

Master's 1: Physics Major (2022/2023)

The 1st year Master's degree includes a program composed of compulsory modules and disciplinary modules (Physics and/or Chemistry). Each student must validate 30 ECTS per semester.

It is organized in two semesters (S1 and S2), from September to the end of December and from January to the end of July. The 12-week research internship is carried out at the end of the second semester, from May to July.

The description of each program is available on the website:

<http://www.ens-lyon.fr/MasterSDM/en/master-1/m1-courses>

Semester 1

Mandatory electives (teaching units)

- English 1 (3 ECTS)
- Experimental Physics: bibliography (3 ECTS)

Disciplinary electives (At least 24 ECTS)

Lectures of your choice

- Condensed matter (6 ECTS)
- Advanced quantum mechanics (6 ECTS)
- Advanced thermodynamics (6 ECTS)
- Fluid physics (6 ECTS)
- Soft Condensed Matter (6 ECTS)
- Numerical analysis (3 ECTS)
- Green functions and applications (3 ECTS)
- Signal Analysis (3 ECTS)
- Geophysics (3 ECTS)
- Tensors and geometry (3 ECTS)
- Electrodynamics and classical field theory (3 ECTS)
- Selected Courses in the Chemistry Major

Semester 2

Mandatory electives (teaching units)

- English 2 (3 ECTS)
- Seminars & professionalization (3 ECTS)
- Experimental physics 2: project (6 ECTS)

Disciplinary elective (at least 6 ECTS)

Lectures of your choice:

- Lasers and matter (6 ECTS)
- Superconductivity, superfluidity, magnetism (6 ECTS)
- Free field Quantification (6 ECTS)
- Climate and energy transition(3 ECTS)
- Introduction to Numerical Statistical Mechanics (3 ECTS)
- Machine learning in Physics and Chemistry (3 ECTS)
- Quantum Optics (3 ECTS)
- Astrophysics (3 ECTS)
- Groups & Symmetries (3 ECTS)
- Introduction to Particle Physics (3 ECTS)
- Introduction to General Relativity (3 ECTS)
- Statistical physics of biological systems (3 ECTS)
- Granular and divided media (3 ECTS)
- Perspective on a current research theme (3 ECTS)
- Basic Chemistry principles (3 ECTS)
- Molecular biology and genetics (3 ECTS)
- Biological cells and tissues (3 ECTS)
- Selected Courses in the Chemistry Major

Mandatory elective: Research Internship in Physics

- 3-month research internship (12 ECTS)

Master's 1: Chemistry Major (2022/2023)

The Master's 1st year degree includes a program composed of compulsory modules and disciplinary modules (Physics and/or Chemistry). Each student must validate 30 ECTS per semester.

It is organized in two semesters (S1 and S2), from September to the end of December and from January to the end of July. The 12-week research internship is carried out at the end of the second semester, from May to July.

The description of each program is available on the website:

<http://www.ens-lyon.fr/MasterSDM/en/master-1/m1-courses>

Semester 1

Mandatory electives (teaching units)

- English 1 (3 ECTS)
- Experimental chemistry 1 (3 ECTS)
- Experimental chemistry 2 (3 ECTS)

Disciplinary electives (at least 21 ECTS)

Lectures of your choice

- Condensed matter (6 ECTS)
- Quantum modeling of molecules (3 ECTS)
- Quantum modeling of materials (3 ECTS)
- Elements of the d-bloc: principles (3 ECTS)
- Elements of the d-bloc: characterization and applications (3 ECTS)
- Electronic spectroscopy (3 ECTS)
- NMR Basics (3 ECTS)
- Stereochemistry 1: Fundamentals (3 ECTS)
- Stereochemistry 2: applications (3 ECTS)
- Catalysis: from fundamental to industrial applications (3 ECTS)
- Macromolecules (3 ECTS)
- Lectures of your choice in the Physics major

Semester 2

Mandatory electives (teaching units)

- English 2 (3 ECTS)
- Seminars & professionalization (3 ECTS)
- Project in Experimental Chemistry (3 ECTS)

Disciplinary electives (at least 9 ECTS)

Lectures of your choice

- Climate and energy transition(3 ECTS)
- Perspective on a current research theme (3 ECTS)
- Numerical simulations and statistical thermodynamics (3 ECTS)
- Machine learning in Physics and Chemistry (3 ECTS)
- Sustainable chemistry (3 ECTS)
- Structural characterization of materials (3 ECTS)
- Catalysis by metals in organic synthesis (3 ECTS)
- From solid to material: structure-property relationship (3 ECTS)
- Chemistry of biological systems (3 ECTS)
- Challenges and strategies in organic chemistry (3 ECTS)
- Molecular dynamic simulations (3 ECTS)
- Molecular biology and genetics (3 ECTS)
- Biological cells and tissues (3 ECTS)
- Lecture of your choice in the Physics major

Mandatory elective: Research Internship in Chemistry

- 3-month research internship (12 ECTS)

Master's 2: Physics, Concepts and Applications (2022/2023)

The first semester, divided into two periods (3a and 3b) of 9 weeks each, is validated by a minimum of 30 ECTS. Each module corresponds to a set of 24 hours of lectures and 10 hours of tutorials and is credited with 6 ECTS.

The second semester is also divided into two periods (4a and 4b). The first 9 weeks are devoted to the optional courses, which enable students to validate a minimum of 9 ECTS. Each module offered corresponds to 18 hours of lessons and is credited with 3 ECTS. This semester ends with a research internship of a minimum duration of sixteen weeks which validates 21 ECTS. Alternatively, the second semester may consist only of a minimum 24-week long internship validating 30 ECTS.

The choice of electives is up to each student, but their selection enables them to 'color' the scientific direction of the course of each student in one of the themes: 'Physics of fundamental interactions', 'Statistical and Non-Linear Physics', 'Condensed Matter, Quantum Matter and Optics', 'Soft Condensed Matter and Biophysics'.

The description of each program is available on the website:

<http://www.ens-lyon.fr/MasterSDM/en/master-2/m2-physics-concepts-and-applications/m2-physics-courses>

Semester 3

Electives of S3A

Lectures of your choice

- Advanced condensed matter: electrons in interaction (6 ECTS)
- Advanced electromagnetism and optics (6 ECTS)
- Advanced soft condensed matter (6 ECTS)
- Advanced statistical mechanics (6 ECTS)
- Computational statistical physics (6 ECTS)
- Interacting quantum fields (6 ECTS)
- Nonlinear physics and instabilities (6 ECTS)
- Path integrals and applications (6 ECTS)

Electives of S3B

Lectures of your choice

- Advanced aspects of symmetries (6 ECTS)
- Advanced fluid mechanics and turbulence (6 ECTS)
- Biophysics (6 ECTS)
- Experimental project (6 ECTS)
- Gauge theories and applications (6 ECTS)
- General relativity and cosmology (6 ECTS)
- Geophysics (6 ECTS)
- Nanophysics (6 ECTS)
- Numerical Project (6 ECTS)
- Particle physics (6 ECTS)
- Phase transitions and critical phenomena (6 ECTS)

Semester 4

Electives of S4A (at least 9 ECTS)

Lectures of your choice

- Advanced condensed matter 2 (3 ECTS)
- Active matter (3 ECTS)
- Advanced mechanics (3 ECTS)
- Astro-particle physics (3 ECTS)
- Granular and jammed materials (3 ECTS)
- Integrable models (3 ECTS)
- Introduction to Quantum Engineering (3 ECTS)
- Large deviation theory (3 ECTS)
- Nonlinear dynamics and statistical theories for geophysical flows (3 ECTS)
- Standard model of particle physics and beyond (3 ECTS)
- String theory (3 ECTS)
- Topological defects in materials (3 ECTS)
- Topological phases (3 ECTS)

Mandatory elective: Research Internship in Physics

Choice of the duration of the research internship:

- 4-month Physics research internship (21 ECTS)
- 6-month Physics research internship (30 ECTS)

Master's 2: Chemistry, Concepts and Applications (2022/2023)

The year is divided into two semesters (3 and 4 of the master's degree), each validated by a minimum of 30 ECTS credits.

Semester 3 consists of teaching units composed of a choice of lectures for 9 ECTS of Advanced Physics & Chemistry methods supplemented by a modular elective of 15 ECTS which enables students to specialize in a theme in addition to a mandatory bibliographic project worth 6 ECTS.

Possible profiles are 'Organic and supramolecular chemistry', 'Materials, Catalysis and Environment', 'Spectroscopies' or 'Opening to another discipline', e.g. geochemistry or biochemistry.

Semester 4 corresponds to the experimental internship in a research laboratory worth 30 ECTS.

The description of each program is available on the website:

<http://www.ens-lyon.fr/MasterSDM/fr/master-2/m2-chimie-concepts-et-applications/m2-chimie-cours>

Semester 3

Mandatory elective

- Bibliographic report (6 ECTS)

Common Core Elective: Advanced Physics & Chemistry Methods (At least 12 ECTS)

Lectures of your choice

- Advanced Electrochemistry (3 ECTS)
- Computational chemistry (3 ECTS)
- Reaction mechanisms (3 ECTS)
- Applied modern magnetic resonance (3 ECTS)
- Crystallography and diffraction (3 ECTS)
- Advanced Mass Spectrometry (3 ECTS)

Specialization electives of your choice (teaching units 12 ECTS)

Choose from :

- UE Organic and supramolecular chemistry (12 ECTS)
- UE: Materials, catalysis and environment (12 ECTS)
- UE Spectroscopy (12 ECTS)
- UE Across disciplines (12 ECTS)

Semester 4

Mandatory elective: Research Internship

- 6-month research internship in Chemistry (30 ECTS)

Master's 2 Computational Physics and Chemistry (2022/2023)

The first semester (S3) lasts from the beginning of September to the end of January. The second semester (S4) begins in early February. Each semester is validated by a minimum of 30 ECTS.

Among the electives specific to the objectives of the Master's 2 degree in "Numerical Modeling", each student must validate a minimum of 15 ECTS. These electives can be supplemented by disciplinary electives of the Master's 2 degree in "Physics, Concepts and Applications" and/or "Chemistry, Concepts and Applications". Please note however, some electives are organized over several periods of the S3.

The description of each course is available on the website

<http://www.ens-lyon.fr/MasterSDM/en/master-2/m2-computational-physics-and-chemistry/m2-computational-physics-and-chemistry-cours>

Semester 3

Specific Electives of the Computational Master's 2 (at least 15 ECTS)

Lectures of your choice :

- Advanced Computational Statistical Physics (6 ECTS)
- Advanced Computational Chemistry (6 ECTS)
- Computational Fluid Dynamics (6 ECTS)
- Quantum Monte Carlo for Condensed Matter and Statistical Physics (3 ECTS)
- Quantum approach of catalytic reactivity (3 ECTS)
- Theoretical Photo-physics and -chemistry (3 ECTS)
- Computational Project (6 ECTS)
- Advanced Topics in Computational Physics and Chemistry: Literature project and seminar (6 ECTS)

Disciplinary Electives of Physics Master's 2

Lectures of your choice

- Advanced condensed matter: electrons in interaction (6 ECTS)
- Advanced electromagnetism and optics (6 ECTS)

- Advanced fluid mechanics and turbulence (6 ECTS)
- Advanced soft condensed matter (6 ECTS)
- Advanced statistical mechanics (6 ECTS)
- Biophysics (6 ECTS)
- Geophysics (6 ECTS)
- Nanophysics (6 ECTS)
- Nonlinear physics and instabilities (6 ECTS)
- Advanced fluid mechanics and turbulence (6 ECTS)
- Phase transitions and critical phenomena (6 ECTS)
- Quantum modeling of molecules (3 ECTS)
- Quantum modeling of materials (3 ECTS)

Disciplinary Electives of Chemistry Master's 2

Lecture of your choice:

- Crystallography and diffraction methods (3 ECTS)
- Texture and functionalities in smart hybrid materials (3 ECTS)
- From molecules to materials for optics (3 ECTS)
- Applied modern magnetic resonance (3 ECTS)
- Structure and dynamics by NMR (3 ECTS)
- Properties of organic free radicals (3 ECTS)
- Reaction mechanisms (3 ECTS)
- Medicinal Chemistry (3 ECTS)
- *In vivo* molecular and functional imaging (3 ECTS)
- Supramolecular chemistry (3 ECTS)
- Advanced Electrochemistry (3 ECTS)

Semester 4

Mandatory Elective: 6-month research internship

Choice of Physics or Chemistry internship

Choose from:

- 6-month research internship in Chemistry (30 ECTS)
- 6-month research internship in Physics (30 ECTS)

Master's 2: Complex systems (2022/2023)

The first semester is devoted to the main electives (UE) of the common core and the specific research electives in modeling, among which each student must validate a minimum of 18 ECTS. The remaining 12 ECTS must be validated among the electives of the "Physics, concepts and applications" of the first semester (or in other master's on the agreement of the persons in charge of the master's 2).

In the second semester, the curriculum is organized so that students are in a research internship for at least 24 weeks (from the end of January to July), to validate 30 ECTS.

The description of each program is available on the website

<http://www.ens-lyon.fr/MasterSDM/en/master-2/m2-complex-systems/m2-complex-systems-courses>

Semester 3

Common Core Elective (at least 12 ECTS)

Lecture of your choice

- Fundamentals in computer science (3 ECTS)
- Complex networks (5 ECTS)
- Methods in complex systems (4 ECTS)
- Research in complex systems (3 ECTS)

Specific electives (at least 6 ECTS)

Lectures of your choice:

- Modeling of social systems (3 ECTS)
- Modeling in biology and medicine (3 ECTS)
- Data analysis and modeling (3 ECTS)
- Machine learning (3 ECTS)

Master's 2 Elective "Physics, Concepts and Applications" (at least 12 ECTS)

Lectures of your choice:

- Advanced condensed matter: electrons in interaction (6 ECTS)
- Advanced electromagnetism and optics (6 ECTS)
- Advanced soft condensed matter (6 ECTS)
- Advanced statistical mechanics (6 ECTS)
- Computational statistical physics (6 ECTS)
- Interacting quantum fields (6 ECTS)
- Nonlinear physics and instabilities (6 ECTS)
- Path integrals and applications (6 ECTS)
- Advanced aspects of symmetries (6 ECTS)
- Advanced fluid mechanics and turbulence (6 ECTS)
- Biophysics (6 ECTS)
- Experimental project (6 ECTS)
- Numerical Project (6 ECTS)
- Gauge theories and applications (6 ECTS)
- General relativity and cosmology (6 ECTS)
- Geophysics (6 ECTS)
- Nanophysics (6 ECTS)
- Particle physics (6 ECTS)
- Phase transitions and critical phenomena (6 ECTS)

Semester 4

Mandatory Elective: Research Internship

- 6-month Physics research internship (30 ECTS)