



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
EXCELLENCE

COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros de
Caminos, Canales y Puertos

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000601 - Fabricación Avanzada De Materiales Funcionales

DEGREE PROGRAMME

04AN - Master Universitario En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	43000601 - Fabricación Avanzada de Materiales Funcionales
No of credits	3 ECTS
Type	Compulsory
Academic year of the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	04AN - Master Universitario en Ingeniería de Materiales
Centre	04 - Escuela Técnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Marta Clement Lorenzo	B-307	marta.clement@upm.es	Sin horario. Tutorials appointments will be fixed by e-mail.
Jimena Olivares Roza (Subject coordinator)	B-307	jimena.olivares@upm.es	Sin horario. Tutorials appointments will be fixed by e-mail.

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty

member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Basic physics and thermodynamics. Basic electricity and magnetism
- Basic knowledge of semiconductors and device physics

4. Skills and learning outcomes *

4.1. Skills to be learned

CE1 - Capacidad para aplicar los fundamentos científicos del comportamiento físico y químico de los materiales para relacionar causalmente sus propiedades fundamentales físicas y químicas con su comportamiento macroscópico y el de los productos con ellos realizados / Ability to apply the scientific foundations of the physical and chemical behavior of materials to correlate their fundamental physical and chemical properties with their macroscopic behavior and that of the products made with them.

CE5 - Capacidad para planificar, explotar y gestionar técnicamente la selección, fabricación, procesado, utilización, reciclado, reutilización y eliminación de materiales, de forma respetuosa con el medio ambiente, de conformidad con la legislación nacional e internacional, y promoviendo el desarrollo sostenible y el bienestar de la sociedad / Ability to technically plan, exploit and manage the selection, manufacturing, processing, use, recycling, reuse and disposal of materials, in an environmentally friendly manner, in accordance with national and international legislation, and promoting sustainable development and well-being of the society

CE6 - Capacidad para controlar y modificar los mecanismos físicos y químicos que determinan las fases del ciclo de vida de los materiales, su durabilidad y su incidencia en el medioambiente con el fin de poder evaluar, controlar y mejorar la seguridad, durabilidad e integridad estructural de los materiales y los componentes fabricados con ellos / Ability to control and modify the physical and chemical mechanisms that determine the phases of the life cycle of materials, their durability and their impact on the environment in order to be able to evaluate, control and improve the safety, durability and structural integrity of materials and components made from them

CG1 - Uso de la lengua inglesa: Los alumnos son capaces de transmitir conocimientos y expresar ideas y argumentos de manera clara, rigurosa y convincente, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia / Use of the English Language: Students are able to transmit knowledge and express ideas and arguments in a clear, rigorous and convincing manner, both orally and in writing, adapting to the characteristics of the situation and the audience .

CG2 - Liderazgo: Los estudiantes son capaces de dirigir y coordinar personas para que trabajen con entusiasmo en la consecución de objetivos en pro del bien común / Leadership: Students are capable of directing and coordinating people so that they work enthusiastically to achieve objectives for the common good.

CG3 - Trabajo en equipo: Los alumnos desarrollan la capacidad para trabajar en equipo, integrarse y colaborar de forma activa en la consecución de objetivos comunes / Teamwork: Students develop the ability to work as a team, integrate and actively collaborate in achieving common goals.

CG4 - Creatividad: Los alumnos son capaces de resolver de forma nueva, original y aportando valor, situaciones o problemas en el ámbito de la ingeniería de materiales / Creativity: Students are able to solve situations or problems in the field of materials engineering in a new, original way and adding value.

CG7 - Uso de las TIC: Los alumnos son capaces de aplicar conocimientos tecnológicos necesarios de manera que les permitan desenvolverse cómodamente y afrontar los retos que la sociedad les va a imponer en su quehacer profesional empleando la informática / Use of ICT: Students are able to apply the necessary technological knowledge in a way that allows them to function comfortably and face the challenges that society is going to impose on them in their professional work using computers.

CG9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

4.2. Learning outcomes

RA43 - HC1 - Ability to communicate in technical English reports, projects, problems, methodologies, results, etc. related to research and innovation and development in materials engineering in a clear and fluid way

RA1 - Saber comunicar conocimientos, procedimientos, resultados o técnicas relacionadas con el comportamiento y el uso de materiales

RA39 - HCC1 - Ability to logically and critically apply the bases of the scientific method in materials science and engineering

RA7 - RA53 - Ser creativo, ejecutando el trabajo con responsabilidad y respeto a los demás

RA41 - HRP1 - Ability to solve problems that require the design of novel structural or functional materials or devices based on them

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

The students will become familiar with the most relevant techniques used in thin film materials technology for the fabrication of electronic devices. These devices include sensors, actuators, RF passive components and devices with complex functionality such as microelectromechanical systems (MEMS). Some particular issues in thin film technology will be studied, which include thin film deposition techniques and control of the film properties, design of a complete technology and specific characterization techniques of polycrystalline thin films. Design and fabrication principles of typical thin-film-based devices will be studied and the fabrication of operative devices will be undertaken.

The course contains an important number of practical sessions, which include the deposition and patterning of thin films.

5.2. Syllabus

1. Introduction to functional materials (semiconductors, insulators, metals, piezoelectric materials, etc.)
2. Technological processes I (Lithography and etching)
3. Technological processes II (3D micromachining)
4. Vacuum technologies
5. Deposition techniques I (Thermal evaporation)
6. Deposition techniques II (Sputtering)
7. Deposition techniques III (Chemical vapour deposition)
8. Examples of thin film devices based on functional materials

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	Introduction Duration: 02:00 Lecture			
2	Topics 1-2 Duration: 02:00 Lecture			
3	Topic 3 Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15
4	Intro lab Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15
5		Practical session 1 Duration: 02:00 Laboratory assignments		Deliverable related to the lab activity Group work Continuous assessment Not Presential Duration: 00:00
6	Topic 4 Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15
7	Topic 5 Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15
8		Practical session 2 Duration: 02:00 Laboratory assignments		Deliverable related to the lab activity Group work Continuous assessment Not Presential Duration: 00:00
9	Topic 6 Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15

10	Topic 7 Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15
11		Practical session 3 Duration: 02:00 Laboratory assignments		Deliverable related to the lab activity Group work Continuous assessment Not Presential Duration: 00:00
12	Topic 8 Duration: 01:45 Lecture			Online quizz Online test Continuous assessment Not Presential Duration: 00:15
13		Practical session 4 Duration: 02:00 Laboratory assignments		Deliverable related to the lab activity Group work Continuous assessment Not Presential Duration: 00:00
14	Assistance to the oral presentation session Duration: 02:00 Additional activities			Oral presentation Individual presentation Continuous assessment Presential Duration: 00:20
15				
16				
17				Exam Written test Continuous assessment Presential Duration: 02:00 Exam Written test Final examination Presential Duration: 02:00 Oral presentation Individual presentation Final examination Presential Duration: 00:20

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
4	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
5	Deliverable related to the lab activity	Group work	No Presential	00:00	2%	4 / 10	CG9 CE1 CG4 CG3 CE6 CG1 CG2 CE5
6	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
7	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
8	Deliverable related to the lab activity	Group work	No Presential	00:00	2%	4 / 10	CG9 CE1 CG4 CG3 CE6 CG1 CG2 CE5

9	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
10	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
11	Deliverable related to the lab activity	Group work	No Presential	00:00	2%	4 / 10	CG9 CE1 CG4 CG3 CE6 CG1 CG2 CE5
12	Online quizz	Online test	No Presential	00:15	2%	4 / 10	CG9 CE1 CE6 CG1 CE5
13	Deliverable related to the lab activity	Group work	No Presential	00:00	15%	4 / 10	
14	Oral presentation	Individual presentation	Face-to-face	00:20	15%	4 / 10	CG9 CG4 CG7 CG1
17	Exam	Written test	Face-to-face	02:00	50%	4 / 10	CE1 CE6 CG1 CE5 CG9

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Exam	Written test	Face-to-face	02:00	65%	4 / 10	CG9 CE1 CG4 CE6 CG1 CE5
17	Oral presentation	Individual presentation	Face-to-face	00:20	15%	4 / 10	CG9 CG4 CG7 CG1

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Exam	Written test	Face-to-face	02:00	80%	4 / 10	CG9 CE1 CG4 CE6 CG1 CE5
Oral presentation	Individual presentation	Face-to-face	00:30	20%	4 / 10	CG9 CG4 CG7 CG1

7.2. Assessment criteria

Note

This subject involves mandatory practical activities that must be taken during the school period as they take place in research facilities with specific equipment. If they are not taken during the school period, the maximum grade in the global evaluation cannot be achieved.

Progressive assessment

Mark required to pass the course: > 5/10 (Minimum mark in each part: 4/10). The assessable items are:

Written exam: 50%

Oral presentation: 15%

Deliverables: 21%

Onlines quizzes: 14%

Overall assessments

Mark required to pass the course: > 5/10 (Minimum mark in each part: 4/10). The assessable items are:

Written exam: 65%

Oral presentation: 15%

Extraordinary exam

Mark required to pass the course: > 5/10 (Minimum mark in each part: 4/10). The assessable items are:

Written exam: 80%

Oral presentation: 20%

Mark required to pass the course: > 5/10 (Minimum mark in each part: 4/10). The assessable items are:

Written exam: 80%

Oral presentation: 20%

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Moodle page of the module	Web resource	Moodle page including all the information related with the module
Laboratories devoted to the fabrication and characterization of materials and devices	Equipment	Research lab conveniently adapted so that students can undertake the fabrication and characterization of the thin film devices with the supervision of a lecturer.
Handbook of Thin Film Technology. Frey, Hartmut, Khan, H. R. Springer (2015)	Bibliography	
Thin Films Material Technology: Sputtering of Compound Materials. Wasa, Kiyotaka, Kitabatake, Makoto, Adachi, Hideaki. Springer (2004)	Bibliography	

Sputtering Materials for VLSI and Thin Film Devices. Jaydeep Sarkar. Elsevier (2013)	Bibliography	
Thin Film Technology Handbook. Aicha Elshabini, Aicha Elshabini-Riad, Fred D. Barlow. McGraw Hill Professional, 1998	Bibliography	
Introduction to Surface and Thin Film Processes. John A. Venables. Cambridge U. Press. 2001	Bibliography	

9. Other information

9.1. Other information about the subject

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year.

* This course invests a significant time and effort in laboratory activities. Since these activities take place in research facilities, small lab groups will be set at the beginning of the semester. Depending on the number of students some lab activities will take place in morning sessions,

Communication with students

* Communication between students and lectures will be through e-mail and Moodle. Any question or concern about the module should be sent to the coordinator. The lectures will answer as soon as possible.

* Tutorials will take place face-to-face if possible or through Zoom

Sustainable development goals

This module can contribute to Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, in particular to targets 4.3 Ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university and 4.4 Substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

As the module deals with microfabrication techniques for TIC components, we will have the opportunity to highlight Goal 9: Industry, Innovation and Infrastructure and its targets 9.5. Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending and 9.8 Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries.