
A	[SNS-SMB] STANDARD MODEL AND BEYOND	FIS/02	06 CFU

Gruppo fisica sperimentale, nucleare e subnucleare*(almeno uno dei seguenti)*

S2	[308BB] DISCRETE SYMMETRIES	FIS/04	06 CFU
S2	[201BB] HADRON COLLIDER PHYSICS	FIS/04	09 CFU
S1	[427BB] PARTICLE DARK MATTER	FIS/01	06 CFU
S2	[302BB] PARTICLE PHYSICS	FIS/04	09 CFU

Gruppo fisica sperimentale*(almeno uno dei seguenti)*

S1	[414BB] FUNDAMENTAL INTERACTIONS LABORATORY S	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU
S2	[0007B] QUANTUM TECHNOLOGIES FOR FUNDAMENTAL INTERACTION PHYSICS	FIS/01	09 CFU
A	[0010B] ASTROPHYSICS AND MULTIMESSENGER LABORATORY	FIS/01	12 CFU
A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU

Insegnamenti a scelta consigliati

massimo

09 CFU

*(include gli insegnamenti vincolati non scelti)***Note aggiuntive**

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**PHYSICS FOR CULTURAL HERITAGE**

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

54 CFU

Gruppo obbligatori*(tutti i seguenti)*

A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU
S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[418BB] PHYSICS FOR CULTURAL HERITAGE	FIS/07	09 CFU

Gruppo tematico*(almeno uno dei seguenti insegnamenti metodologici di ambito archeologico/storico/artistico)*

S2	[402LL] ARCHEOLOGY OF PRODUCTION	L-ANT/10	06 CFU
S1	[614LL] HISTORY OF ART RESTORATION	L-ART/04	06 CFU
S1	[1261L] HISTORY OF ARTISTIC TECHNIQUES	L-ART/04	06 CFU
S1	[289LL] METHODOLOGY OF HISTORICAL-ARTISTIC RESEARCH	L-ART/04	06 CFU
S1	[1276L] METHODS OF ARCHAEOLOGICAL RESEARCH	L-ANT/10	06 CFU
S1	[1407L] PALEOECOLOGIA E BIOARCHEOLOGIA	L-ANT/10	06 CFU

Gruppo fisica teorica*(almeno uno dei seguenti)*

S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo microfisica e struttura della materia*(almeno uno dei seguenti)*

S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[0043B] PHOTONICS AND MATERIALS	FIS/03	06 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S2	[192BB] ASTROPARTICLE PHYSICS	FIS/05	09 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

21 CFU

(include i vincolati non scelti, ed eventuali altri insegnamenti di ambito archeologico/storico/artistico)

S1	[244CC] CHEMICAL PHYSICS OF MOLECULES	CHIM/02	09 CFU
S1	[1403L] COMPETENZE DIGITALI PER I BENI CULTURALI	L-ANT/10	06 CFU
S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[1237L] DIAGNOSTICS FOR THE STUDY OF WORKS OF ART	L-ART/04	06 CFU
S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[414BB] FUNDAMENTAL INTERACTIONS LABORATORY S	FIS/01	09 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU
S1	[412BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY S	FIS/01	09 CFU
S1	[1095I] RADIATION PROTECTION	ING-IND/20	06 CFU
S1	[338BB] SIGNAL PROCESSING FOR PHYSICS	FIS/01	06 CFU
S2	[217BB] ACCELERATOR PHYSICS	FIS/04	09 CFU
S2	[221BB] ATOM OPTICS	FIS/03	09 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[198BB] DOSIMETRY	FIS/07	06 CFU
S2	[080BB] ELECTRONICS AND SENSORS	FIS/07	06 CFU
S2	[124BB] NUCLEAR MAGNETIC RESONANCE	FIS/07	06 CFU
S2	[203BB] PHYSICS OF PHOTONIC DEVICES	FIS/03	09 CFU
S2	[354BB] QUANTUM OPTICS AND PLASMA PHYSICS	FIS/03	09 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
A	[281BB] MEDICAL PHYSICS LABORATORY B	FIS/01	15 CFU

Note aggiuntive

- Among the various modules of the course [360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS, please include the module "Medical Imaging".

**PHYSICS OF BIOSYSTEMS**

(Curriculum FISICA DELLA MATERIA)

Insegnamenti vincolati del PdS

minimo

54 CFU

Gruppo obbligatori*(tutti i seguenti)*

S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU

Gruppo fisica della materia*(almeno uno dei seguenti)*

S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU
S1	[389BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU

Gruppo fisica sperimentale*(almeno uno dei seguenti)*

A	[403BB] BIO-SYSTEMS LAB	FIS/01	15 CFU
A	[411BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY	FIS/01	15 CFU

Gruppo fisica teorica*(almeno uno dei seguenti)*

S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

21 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[1054I] BIOFLUIDS AND MATERIALS INTERACTIONS	ING-IND/22	03 CFU
S1	[178EE] BIOINFORMATICS	INF/01	03 CFU
S1	[244CC] CHEMICAL PHYSICS OF MOLECULES	CHIM/02	09 CFU
S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[389BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU
S1	[1057I] MANUFACTURING OF POLYMERS AND NANOCOMPOSITES FOR BIOMEDICAL APPLICATION	ING-IND/22	03 CFU
S1	[205BB] MEDICAL PHYSICS	FIS/07	09 CFU
S1	[1053I] NANOMEDICINE AND REGENERATIVE MEDICINE	ING-IND/22	06 CFU
S1	[0043B] PHOTONICS AND MATERIALS	FIS/03	06 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU
S2	[0005B] 3D AND 4D NANOMATERIALS AND DEVICES	FIS/03	09 CFU
S2	[728II] BIOMATERIALS	ING-IND/22	06 CFU
S2	[0008B] BIOPHYSICS FOR EFLASH THERAPY	FIS/07	09 CFU
S2	[0039E] CELL BIOPHYSICS	BIO/10	03 CFU
S2	[0042B] GRAPHICS AND ANIMATION WITH PYTHON	FIS/03	03 CFU
S2	[0021B] MICROBIOROBOTICS	FIS/03	06 CFU
S2	[0037B] MOLECULAR IMAGING	FIS/07	06 CFU
S2	[0020B] NEUROENGINEERING	FIS/03	06 CFU
S2	[0040B] QUANTUM BIOLOGY	FIS/03	09 CFU
S2	[383BB] SPECTROSCOPY AND MICROSCOPY OF NANOMATERIALS	FIS/03	06 CFU
A	[374BB] COMPUTATIONAL PHYSICS LABORATORY S	FIS/01	06 CFU
A	[365BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS S	FIS/01	06 CFU
A	[1056I] FUNDAMENTALS OF BIOPHYSICS AT THE NANOSCALE	ING-IND/22	06 CFU
A	[SNS-PLC] PHYSICS OF THE LIVING CELL	FIS/03	06 CFU

Note aggiuntive

Please note that the 15 CFU course [411BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY can be replaced by the "short" 9 CFU version [412BB], in combination with the 6 CFU exam [326BB] COMPUTATIONAL PHYSICS LABORATORY S (module "Calcoli da principi primi" e "Dinamica molecolare classica" are strongly suggested).

Among the possible thematic paths within "Physics of Biosystems", the following elective courses are suggested:

Path BIOPHYSICS: it focused on processes and techniques relevant to cellular and molecular biophysics.

- [403BB] Bio-systems lab (15 CFU)
- [0039E] Cell biophysics (3 CFU)
- [309BB] Disordered systems out of equilibrium (9 CFU)
- [399BB] Introduction to molecular biophysics (6 CFU)

Path ACTIVE MATTER: it provides the physics basis to understand complex mechanisms underpinning "bio-inspired" materials.

- [230BB] Complex systems (9 CFU)



- [309BB] Disordered systems out of equilibrium (9 CFU)
- [0021B] Microbiorobotics (6 CFU)
- [411BB] Physics of matter and nanotechnology laboratory (15 CFU)

Path BIOPHYSICS FOR FLASH (experimental): it provides basic physics competences on the mechanisms and experimental biophysics techniques relevant to the impact of Flash radiotherapy.

- [0008B] Biophysics for eflash therapy (9 CFU)
- [403BB] Bio-systems lab (15 CFU)
- [399BB] Introduction to molecular biophysics (6 CFU)
- [205BB] Medical physics (9 CFU)
- [0042B] Graphics and animation with python (3 CFU)

Path BIOPHYSICS FOR FLASH (computational): it provides basic physics competences on the mechanisms and computational biophysics techniques relevant to the study of Flash radiotherapy.

- [0008B] Biophysics for eflash therapy (9 CFU)
- [399BB] Introduction to molecular biophysics (6 CFU)
- [205BB] Medical physics (9 CFU)
- [412BB] Physics of matter and nanotechnology laboratory S (9 CFU)
- [374BB] Computational physics laboratory S (6 CFU)

**PHYSICS OF GEOFLUIDS DYNAMICS AND SOLID EARTH**

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

60 CFU

Gruppo obbligatori*(tutti i seguenti, eccetto 0024B se già dato alla LT)*

S1	[0048B] EARTH SENSING AND GEOPHYSICAL MONITORING INSTRUMENTATION	FIS/03	06 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S2	[0022B] LABORATORY OF INSTRUMENTAL SEISMOLOGY	FIS/01	09 CFU
S2	[0023B] MECHANICS OF GEOPHYSICAL FLUIDS	FIS/06	09 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S1	[346BB] ROCK PHYSICS	FIS/03	06 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo tematici*(almeno uno dei seguenti)*

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S2	[454II] COMPUTATIONAL FLUIDODYNAMICS	ING-IND/06	06 CFU
S2	[288DD] EARTHQUAKE SEISMOLOGY	GEO/10	06 CFU
S2	[375BB] LARGE SCALE PHYSICAL OCEANOGRAPHY	FIS/03	09 CFU
S1	[338BB] SIGNAL PROCESSING FOR PHYSICS	FIS/01	06 CFU

Insegnamenti a scelta consigliati

massimo

15 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[226BB] ASTROPHYSICAL PROCESSES	FIS/05	09 CFU
S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S2	[454II] COMPUTATIONAL FLUIDODYNAMICS	ING-IND/06	06 CFU
S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU
S1	[1074I] INTRODUCTION TO MACHINE LEARNING IN GEOPHYSICS	GEO/11	03 CFU
S1	[234DD] INVERSE PROBLEMS IN GEOPHYSICS	GEO/11	06 CFU
S1	[338BB] SIGNAL PROCESSING FOR PHYSICS	FIS/01	06 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU
S2	[267DD] COMPUTATIONAL GEOPHYSICS	GEO/11	06 CFU
S2	[288DD] EARTHQUAKE SEISMOLOGY	GEO/10	06 CFU
S2	[375BB] LARGE SCALE PHYSICAL OCEANOGRAPHY	FIS/03	09 CFU
S2	[322BB] NONLINEAR DYNAMICS	FIS/03	09 CFU

Note aggiuntive

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**PHYSICS OF MATTER**

(Curriculum FISICA DELLA MATERIA)

Insegnamenti vincolati del PdS

minimo

57 CFU

Gruppo obbligatori*(tutti i seguenti)*

S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
A	[411BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY	FIS/01	15 CFU

Gruppo fisica della materia (gruppo 1)*(almeno uno dei seguenti)*

S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU

Gruppo fisica della materia (gruppo 2)*(almeno uno dei seguenti)*

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU

Gruppo fisica teorica*(almeno uno dei seguenti)*

S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S2	[063BB] ASTROPARTICLE PHYSICS S	FIS/05	06 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

18 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[244CC] CHEMICAL PHYSICS OF MOLECULES	CHIM/02	09 CFU
S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S2	[0045B] GROUP THEORY FOR MATERIAL SCIENCE	FIS/03	03 CFU
S1	[389BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU
S1	[0043B] PHOTONICS AND MATERIALS	FIS/03	06 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[382BB] QUANTUM LIQUIDS	FIS/03	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU
S2	[0005B] 3D AND 4D NANOMATERIALS AND DEVICES	FIS/03	09 CFU
S2	[221BB] ATOM OPTICS	FIS/03	09 CFU
S1	[0039B] THE PHYSICS OF EVERY DAY LIFE	FIS/01	06 CFU
S2	[370BB] CONDENSED MATTER PHYSICS	FIS/03	09 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[426BB] ENTANGLEMENT: ADVANCED THEORETICAL CONCEPTS AND APPLICATIONS IN QUANTUM TECHNOLOGIES	FIS/03	03 CFU
S2	[0004B] FLEXIBLE AND NANO-ELECTRONICS	FIS/03	09 CFU
S2	[0042B] GRAPHICS AND ANIMATION WITH PYTHON	FIS/03	03 CFU
S2	[0034B] INTRODUCTION TO THE PHYSICS OF CONTROLLED NUCLEAR FUSION	FIS/03	06 CFU
S2	[322BB] NONLINEAR DYNAMICS	FIS/03	09 CFU
S2	[203BB] PHYSICS OF PHOTONIC DEVICES	FIS/03	09 CFU
S2	[354BB] QUANTUM OPTICS AND PLASMA PHYSICS	FIS/03	09 CFU
S2	[0007B] QUANTUM TECHNOLOGIES FOR FUNDAMENTAL INTERACTION PHYSICS	FIS/01	09 CFU
S2	[383BB] SPECTROSCOPY AND MICROSCOPY OF NANOMATERIALS	FIS/03	06 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU

Note aggiuntive

- The 15 CFU exam [411BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY can be replaced by the "short" 9 CFU version [412BB], in combination with at least two modules (6 CFU) of [326BB] COMPUTATIONAL PHYSICS LABORATORY S. The modules "Calcoli da principi primi" e "Dinamica molecolare classica" are strongly suggested in this case.

**PHYSICS OF THE UNIVERSE**

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

60 CFU

Gruppo obbligatori*(tutti i seguenti)*

S2	[192BB] ASTROPARTICLE PHYSICS	FIS/05	09 CFU
A	[0010B] ASTROPHYSICS AND MULTIMESSENGER LABORATORY	FIS/01	12 CFU
S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU

Gruppo fisica sperimentale*(almeno uno dei seguenti)*

A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
S2	[0046B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES	FIS/07	09 CFU
S2	[0007B] QUANTUM TECHNOLOGIES FOR FUNDAMENTAL INTERACTION PHYSICS	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU

Gruppo microfisica e struttura della materia*(almeno uno dei seguenti)*

S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S1	[226BB] ASTROPHYSICAL PROCESSES	FIS/05	09 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[275BB] COSMOLOGY OF THE EARLY UNIVERSE S	FIS/05	06 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

15 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[0013B] ADVANCED TECHNOLOGIES FOR GROUND-BASED ASTROPHYSICS: FROM MICROWAVES TO VISIBLE LIGHT	FIS/05	06 CFU
S1	[306BB] EXPERIMENTAL METHODS FOR ASTROPARTICLE PHYSICS	FIS/01	09 CFU
S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[414BB] FUNDAMENTAL INTERACTIONS LABORATORY S	FIS/01	09 CFU
S1	[385BB] INTRODUCTION TO NEUTRINO PHYSICS	FIS/04	03 CFU
S1	[0011B] MULTIMESSENGER AND HIGH-ENERGY ASTROPHYSICS	FIS/05	06 CFU
S1	[427BB] PARTICLE DARK MATTER	FIS/01	06 CFU
S1	[0012B] PHYSICS OF STAR FORMATION	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[274BB] COSMOLOGY OF THE EARLY UNIVERSE	FIS/02	09 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[369BB] EXTRAGALACTIC ASTROPHYSICS AND COSMOLOGY	FIS/05	09 CFU
S2	[251BB] GRAVITATION THEORY	FIS/02	09 CFU
S2	[140BB] GRAVITATION THEORY S	FIS/02	06 CFU
S2	[0046B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES	FIS/07	09 CFU
S2	[0047B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES S	FIS/07	06 CFU
S2	[0016B] THEORY OF NUCLEAR INTERACTION S	FIS/02	06 CFU

Note aggiuntive

Among the possible thematic paths within "Physics of the Universe", the following elective courses are suggested:

Path GRAVITATIONAL WAVES and COMPACT OBJECTS:

- [0046B] Physics and detectors of gravitational wave physics (9 CFU or the short 6 CFU version [0047B])
- [251BB] Gravitation theory (9 CFU or the short 6 CFU version [140BB])

Path COSMOLOGY and DARK MATTER:

- [274BB] Cosmology of the early universe (9 CFU)
- [369BB] Extragalactic astrophysics and cosmology (9 CFU)
- [427BB] Particle dark matter (6 CFU)

**PLASMA PHYSICS**

(Curriculum FISICA DELLA MATERIA)

Insegnamenti vincolati del PdS

minimo

60 CFU

Gruppo obbligatori*(tutti i seguenti, eccetto 0024B se già dato alla LT)*

A	[374BB] COMPUTATIONAL PHYSICS LABORATORY S	FIS/01	06 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[412BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY S	FIS/01	09 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo tematico*(almeno due dei seguenti)*

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S2	[454II] COMPUTATIONAL FLUIDODYNAMICS	ING-IND/06	06 CFU
S2	[0034B] INTRODUCTION TO THE PHYSICS OF CONTROLLED NUCLEAR FUSION	FIS/03	06 CFU
S2	[0023B] MECHANICS OF GEOPHYSICAL FLUIDS	FIS/06	09 CFU

Insegnamenti a scelta consigliati

massimo

15 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[309BB] DISORDERED SYSTEMS OUT OF EQUILIBRIUM	FIS/03	09 CFU
S1	[389BB] INTRODUCTION TO MOLECULAR BIOPHYSICS	FIS/03	06 CFU
S1	[654AA] MACHINE LEARNING	INF/01	09 CFU
S1	[387BB] PHYSICS OF BIOSYSTEMS	FIS/03	09 CFU
S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[221BB] ATOM OPTICS	FIS/03	09 CFU
S2	[279BB] COMPLEX SYSTEMS - NEURAL DYNAMICS	FIS/03	09 CFU
S2	[454II] COMPUTATIONAL FLUIDODYNAMICS	ING-IND/06	06 CFU
S2	[370BB] CONDENSED MATTER PHYSICS	FIS/03	09 CFU
S2	[0034B] INTRODUCTION TO THE PHYSICS OF CONTROLLED NUCLEAR FUSION	FIS/03	06 CFU
S2	[0022B] LABORATORY OF INSTRUMENTAL SEISMOLOGY	FIS/01	09 CFU
S2	[375BB] LARGE SCALE PHYSICAL OCEANOGRAPHY	FIS/03	09 CFU
S2	[0023B] MECHANICS OF GEOPHYSICAL FLUIDS	FIS/06	09 CFU
S2	[322BB] NONLINEAR DYNAMICS	FIS/03	09 CFU
S2	[354BB] QUANTUM OPTICS AND PLASMA PHYSICS	FIS/03	09 CFU
S2	[425BB] QUANTUM THERMODYNAMICS	FIS/03	06 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU
A	[365BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS S	FIS/01	06 CFU
A	[SNS-SMLM] STATISTICAL AND MACHINE LEARNING MODELS FOR TIME SERIES ANALYSIS	FIS/03	06 CFU

Note aggiuntive

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**QUANTUM COMPUTING AND TECHNOLOGIES**

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

42 CFU

Gruppo obbligatori*(tutti i seguenti)*

S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo fisica della materia*(almeno uno dei seguenti)*

S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU

Gruppo fisica sperimentale*(almeno uno dei seguenti)*

S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU
S1	[412BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY S	FIS/01	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

33 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[244CC] CHEMICAL PHYSICS OF MOLECULES	CHIM/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[382BB] QUANTUM LIQUIDS	FIS/03	09 CFU
S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[221BB] ATOM OPTICS	FIS/03	09 CFU
S2	[370BB] CONDENSED MATTER PHYSICS	FIS/03	09 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[426BB] ENTANGLEMENT: ADVANCED THEORETICAL CONCEPTS AND APPLICATIONS IN QUANTUM TECHNOLOGIES	FIS/03	03 CFU
S2	[827II] MATERIALS AND DEVICES FOR NANOSCALE ELECTRONICS	ING-INF/01	06 CFU
S2	[203BB] PHYSICS OF PHOTONIC DEVICES	FIS/03	09 CFU
S2	[0040B] QUANTUM BIOLOGY	FIS/03	09 CFU
S2	[0019B] QUANTUM MACHINE LEARNING	FIS/03	03 CFU
A	[SNS-MQT] METHODS IN QUANTUM TECHNOLOGIES: THEORY AND APPLICATIONS	FIS/03	08 CFU

Note aggiuntive

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**THEORETICAL PHYSICS**

(Curriculum FISICA TEORICA)

Insegnamenti vincolati del PdS

minimo

60 CFU

Gruppo obbligatori*(tutti i seguenti)*

S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU

Approfondimento teorica*(almeno due fra i seguenti)*

S1	[228BB] GENERAL RELATIVITY	FIS/02	09 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S2	[197BB] QUANTUM CHROMODYNAMICS	FIS/02	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo fisica sperimentale*(almeno uno dei seguenti)*

A	[0010B] ASTROPHYSICS AND MULTIMESSENGER LABORATORY	FIS/01	12 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
A	[360BB] COMPUTING METHODS FOR EXPERIMENTAL PHYSICS AND DATA ANALYSIS	FIS/01	09 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S1	[414BB] FUNDAMENTAL INTERACTIONS LABORATORY S	FIS/01	09 CFU
S2	[0046B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES	FIS/07	09 CFU
S1	[412BB] PHYSICS OF MATTER AND NANOTECHNOLOGY LABORATORY S	FIS/01	09 CFU
S1	[193BB] STATISTICAL DATA ANALYSIS	FIS/01	09 CFU

Gruppo microfisica e struttura della materia*(almeno uno dei seguenti, a meno che non sia stato già scelto 206BB nel secondo gruppo)*

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S2	[370BB] CONDENSED MATTER PHYSICS	FIS/03	09 CFU
S1	[305BB] FUNDAMENTAL INTERACTIONS	FIS/04	09 CFU
S1	[304BB] FUNDAMENTALS OF LIGHT MATTER INTERACTION	FIS/03	09 CFU
S1	[206BB] NUCLEAR PHYSICS	FIS/04	09 CFU
S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU

Gruppo astrofisica*(almeno uno dei seguenti)*

S2	[192BB] ASTROPARTICLE PHYSICS	FIS/05	09 CFU
S2	[063BB] ASTROPARTICLE PHYSICS S	FIS/05	06 CFU
S1	[226BB] ASTROPHYSICAL PROCESSES	FIS/05	09 CFU
S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S2	[274BB] COSMOLOGY OF THE EARLY UNIVERSE	FIS/02	09 CFU
S2	[275BB] COSMOLOGY OF THE EARLY UNIVERSE S	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[211BB] STELLAR PHYSICS	FIS/05	09 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

15 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[404BB] NONPERTURBATIVE APPROACHES TO QUANTUM FIELD THEORIES S	FIS/02	06 CFU
S1	[358BB] NONPERTURBATIVE APPROACHES TO QUANTUM FIELD THEORIES	FIS/02	09 CFU
S1	[427BB] PARTICLE DARK MATTER	FIS/01	06 CFU
S2	[274BB] COSMOLOGY OF THE EARLY UNIVERSE	FIS/02	09 CFU
S2	[275BB] COSMOLOGY OF THE EARLY UNIVERSE S	FIS/05	06 CFU
S2	[251BB] GRAVITATION THEORY	FIS/02	09 CFU
S2	[0046B] PHYSICS AND DETECTORS OF GRAVITATIONAL WAVES	FIS/07	09 CFU
S2	[425BB] QUANTUM THERMODYNAMICS	FIS/03	06 CFU
S2	[0016B] THEORY OF NUCLEAR INTERACTION S	FIS/02	06 CFU
A	[326BB] COMPUTATIONAL PHYSICS LABORATORY	FIS/01	09 CFU
A	[374BB] COMPUTATIONAL PHYSICS LABORATORY S	FIS/01	06 CFU
A	[SNS-EFT] EFFECTIVE FIELD THEORIES I AND II	FIS/02	06 CFU
A	[SNS-SMB] STANDARD MODEL AND BEYOND	FIS/02	06 CFU

Note aggiuntive

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THEORY OF QUANTUM MATERIALS

(Curriculum GENERALE)

Insegnamenti vincolati del PdS

minimo

48 CFU

Gruppo obbligatori

(tutti i seguenti)

A	[374BB] COMPUTATIONAL PHYSICS LABORATORY S	FIS/01	06 CFU
S1	[213BB] QUANTUM FIELD THEORY	FIS/02	09 CFU
S1	[204BB] SOLID STATE PHYSICS	FIS/03	09 CFU
S1	[207BB] STATISTICAL PHYSICS	FIS/02	09 CFU

Gruppo fisica della materia

(almeno uno dei seguenti)

S2	[370BB] CONDENSED MATTER PHYSICS	FIS/03	09 CFU
S1	[382BB] QUANTUM LIQUIDS	FIS/03	09 CFU

Gruppo astrofisica

(almeno uno dei seguenti)

S2	[368BB] ASTROPHYSICS	FIS/05	06 CFU
S1	[353BB] PLASMA PHYSICS	FIS/03-05	09 CFU
S2	[098BB] STELLAR PHYSICS S	FIS/05	06 CFU

Insegnamenti a scelta consigliati

massimo

27 CFU

(include gli insegnamenti vincolati non scelti e quelli a seguire)

S1	[230BB] COMPLEX SYSTEMS	FIS/03	09 CFU
S1	[0024B] FLUID DYNAMICS	FIS/03	06 CFU
S1	[376BB] QUANTUM COMPUTING AND TECHNOLOGIES	FIS/03	09 CFU
S1	[382BB] QUANTUM LIQUIDS	FIS/03	09 CFU
S2	[214BB] ADVANCED QUANTUM FIELD THEORY	FIS/02	09 CFU
S2	[370BB] CONDENSED MATTER PHYSICS	FIS/03	09 CFU
S2	[0009B] DETECTION TECHNIQUES: FROM LAB TO SPACE	FIS/01	09 CFU
S2	[426BB] ENTANGLEMENT: ADVANCED THEORETICAL CONCEPTS AND APPLICATIONS IN QUANTUM TECHNOLOGIES	FIS/03	03 CFU
S2	[0004B] FLEXIBLE AND NANO-ELECTRONICS	FIS/03	09 CFU
S2	[0007B] QUANTUM TECHNOLOGIES FOR FUNDAMENTAL INTERACTION PHYSICS	FIS/01	09 CFU
S2	[425BB] QUANTUM THERMODYNAMICS	FIS/03	06 CFU
A	[SNS-MQT] METHODS IN QUANTUM TECHNOLOGIES: THEORY AND APPLICATIONS	FIS/03	08 CFU

Note aggiuntive

- In the exam [374BB] COMPUTATIONAL PHYSICS LABORATORY S, it is strongly suggested to attend the modules "Calcoli da principi primi" and "Dinamica molecolare classica". The 9 CFU of the exam can also be included, by adding an additional module.

PIANO FREE STUDY PLAN

(Curriculum GENERALE)

According to the regulations, any Individual Study Plan (PdSI) must meet certain general requirements, including in particular:

- At least 6 ECTS credits in courses in the FIS/01 sector;
- At least 6 ECTS credits in courses in the FIS/02 sector;
- At least 6 ECTS credits in courses in the FIS/03 or FIS/04 sector;
- At least 6 ECTS credits in courses in the FIS/05 sector;

For a complete list of the constraints that must be satisfied — for example, the total number of ECTS credits dedicated to related and supplementary subjects — please refer to the official regulations of the Master's Degree Program. The total number of credits thus accumulated must reach 75 ECTS, which, combined with the 45 ECTS of the final examination, adds up to the required 120 ECTS.

The submission of a free-form Individual Study Plan (PdSI) must be motivated by specific educational needs and one should first verify if the intended goals can be achieved through one of the recommended study plans. The recommended approach for creating a free-form PdSI is to **start from one of the suggested plans**, and to replace some of the courses with others, in order to assemble a new plan that meets administrative requirements and forms a complete and coherent academic path. When submitting a free-form PdSI, a **motivation behind the proposed plan must be uploaded in CAPS**. Please note that comments and attachments can only be added after the PdSI has been submitted. The approval of the PdSI will be based on the adequacy of the proposed educational path, which must consist of a set of courses that not only comply with general rules but also constitute a complete and coherent program. In particular, make sure to respect course prerequisites and avoid courses with overlapping or redundant content. Be aware that the approval process for a free-form study plan is inherently slower and its outcome is uncertain.