

**COURSE DATA****DATA SUBJECT****Code:** 46988**Name:** Introduction to the Master's Degree in Advanced Materials**Cycle:** Master's Degree**ECTS Credits:** 8**Academic year:** 2025-26**STUDY (S)**

Degree	Center	Acad. year	Period
2278 - Master in Advanced Materials	Facultat de Química	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2278 - Master in Advanced Materials	Materias Obligatorias	COMPULSORY

COORDINATION

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SUMMARY

Students will take this module from October to December at the university where they are enrolled. The introductory module to the master's degree will familiarize students with the fundamental concepts of advanced materials and prepare them to assimilate the new knowledge and more advanced content of the following modules, which will be taught intensively.

After completing the Introduction to the Master's Degree in Advanced Materials course, the objective is for students to:

1. Understand the main types of 2D materials based on their structural characteristics and composition.
2. Understand the top-down and bottom-up preparation techniques for 2D materials, van der Waals heterostructures, and nanocomposites.
3. Acquire knowledge of the components, molecules, and materials that are essential for the design and construction of quantum devices.

PREVIOUS KNOWLEDGE**RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE**



There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

Previous knowledge of chemistry, physics or materials science as taught in the degrees indicated in the recommended entry profile to the master's degree is required.

COMPETENCES / LEARNING OUTCOMES

DESCRIPTION OF CONTENTS

U1.1- Basic concepts on the properties of advanced materials.

- Crystal structures of solids, the reciprocal lattice, defects in solids.
- Electronic structure of materials: Orbitals and bands in one dimension. Bloch functions and band structures; the Fermi level; density of states.
- Relationship between crystal structure and electronic structure and properties: Electrical properties of materials (insulators, semiconductors, metals, and superconductors). Optical properties (light-matter interaction, optical absorption in semiconductors, the concept of exciton and excitonic recombination). Magnetic properties (magnetic interactions; magnetic ordering; magneto-structural correlations). Electrochemical properties (relationship of structure with photocatalytic, electrocatalytic, and energy storage properties).

U1.2- Fundamentals of advanced materials preparation and processing techniques.

- Main preparation techniques for nanostructured materials and nanoparticles.
- Advanced material preparation techniques from solution (intercalation chemistry, colloidal chemistry, supramolecular chemistry) and solid-state (chemical vapor deposition (CVD), chemical vapor transport (CVT), etc.)
- Processing of materials as thin films (Langmuir-Blodgett techniques, layer-by-layer, spin coating, electrochemical growth, self-assembled monolayers (SAMs), molecular sublimation, sputtering, etc.)

U1.3 - Fundamentals of materials characterization techniques

- Diffraction techniques: X-ray diffraction, electron diffraction, neutron diffraction.
- Spectroscopic techniques: vibrational spectroscopy (Raman, IR), photoelectron spectroscopy, and related techniques (XPS, UPS, NEXAFS).
- Microscopy: Electron microscopy, far-field microscopy. Local probe microscopy (AFM, STM, MFM, SNOM)
- Magnetic and electron transport techniques.
- Electrochemical techniques used in energy storage and conversion (voltaamperometry, chronoamperometry, impedance).

**WORKLOAD****PRESENCIAL ACTIVITIES**

Activity	Hours
Theory	70,00
Classroom practices	10,00
Total hours	80,00

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	60,00
Independent study and work	0,00
Preparation of lessons	0,00
Preparation for assessment activities	60,00
Resolution of case studies	0,00
Total hours	120,00

TEACHING METHODOLOGY

The main training activities and teaching methodologies will be **theoretical lectures, seminars, and formal tutorials**. During the seminars, the theoretical content of the module will be worked on in a practical manner. The methodologies used include article discussions, guided debate and discussion, discussion of practical cases and problem-solving and question-solving, and visits to laboratories and scientific facilities.

Students will be required to complete, individually or in groups, assignments related to some of the concepts explained during the lectures and will also work independently to prepare for the lectures and the module exam.

In formal tutorials, the professor will guide students in their learning process by answering questions about the subject matter, which will serve to reinforce their knowledge. These group tutorials will be conducted primarily in person, as both professors and students are from the same university.

EVALUATION

SE1 - Written exam on core subject content: 30-60%

SE2 - Individual or group work: 30-60%

SE3 - Active participation in in-person activities: 10-20%

SE1 - Written exam on core subject content: Students' achievement of the various learning outcomes will be assessed through individual written exams. The degree of mastery of the main concepts and topics taught in the module will be taken into account, as well as their ability to apply them in different academic and practical contexts. These exams will be administered in person, ensuring equal conditions for all students and facilitating a controlled and reliable assessment. Exams may include different types of questions, such as multiple choice, short and complex answers, and problem-solving, in order to evaluate both the knowledge acquired and the students' analytical, synthesizing, and argumentative skills.



SE2 - Completion of individual or group work: Students' achievement of the various learning outcomes will be assessed through the evaluation of work related to the content taught in the module. These work may be completed individually or in small groups, followed by oral presentation.

Aspects such as depth and precision in understanding the content, coherence and logical structure in the presentation of the work, as well as the correct use of bibliographic sources and the relevance of the conclusions reached will be considered. In addition, the student's ability to work in teams will be taken into account, fostering collaboration skills, effective communication, and joint problem-solving.

The oral presentation of the work will assess the student's ability to communicate information in a clear, structured, and convincing manner, as well as their mastery of the content related to the modules.

SE3 - Active participation in face-to-face activities: continuous assessment of students based on their involvement and commitment in the teaching-learning process. Their participation in debates and discussions and in solving simple problems related to the module's content will be taken into account.

Students' level of interest, understanding, and analytical skills in the content taught will be assessed, as well as their ability to formulate relevant questions and comments and respond to questions and problems posed by the instructor.

Attendance at training activities is mandatory. To pass the module, students must have attended all in-person training activities, except in duly justified cases

REFERENCES