Universidad de Alcalá

TEACHING GUIDE

Microelectronic Technology

Master in
Telecommunication Engineering

Universidad de Alcalá

Academic Year 2023/2024

1st Year - 2nd Semester

Approved by the School Board on June 12th, 2023

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_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_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_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

en_EURACE - Link to the correlation table between the Learning Outcomes, according to the ENAEE (European Network for Accreditation of Engineering Education) standards, and the Master's subjects where the corresponding skills are acquired.

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, as well as to reflect on, analyse and evaluate the multiple mathematical models and equations that make it possible to quantify the different devices studied in the course.

RA2. Ability to describe technological processes for manufacturing integrated circuits and identify the different processes that take place, as well as planning processing steps for the fabrication of simple structures..

RA3. Ability to identify the limitations of electronic devices with their internal structure and manufacturing processes, and to propose some current alternatives to overcome these limitations.

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

RA5. Work in a team to develop empathy, value the work of others, synthesis and organisation skills.

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.
- **Group and cooperative work**: On the one hand, exercises and problems will be solved in a participatory way with the aim of promoting significant learning that allows the student to deepen the theoretical knowledge acquired, relate it and apply it creatively to the resolution of situations that, as the course progresses, will gradually resemble real engineering problems. On the other hand, group work has similar objectives to those previously mentioned, but also encourages the organisation and synthesis of ideas, as well as the carrying out of bibliographic searches. In both cases, they will allow the monitoring of collaborative work, which will be enhanced so that they not only work together to achieve the objective, but also cooperate in achieving the goal.
- **Personal work and study**: Throughout the learning process in the subject, the student will have to make use of different bibliographic or electronic sources and resources, so that they become familiar with the documentation environments that they will use professionally in the future. In addition, the teaching staff will provide the materials necessary to follow the course (theoretical foundations, exercises and problems, audiovisual references, etc.) so that the student can meet the objectives of the course, as well as achieve the expected competences. Part of the work carried out will be integrated into an electronic portfolio that will facilitate formative assessment throughout the course. The students will have group tutorials (if requested by the students themselves) and (if requested by the students themselves) and individual tutorials.

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 proposed evaluation process is inspired by continuous evaluation, although, respecting the regulations of the University of Alcalá, the student may take the final evaluation. To qualify for the final evaluation, students of the Master's Degree will have to request it in writing to the director of the Master's Degree in the first two weeks of teaching the subject, explaining the reasons that prevent them from following the continuous evaluation system. The evaluation of the learning process of all students who do not submit an application in this regard or see it denied will be carried out, by default, according to the continuous evaluation model described below. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

- **Electronic portfolio (EP)**. A set of activities such as writings, readings and reflective diary, which facilitate the analysis and evaluation of the concepts worked on in the subject, as well as formative evaluation.
- **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:

- **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. Understand, analyse and evaluate the multiple mathematical models and expressions that allow the quantification of the different devices studied in the course, as well as the fundamental properties derived from them that govern the semiconductor-based devices considered.

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, as well as the ability to propose logical sequences for the manufacture of simple devices.

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

CE5. Ability to document, express and present adequately and reasonably the theoretical/practical work carried out.

CE6. Ability to work in a team.

GRADING TOOLS

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

a. Electronic portfolio (**EP**). A set of written exercises, readings and a reflective journal, which facilitates analysis and evaluation of the concepts worked on in the subject, as well as formative evaluation 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 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; CGestion1, CTecTel10, CTecTel14	RA1, RA2, RA3, RA4	CE1, CE2; CE3; CE4, CE5	EP	40%
CB6, CB7, CB8, CB9, CB10; CGT1-6; CT2-5; CGestion1	RA1, RA2, RA3, RA4, RA5	CE1, CE3; CE4, CE5, CE6	TG	30%
CB7; CB9; CG1, CG4; CT1, CT4, CT5; CTecTel10, CTecTel14,	RA1, RA2, RA3	CE1, CE2; CE3, CE5	PEF	30%

In order to pass the continuous assessment, students must obtain an overall weighted grade equal to or higher than 5 out of 10.
Students who follow the continuous assessment model will be considered to be absent in the ordinary exam when he/she does not participate in the group work.

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, RA5	CE1, CE3; CE4, CE5, CE6	TI	30%
CB6; CB7; CB9; CB10; CG1, CG4; CT1, CT4, CT5; CTecTel10, CTecTel14, CGestion1	RA1, RA2, RA3	CE1, CE2, CE3, CE4, CE5	PEF	70%

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

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.