Universidad de Alcalá

TEACHING GUIDE

Microelectronic Technology

Master in
Telecommunication Engineering

Universidad de Alcalá

Academic Year 2022/2023

1st Year - 2nd Semester

Approved by the School Board on June 3, 2022

TEACHING GUIDE

Course Name:	**Microelectronic Technology**
Code:	**201813**
Master in:	**Telecommunication Engineering**
Department and area:	**Electrónica** **Tecnología Electrónica**
Type:	**Compulsory**
ECTS Credits:	**3.0**
Year and semester:	**1st Year, 2nd Semester**
Teachers:	Ana Jiménez Martín
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish / English Friendly

1. COURSE SUMMARY

PresentationThe 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/355/2009:

en_CB6 - To have and understand knowledges that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context

en_CB7 - That students know how to apply the acquired knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

en_CB8 - That students be able to integrate knowledge and face the complexity of making judgements based on incomplete or limited information that includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.

en_CB9 - That students be able to communicate their findings and the ultimate knowledge and reasons behind them to specialized and non-specialized audiences in a clear and unambiguous manner.

en_CB10 - That students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

en_CGT1 - Skill of analysis and synthesis.

en_CGT2 - Skill of organization and planning.

en_CGT3 - Skill to analyze and search for information from diverse sources

en_CGT4 - Skill to make decisions.

en_CGT5 - Skill to adapt to new situations.

en_CGT6 - Commitment to Human Rights, democratic principles, equality between women and men, solidarity, environmental protection and with the promotion of a culture of peace

en_CT1 - Troubleshooting skill

en_CT2 - Ethical commitment to work

en_CT3 - Skill to work in a team

en_CT4 - Working in a pressure environment

en_CT5 - Motivation for quality

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/355/2009:

en_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.

en_CTecTel10 - Ability to design and manufacture integrated circuits

en_CTecTel14 - Ability to develop electronic instrumentation, as well as transducers, actuators and sensors

Learning Outcomes

After succeeding in this subject the students will be able to:

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

Contents Blocks	Total number of hours
Chapter 1- Semiconductor Materials	3 hours
Chapter 2.- Semiconductor junctions	4 hours
Chapter 3.- MOSFET devices	4 hours
Chapter 4.- MOSFET: short channel effects	8 hours
Chapter 5.- Integrated circuits manufacturing technologies	5 hours
Chapter 6.- Integrated circuits manufacturing	4 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	30 hours (28 hours on-site +2 exams hours)
Number of hours of student work:	45
Total hours	75

4.2. Methodological strategies, teaching 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, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning

Assesment Guidelines (last modified in the Governing Board of October 31, 2019) as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

- Assignments (En), exercises or theoretical-practical works proposed in class throughout the course.
- A collaborative work (TG) that will be established throughout the course and which will cover practically the entire syllabus.
- Final examination (PEF), with several questions (analysis and/or synthesis) referring to specific aspects of the syllabus covered by the theory classes and exercises.

Assessment through final exam:

- An individual work (TI) that will be defined during the course and which will cover practically the entire syllabus.
- Final examination (PEF), with several questions (analysis and/or synthesis) referring to specific aspects of the syllabus covered by the theory classes and exercises

Extraordinary Call

- The procedure will be the same as that described for the assessment by means of a final exam in the ordinary call.

5.2. EVALUATION

EVALUATION CRITERIA

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. 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.

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

a. 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.
b. 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.
c. Final assessment (**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.

GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6, CB7, CB8, CB9, CB10; CGT1-6; CT1-5; CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3, RA4	CE1, CE2; CE3; CE4, CE5	En	30%
CB6, CB7, CB8, CB9, CB10; CGT1-6; CT1-5; CGestion1	RA1, RA2, RA3, RA4	CE1, CE2; CE3; CE4, CE5	TG	30%
CB7; CB9; CG1, CG4; CT1, CT4, CT5; CTecTel10, CTecTel14,	RA1, RA2, RA3	CE1, CE2; CE3, CE4, CE5	PEF	40%

In the ordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6, CB7, CB8, CB9, CB10; CGT1-6; CT1-5; CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3, RA4	CE1, CE2, CE3, CE4, CE5	TI	20%
CB6; CB7; CB9; CB10; CG1, CG4; CT1, CT4, CT5; CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3	CE1, CE2, CE3, CE4, CE5	PEF	80%

Extraordinary call

For all students, the extraordinary call will follow the guidelines set for the ordinary one in their final assessment mode. However, 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

6.1. Basic Bibliography

- Documentation generated by teachers for the course, which will be provided to students directly, or posted on the course Web siteTextbooks:.
- M. Sze “Semiconductor Devices. Physics and Technology” John Wiley & Son, 1985
- Singh. “Dispositivos Semiconductores”. McGraw Hill, 1997
- M. Rabaey, A. Chandrakasan, B. Nikolic “Circuitos Integrados Digitales” Pearson Prentice Hall, 2ª Edición, 2004.

6.2. Additional Bibliography

- IEEE Transactions on Signal Processing.
- IEEE Communications Magazine

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.