# ANX-PR/CL/001-01

# LEARNING GUIDE

## SUBJECT

**93000836 - Microelectronic Technology**

## DEGREE PROGRAMME

09AQ - Master Universitario En Ingenieria De Telecomunicacion

## ACADEMIC YEAR & SEMESTER

2021/22 - Semester 2

# Index

## Learning guide

# 1. Description

## 1.1. Subject details

| | |
|---|---|
| **Name of the subject** | 93000836 - Microelectronic Technology |
| **No of credits** | 6 ECTS |
| **Type** | Optional |
| **Academic year ot the programme** | Second year |
| **Semester of tuition** | Semester 4 |
| **Tuition period** | February-June |
| **Tuition languages** | English |
| **Degree programme** | 09AQ - Master Universitario en Ingenieria de Telecomunicacion |
| **Centre** | 09 - Escuela Tecnica Superior De Ingenieros De Telecomunicacion |
| **Academic year** | 2021-22 |

# 2. Faculty

## 2.1. Faculty members with subject teaching role

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

CE10 - Capacidad para diseñar y fabricar circuitos integrados.

CE15 - Capacidad para la integración de tecnologías y sistemas propios de la Ingeniería de Telecomunicación, con carácter generalista, y en contextos más amplios y multidisciplinares como por ejemplo en bioingeniería, conversión fotovoltaica, nanotecnología, telemedicina.

CG2 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CG4 - 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.

CG5 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CT1 - Capacidad para comprender los contenidos de clases magistrales, conferencias y seminarios en lengua inglesa.

CT3 - Capacidad para adoptar soluciones creativas que satisfagan adecuadamente las diferentes necesidades planteadas.

CT4 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo.

CT5 - Capacidad para gestionar la información, identificando las fuentes necesarias, los principales tipos de documentos técnicos y científicos, de una manera adecuada y eficiente.

### 4.2. Learning outcomes

RA122 - Conocer a nivel básico los procesos tecnológicos que se usan en la fabricación de circuitos integrados

RA125 - Conocer las aplicaciones de las tecnologías microelectrónicas a dispositivos electrónicos particulares como dispositivos pasivos de alta frecuencia, sensores, MEMS, etc.

RA124 - Conocer el concepto de tecnología de fabricación microelectrónica y saber diseñar esquemáticamente una ruta de fabricación de CI

* 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

In the subject Microelectronic Technology the students will deal with technologies currently used in the microfabrication of integrated circuits. The concept of technology is introduced as a concatenation of technological processes. Each individual process is described together with concepts about integration by highlighting the importance of their interrelation to build a complete technology.

The main objective is students becoming familiar with processes involved in the microfabrication of ICs and with the fabrication technologies used currently.

## 5.2. Syllabus

1. Schedule and module rules

2. Introduction

3. Technological processes I (Lithography and etching)

4. Device fabrication technology

5. Technological processes II (Materials, thermal oxidation, ion implantation)

6. Vacuum technologies

7. Deposition techniques I (Thermal evaporation)

8. Deposition techniques II (Sputtering)

9. Deposition techniques III (CVD)

# 6. Schedule

## 6.1. Subject schedule*

| Week | Face-to-face classroom activities | Face-to-face laboratory activities | Distant / On-line | Assessment activities |
|---|---|---|---|---|
| 1 | **Introduction**<br>Duration: 02:00<br>Lecture | | | |
| 2 | **Topics 1-2**<br>Duration: 02:00<br>Lecture | | | |
| 3 | **Topic 3**<br>Duration: 02:00<br>Lecture | | | |
| 4 | **Intro lab**<br>Duration: 02:00<br>Lecture | | | |
| 5 | **Topic 4**<br>Duration: 02:00<br>Lecture | **Practical session 1: Simulation of the technology**<br>Duration: 04:00<br>Laboratory assignments | | |
| 6 | **Tema 5**<br>Duration: 02:00<br>Lecture | **Practical session 2**<br>Duration: 04:00<br>Laboratory assignments | | |
| 7 | | | | **Test 1**<br>Written test<br>Continuous assessment<br>Presential<br>Duration: 01:00 |
| 8 | **Topic 6**<br>Duration: 02:00<br>Lecture | **Practical session 3**<br>Duration: 04:00<br>Laboratory assignments | | |
| 9 | **Visit to the ion implanter at CAI de Técnica Físicas of UCM**<br>Duration: 02:00<br>Additional activities | **Practical session 4**<br>Duration: 04:00<br>Laboratory assignments | | **Deliverable related with the lab sessions**<br>Individual work<br>Continuous assessment and final examination<br>Not Presential<br>Duration: 00:00 |
| 10 | **Topic 7**<br>Duration: 02:00<br>Lecture | **Practical session 5**<br>Duration: 04:00<br>Laboratory assignments | | |
| 11 | **Topic 8**<br>Duration: 02:00<br>Lecture | **Practical session 6**<br>Duration: 04:00<br>Laboratory assignments | | **Oral presentation**<br>Individual presentation<br>Continuous assessment<br>Presential<br>Duration: 00:20 |

| | | | | |
|---|---|---|---|---|
| 12 | | **Practical session 7**<br>Duration: 04:00<br>Laboratory assignments | | **Oral presentation**<br>Individual presentation<br>Continuous assessment<br>Presential<br>Duration: 00:20 |
| 13 | **Assistance to the oral presentation session**<br>Duration: 04:00<br>Additional activities | | | **Oral presentation**<br>Individual presentation<br>Continuous assessment<br>Presential<br>Duration: 00:20<br><br>**Oral presentation**<br>Individual presentation<br>Final examination<br>Presential<br>Duration: 00:30<br><br>**Deliverable related with the lab sessions.**<br>Individual work<br>Continuous assessment and final examination<br>Not Presential<br>Duration: 00:00 |
| 14 | | | | |
| 15 | | | | **Test 2**<br>Written test<br>Continuous assessment<br>Presential<br>Duration: 02:00 |
| 16 | | | | |
| 17 | | | | **Test**<br>Written test<br>Final examination<br>Presential<br>Duration: 03:00 |

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. Continuous assessment

| Week | Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|---|---|---|---|---|---|---|---|
| 7 | Test 1 | Written test | Face-to-face | 01:00 | 30% | 4 / 10 | CT1<br>CT3<br>CE10 |
| 9 | Deliverable related with the lab sessions | Individual work | No Presential | 00:00 | 10% | 4 / 10 | CG2<br>CT5<br>CG4<br>CT4<br>CT3<br>CG5<br>CE10<br>CE15 |
| 11 | Oral presentation | Individual presentation | Face-to-face | 00:20 | 10% | 4 / 10 | CT3<br>CE15 |
| 12 | Oral presentation | Individual presentation | Face-to-face | 00:20 | 0% | 4 / 10 | |
| 13 | Oral presentation | Individual presentation | Face-to-face | 00:20 | 0% | 4 / 10 | |
| 13 | Deliverable related with the lab sessions. | Individual work | No Presential | 00:00 | 10% | 4 / 10 | |
| 15 | Test 2 | Written test | Face-to-face | 02:00 | 40% | 4 / 10 | CT3<br>CE15 |

### 7.1.2. Final examination

| Week | Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|---|---|---|---|---|---|---|---|
| 9 | Deliverable related with the lab sessions | Individual work | No Presential | 00:00 | 10% | 4 / 10 | CG2<br>CT5<br>CG4<br>CT4<br>CT3<br>CG5<br>CE10<br>CE15 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | Oral presentation | Individual presentation | Face-to-face | 00:30 | 10% | 4 / 10 | CG4<br>CT3<br>CE15 |
| 13 | Deliverable related with the lab sessions. | Individual work | No Presential | 00:00 | 10% | 4 / 10 | |
| 17 | Test | Written test | Face-to-face | 03:00 | 70% | 4 / 10 | CG2<br>CT5<br>CT1<br>CT4<br>CG5<br>CE10 |

### 7.1.3. Referred (re-sit) examination

| Description | Modality | Type | Duration | Weight | Minimum grade | Evaluated skills |
|---|---|---|---|---|---|---|
| Exam | Written test | Face-to-face | 02:00 | 100% | 5 / 10 | CG5<br>CE10<br>CE15<br>CG2<br>CT5<br>CG4<br>CT1<br>CT4<br>CT3 |

## 7.2. Assessment criteria

**Continuous evaluation**

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

Exam 1: 30%

Exam 2: 40%

Deliverables: 20%

Oral presentation: 10%

* Attendance to lab sessions is mandatory.

**Final exam**

Students who choose the final exam option (or fail the continuous evaluation) must sit an exam (70% of the final mark), submit the deliverables of the laboratory sessions (20%) and give an oral presentation (10%) to pass the course.

Mark required in the final exam to pass the course: > 5/10 (Minimum mark in each part: 4/10)

* Attendance to lab sessions is mandatory.

**Continuous evaluation is the default option.**

For taking the final exam option, students must inform the coordinator in writing by the end of the third week of the module.

**Extraordinary exam**

Students who fail the continuous evaluation or the final exam must sit an exam to pass the course.

Mark required in the final exam to pass the course: > 5/10

* Attendance to lab sessions is mandatory.

## 8. Teaching resources

### 8.1. Teaching resources for the subject

| Name | Type | Notes |
|---|---|---|
| Website of the module | Web resource | All relevant information of the module will be posted on its Moodle website. |
| Laboratorios de fabricación y caracterización de materiales y dispositivos | Equipment | Research lab conveniently adapted so that students can undertake the fabrication and characterization of MOS transistors 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, especially considering the COVID19 evolution. So, both teaching and evaluation activities may be converted to online activities if required by the health situation.

* 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. The lab activities will be on 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 or any specific lecture by e-mail. The lectures will answer as soon as possible.

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

**Platforms for online teaching**

* Teams or Zoom will be used for online teaching.

**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.