Universidad de Alcalá

TEACHING GUIDE

Microelectronic Technology

Master in Telecommunications Engineering
Code 201813

Universidad de Alcalá

Academic Year 2019/2020

1st Year – 2nd Semester

TEACHING GUIDE

Course Name:	**Microelectronic Technology**
Code::	**201813**
Master in:	**Telecommunication Engineering**
Department::	**Electronic**
Type:	**Mandatory**
ECTS Credits:	**3**
Year and semester:	**1st year / 2nd semester**
Teachers:	**Ana Jiménez Martín**
Tutoring schedule:	**Check website in Black Board.**
Language:	Spanish/English friendly

1. INTRODUCTION

The subject of Microelectronics Technology is a compulsory 3 ECTS course included in the first semester - first year of the Master of Telecommunication Engineering. The course is designed to teach the physical principles and operational characteristics of advanced semiconductor electronic devices with emphasis on field-effect transistors. The course provides elementary background in solid state electronic devices and is intended to help students to continue advanced research in the variety of different branches of semiconductor microelectronics. This course provides also an overview of processing steps for semiconductor device fabrication. The goal of this course is to give a thorough understanding of the design and process technology of modern integrated circuits and a clear understanding of the economic and technical trade-offs inherent in this industry.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the *Orden CIN/352/2009*: **CB6, CB7, CB8, CB9, CB10, CG1-6, and CT1-5**.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the *Orden CIN/352/2009*:

CTecTel10: Ability to design and manufacture integrated circuits

CTecTel14: Ability to develop electronic instrumentation, as well as transducers, actuators and sensors

CGestion1: Ability to integrate technologies and systems typical of Telecommunications Engineering, with a generalist nature, and in broader and multidisciplinary contexts such as in bioengineering, photovoltaic conversion, nanotechnology, telemedicine.

Learning Outcomes:

The expected learning outcomes, expressed in the form of knowledge and skills and abilities that students should have achieved are as follows

RA1. Ability to explain the principle of operation and characteristics of semiconductor-based electronic devices and to be interested in current technologies.

RA2. Ability to describe technological processes for manufacturing integrated circuits and identify the different processes that take place.

RA3. Ability to identify the limitations of electronic devices with their internal structure and manufacturing processes.

RA4. Work together to assess and correctly express results in written form through technical reports.

3. CONTENTS

Content blocks	Hours*
Chapter 1- Materiales semiconductores: electric conduction characteristics, band diagram	4
Chapter 2.- Unión PN: structure, characteristics, static and dynamic behaviour..	4
Chapter 3.- MOSFET devices and its technology evolution. MOS diode, MOS transistor. Long-channel MOSFET. Short-channel effects. CMOS inverter. MOSFET technology evolution.	10
Chapter 4.- Integrated circuits manufacturing technologies. Introduction. Epitaxial growth. Oxidation. Doping. Photolithographic process. Etching. Layer deposition.	4
Chapter 5.- Integrated circuits manufacturing: an introduction. CMOS technology.	6

Teaching Schedule

The timing and final course schedule will be adapted to the official calendar and will be described in a document available at the beginning of the term.

4. TEACHING METHODOLOGIES-LEARNING ACTIVITIES

4.1. Credit distribution (specified in hours)

Number of hours:	30 hours (28 h on-site + 2h for assessment)
Number of hours of student work:	46 hours
Total hours:	75 hours

4.2. Methodological strategies, materials and resources

In the teaching-learning process the following training activities will be carried out:

- ***Theory classes*** that allow to introduce the necessary knowledge for the correct development of the learning process. Lectures will be based on a JITT (Just in time teaching) learning strategy that uses feedback between classroom activities and work that students do at home in advance. Classroom sessions will be carried out in large groups, encouraging inductive models based on the approach and resolution of problems through argumentation, discussion and group work.
- ***Practical lectures*** taught mostly in small groups based on solving exercises or group work. The aim of these classes is to promote meaningful learning that allows students to deepen their theoretical knowledge, relate and apply them creatively to solve more complex problems. Additionally, they could have to explain and defend their work to the rest of the class, as well as group discussion. Occasionally, they could attend at conferences, meetings or scientific discussions related to the subject
- ***Tutorials***: individual and group.

Collaborative work will be encouraged with the aim of not only working together, but above all, cooperating in the achievement of a common goal.

Along the course, students should make use of different sources and electronic or bibliographic resources, so that they will become acquainted with the future documentation environments they will use professionally. Additionally, the teaching staff will facilitate the materials for the module (theoretical, exercises and problems, practice manuals, visual references, etc.), so that students can meet the objectives of the course.

The student may attend group and individual tutorials (if requested by the students) according to his/her needs and after agreement with the corresponding lecturers. Whether

individually or in small groups, these tutorials will allow to solve the questions and consolidate the acquired knowledge. They also help to make an adequate monitoring and to evaluate the progress of the teaching-learning mechanisms.

Finally, the development of the course will be detailed in the course website. All materials produced for the course will be available (slides, set of exercises, detailed schedules for each group and class, intermediate scores and all relevant information).

5. ASSESSMENT: Procedures, assessment criteria and grading system

The evaluation process is based on the continuous assessment of the student. Because of that, the attendance is considered as a fundamental key of the learning process. However, any student may request the final assessment model for which shall meet the requirements and follow the application procedures established by the School. The assessment of the learning process of all students who do not apply for the final model, or their request is rejected, will be carried out following the continuous assessment model.

5.1 ASSESSMENT CRITERIA

The evaluation process aims at assessing the degree and depth of the student's acquisition of the course skills previously described. Consequently, the evaluation criteria to be applied in the various tests that are part of the process, ensure that the student has the appropriate level in the following contents and skills:

CE1. Ability to describe the fundamental properties of semiconductor-based devices.

CE2. Ability to integrate the conceptual knowledge about the different devices to solve correctly and creatively specific problems.

CE3. Ability to describe IC manufacturing and the necessary technologies for that.

CE4. Ability to analyze and define semiconductor based devices for later integration in the design of an electronic system.

CE5. Ability to adequately document the theoretical and practical works carried out.

5.2 ASSESSMENT PROCEDURES

The assessment criteria, as defined in section 5.1, apply to the following assessment tools.

a) Assignments (**En**), exercises or theoretical-practical works proposed in class throughout the course.

b) Group work (**TG**), Collaborative work focused on reflection and relation between different devices and technologies addressed in the subject. It will be followed up by the teacher and finalized with a technical report, being possible to request the oral defense of it. The evaluation will be carried out through agreed-upon rubrics

c) Individual work (**TI**), Theoretical-practical work that pursues reflection and relationship between different devices addressed in the course. It will be followed up by the

teacher and finalized with a technical report, being possible to request the oral defense of it. The evaluation will be carried out through agreed-upon rubrics

d) Final test (**PEF**) It is based on a number of questions (theory and practice, analysis and / or synthesis) regarding to the specific aspects of all content covered by the course.

5.3 GRADING CRITERIA

This section quantifies the grading criteria for passing the module.

A. Ordinary call:

A.1. **Continuous assessment:** The following table summarizes the relationship between skills, learning outcomes and assessment procedures of this module. Also the weight of each assessment instrument in the final mark is specified.

Skill	Learning outcomes	Assessment criteria	Assessment tool	Final mark weight (%)
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3, RA4	CE1, CE3; CE4, CE5	TG	20%
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3, RA4	CE1, CE2;CE3; CE4, CE5	En	40%
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3	CE1, CE2; CE3, CE4, CE5	PEF	40%

According to the assessment criteria of the course (section 5.1), Students are deemed to have passed the course (proving the acquisition of the theoretical and practical skills) if the following requirements are met:

- Have completed at least 70% of the assignments.
- The score should be at least 5 out of 10 to pass the module.

Students who follow the continuous assessment model, will be considered as no- attendant when they do not take part of the group-work (**TG**).

A.2. Final assessment model. The following table summarizes the relationship between skills, learning outcomes and assessment procedures of this module. Also the weight of each assessment instrument in the final mark is specified:

Skills	Learning outcomes	Assessment criteria	Assessment tool	Final mark weight (%)
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3, RA4	CE1, CE3; CE4, CE5	TI	20%
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3	CE1, CE2; CE3, CE4, CE5	PEF	80%

B. Extraordinary call:

For all students, the extraordinary call will follow the guidelines set for the ordinary one in their final assessment mode. Therefore the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows:

Skills	Learning outcomes	Assessment criteria	Assessment tool	Final mark weight (%)
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3, RA4	CE1, CE3; CE4, CE5	TI / TG*	20%
CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3	CE1, CE2; CE3, CE4, CE5	PEF	80%

* Those students who having failed the ordinary call as a whole, if they have achieved a satisfactory score in TI or TG , they could keep that mark in the extraordinary call.

6. BIBLIOGRAPHY

Basic Bibliography

Documentation generated by teachers for the course, which will be provided to students directly, or posted on the course Web site

Textbooks:.

- S.M. Sze “Semiconductor Devices. Physics and Technology” John Wiley & Son, 1985
- J. Singh. “Dispositivos Semiconductores”. McGraw Hill, 1997
- J.M. Rabaey, A. Chandrakasan, B. Nikolic “Circuitos Integrados Digitales” Pearson Prentice Hall, 2ª Edición, 2004.
- R.F. Pierret, Temas selectos de ingeniería: “Dispositivos de efecto campo” y “Fundamentos de semiconductores” Addison-Wesley Iberoamericana, 2ª Edición, 1990
- Lluís Prat Viñas & Josep Calderer Cardona. “Dispositivos electrónicos y fotónicos. Fundamentos”. Ediciones UPC
- Hu Chenming “Modern Semiconductor Devices for Integrated Circuits”. Prentice Hall, 2010. http://www.eecs.berkeley.edu/~hu/
- A. López, P. Ramos, L.M. Bergasa y P. Martín. “Laboratorio de Prácticas de Dispositivos Electrónicos". Ed. Servicio de Publicaciones de la Universidad de Alcalá (2006). (Prácticas de simulación).

Additional Bibliography

- J.M. Albella, J.M. Martínez-Duart, F. Agulló-Rueda. "Fundamentos de microelectrónica, nanoelectrónica y fotónica", Prentice-Hall.
- M.N. Horenstein. “Microelectrónica: circuitos y dispositivos”. Prentice Hall.
- J. del Alamo “Integrated Microelectronic Devices” MIT Open Courseware