

**COURSE DATA****DATA SUBJECT****Code:** 46989**Name:** Graphene and Other Two-Dimensional Materials**Cycle:** Master's Degree**ECTS Credits:** 6**Academic year:** 2025-26**STUDY (S)**

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

SUBJECT-MATTER

Degree	Subject-matter	Character
2278 - Master in Advanced Materials	Grafeno y otros materiales bidimensionales	COMPULSORY

COORDINATION**SUMMARY**

This course will be taught, together with the module MA3, intensively during 3 weeks in January and each year at a different university. The course will be taught in English.

The discovery of graphene has made 2D materials one of the most important research focuses in current Materials Science. This course aims to introduce students to the study of these advanced materials, from the new physics that emerges at the 2D limit to the chemical design and controlled and scalable production of new 2D materials and heterostructures for their applications.

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. Previous knowledge of materials science as taught in the Introduction Module (MA1) is required.

COMPETENCES / LEARNING OUTCOMES



DESCRIPTION OF CONTENTS

U2.1. Introduction to 2D materials.

- Graphene: preparation techniques and general properties.
- Classification of 2D materials. Examples of materials with relevant properties.
- Top-down and bottom-up preparation techniques.
- Van der Waals heterostructures.

U2.2. Emerging physical properties at the 2D boundary

- Superconductivity and magnetism in 2D materials. Excitons in 2D materials: valleytronics. Advanced characterization techniques.
- Emergent properties in heterostructures. Twistronics.
- Control of properties in 2D materials: effect of doping; effect of stress; effect of the application of electric or magnetic fields; etc.

U2.3 Application of chemistry to the development of 2D materials.

- Chemical functionalization of 2D materials.
- Molecular approach to 2D materials.
- Fabrication and properties of hybrid heterostructures and nanocomposites based on 2D materials.

U2.4. Applications of 2D materials

- Electronic devices: field effect transistors, optoelectronic devices, spintronic devices.
- Mechanical devices: membranes and sensors.
- Electroactive 2D materials for energy storage and generation.
- Applications in medicine.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	36,00
Classroom practices	25,00
Total hours	61,00

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	0,00
Preparation of lessons	7,00
Preparation for assessment activities	32,00
Resolution of case studies	50,00
Total hours	89,00

TEACHING METHODOLOGY



The main training activities and face-to-face teaching methodologies will be the **theoretical classes** and the **seminars**. During the seminars, the theoretical contents of the modules will be worked on in a practical way. Among the methodologies used in the seminars are the discussion of articles, debate and guided discussion, discussion of practical cases and resolution of problems and questions and visits to laboratories and scientific facilities of the university where the classes are held that year.

These training activities will be carried out intensively each year at a different university, which will be attended by students and teaching staff from all the universities. Through this mobility between the participating universities, students will be able to benefit from the knowledge of various renowned professors and researchers distributed throughout the territory. Given that these modules deal with advanced and specific concepts, the inter-university nature of the master's degree means that students will be able to count on expert lecturers in each of the subjects covered at all the universities.

After the theory classes, students will have to solve a series of **questions and problems** posed by each of the lecturers of these modules, through this work, students will develop and assimilate the concepts studied during the face-to-face classes.

The resolution of these questions involves a great deal of individual work by the students, as well as the pooling with the rest of the students, and they will also have the participation of the teaching staff to resolve any doubts. During the seminar hours, guidelines will have been given for the resolution of the questions and initial doubts will have been resolved. In the weeks following the intensive classes, group **tutoring sessions** will be carried out in online, synchronous and interactive mode. During these sessions, guidance will be offered to students and doubts will be resolved about the questionnaire, once students have started working on it, as well as about the preparation of the exam.

Students will also be able to contact the professors individually at any time to resolve any doubts they may have.

This combination encourages direct interaction between students and teachers as well as the autonomous work of students, which allows them to deepen their knowledge of the topics covered and apply what they have learnt autonomously.

EVALUATION

SE3- Active participation in face-to-face activities: 10%

SE1- Written exam on basic subject content: 90%

SE3- Active participation in face-to-face activities: Continuous assessment of students based on their involvement and commitment to the teaching-learning process. Their participation in debates and discussions, as well as in solving simple problems related to the module content, will be taken into account. Students' level of interest, understanding and analytical ability of the content taught, as well as their ability to formulate relevant questions and comments and respond to questions and problems posed by the professor will be assessed.

SE1- Written exam on basic subject content: Students' achievement of the various learning outcomes will be assessed through an individual final written exam. The degree of mastery of the fundamental concepts taught during the theoretical classes and intensive seminars, as well as the students' independent work through solving questions posed by the professors, will be taken into account.

Exams may include different types of questions, such as short answers, short essays, and problem-solving, in order to assess both the knowledge acquired and the students' analytical, synthesizing, and



argumentative skills.

Each student will take the exam, in person, at their university of enrolment. It will be a common exam for all participating universities, ensuring equal conditions for all students and facilitating a controlled and reliable assessment.

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

REFERENCES