COURSE DATA

Data Subject	
Code	34875
Name	Electronic and Photonic Devices
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1403 - Degree in Telematics Engineering	School of Engineering	2	Second term

Subject-matter

Degree	Subject-matter	Character
1403 - Degree in Telematics Engineering	3 - Electronic and photonic components and circuits	Basic Training

Coordination

Name	Department
VILA FRANCES, JOAN	242 - Electronic Engineering

SUMMARY

This 6 ECTS subject is given in the first four-month period of the second course of the Grade of Telematics Engineering. The subject allows to the student to reach a basic electronic knowlege and is developped in 150 working hours for the student along the four-month period: 90 hours of self-organised work and 60 hours of classroom lessons.

This subject as part of the matter “Electronic and Photonic Components and Circuits” has a basic training nature and provides a basic knowledge about electronic and photonic components and circuits. Specifically, this subject tries to offer to the student of the Grade an introduction to the electronic circuits and to the devices, both electronics and photonics, used in those circuits. As it is expressed in the contents of the Module of the grades in which this subject is given:"It offers to the students an introduction to electronic circuits. It will be described the physical and electronic operation, constituent materials and the circuital models of the different electronic and photonic devices. Also the basic knowledge of circuit theory and its application to the devices will be acquired”. Also "the principles of digital logic will be known”. It is intended, in this subject, “the students learn to understand the electronic circuits and its devices, they can apply the different techniques to solve and design circuits and how to use the electronic devices in these circuits”.

Of all the contents of the subject “Electronic and Photonic Components and Circuits”, the course “Electronic and Photonic Devices” is responsible of the description of the devices from inside the device to its output characteristics in a macroscopic scale, including its equivalent circuits. At the end of the course there will be seen some circuits using these devices to emphasize the knowledge about their operation.

Apart from the purely theoretical contents, the course will provide the student with the general knowledge necessary to solve engineering problems. The knowledge of how to solve these problems will be acquired in the problem sessions of the course where the students must find solutions to problems whose approach requires obtaining several solutions prior to final result.

About the skills that are needed for any engineer, the course contributes with the knowledge necessary to assemble of basic circuits on laboratory boards. The course provides the student the skills of search the components needed in a circuit, schematic circuits understanding, assembly of several devices with common nodes, measure on the circuits with laboratory instrumentation, show a set of measurements both on a table and on a graph and, finally, interpretation of the above mentioned data once obtained.

The course general objectives are to provide the student the necessary knowledge to understand the inner behaviour of electronic and photonic devices, know how the internal space charge regions are produced and how the internal electric field and the contact potential are modified when a device is forward or reverse biased. Once the devices are understood from the internal point of view, its output characteristics and equivalent circuits are shown. To consolidate the material taught in the course, in the last part of the course several simple circuits where the devices learned are used will be seen.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The needed background to follow the course is acquired in the mathematics courses and in the course Electronic Circuits taught in first year of the grade. Within this knowledge must be emphasized the integral and derivative operation, the recognition of graphs and the data extraction from them. For the last part of the course a basic understanding of circuit theory is needed.

OUTCOMES

1403 - Degree in Telematics Engineering

- G3 - Acquisition of the knowledge of the basic and technological subjects that allows students to learn new methods and theories and endows them with the versatility to adapt to new situations.

- G4 - Ability to solve problems with initiative, decision-making and creativity, and to communicate and transmit knowledge, abilities and skills, understanding the ethical and professional responsibility of the activity of a telecommunications technical engineer.
- B4 - Understand and master the basic concepts of linear systems and the related functions and transforms, electric circuit theory, electronic circuits, physical principle of semiconductors and logic families, electronic and photonic devices, materials technology and their application to solve engineering problems.

LEARNING OUTCOMES

The main result of learning is to understand the macroscopic characteristics and performance of electronic and photonic devices through the knowledge of its behavior at a microscopic level. When a student of the Grade uses an electronic or photonic device, he will know that it has constraints and nonlinear characteristics that depend on the manufacturing process. (G3, G4, G5 y B4)

Other results obtained by the student's learning of this subject are the following:

- Understand the operation of basic electronic and photonic devices and their features and limitations. (G3, G4, G5 y B4)
- Known the different materials used to manufacture the devices and their basic characteristics. (G3, G4, G5 y B4)
- Linearize the different devices and obtain its equivalent circuits to understand its operation. (G3, G4, G5 y B4)
- Be able to recognize the basic electronic and photonic components and simple electronic circuits. (G5 y B4)

Skills to be acquired:

After completing the course the student should be able to:

- Understand the internal structure of the silicon crystal, its covalent bond and how the dopant atoms act on the silicon.
- Understand the internal structure of a junction diode, and how this structure changes depending on the applied voltage. Knowing the output characteristic, the equivalent circuit and the dynamic behavior of the junction diode. Knowing the different types of diodes, Schottky diodes and Zener diodes. Learn simple circuits that use diodes.
- Understand the internal structure of the bipolar transistor, its different configurations and characteristic curves. Know its operation regions and some examples of circuits with bipolar transistors.
- Understand the internal structure of unipolar transistors. Know the characteristics, the operating areas and the limitations of unipolar transistors.
- Know the small-signal models of unipolar transistors and their applications in simple circuits.
- Know the operation of bipolar and unipolar transistor in switching operation.
- Know the basic logic gates with unipolar transistors (CMOS).

- Know the devices that are light-sensitive, the devices that emit light when excited and know the most currently used devices that convert light into current.

After the student has completed the course “Electronic and Photonic Devices”, he must have acquired a number of social aptitudes. These social aptitudes can be classified as instrumental, personal and systemic.

Instrumental aptitudes:

- Ability to analyze an engineering problem for its optimal resolution.
- Ability to organize and plan the course like a project.
- Appropriate use of scientific-technical terms.
- Ability to manage the time spent for the study.
- Ability to write documents in a formal language understandable to other engineers.
- Ability to make decisions.

Personal aptitudes:

- Ability to work in a multidisciplinary team.
- Ability to work in an international context.
- Ability to communicate with experts in other areas.
- Skills in interpersonal relationships.
- Critical reasoning.
- Ethical commitment.

Systemic aptitudes:

- Ability to apply the knowledge acquired in the course.
- Ability to learn and work independently.
- Adaptation to new situations.
- Creativity. Ability to explore new solutions.
- Leadership. Initiative and enterprising spirit.
- Capacity of personal improvement in problem solving.

DESCRIPTION OF CONTENTS

1. Introduction

Topic 1: Introduction to semiconductor materials. Intrinsic and doped semiconductor materials. Doped techniques in semiconductor materials.

2. The semiconductor diode

Topic 2: The pn junction. The PN junction with and without polarization. The polarized PN junction. Currents in the PN junction. The static characteristic.
Topic 3: Types of diodes. The avalanche effect. The Zener diode. The Schottky diode. Parameters and characteristis of the different types of diodes. Datasheets.
Topic 4: Using diodes. Switching response. The small-signal model. Application examples using signal diodes. Circuits using Zener diodes.

PRACTICE 1: Introduction to the laboratory equipment. Experimental determination of the I-V characteristic of the Si junction diode. (5 hours)

3. The bipolar transistor

Topic 5: PNP and NPN junctions without polarization and polarized. Operating regions based on the minority carrierss concentration in the base. Parameters and currents depending on the internal characteristics of bipolar transistors. Parameters and characteristic curves of bipolar transistors.
Topic 6: Datasheets of bipolar transistors.
Topic 7: Use of bipolar transistors. Switching transients. The small-signal model. Examples of application of bipolar transistors.

PRACTICE 2: Obtaining experimental characteristic of the bipolar transistor (VCE-IC) in the common emitter configuration. Current gain for common emitter configuration. (2.5 hours)

4. The unipolar transistor

Topic 8: Internal structure of unipolar transistors. The MOSFET transistor. Operating regions and currents of unipolar transistors as function of their internal characteristics. Curves and characteristic parameters of the unipolar transistor.
Topic 9: Datasheets of unipolar transistors.
Topic 10: Using unipolar transistors. Switching study. The small-signal model. Application examples of unipolar transistors.

PRACTICE 3: MOSFET transistor characteristics. (2.5 hours)
PRACTICE 4: Switching bipolar and unipolar transistor: Comparative. (2.5 hours)

5. Families and logic gates

Topic 11: Families and logic gates. Basic logic gates.

PRACTICE 5: Transfer characteristic of logical gates (2.5 hours)

6. Photonic devices

Topic 12: Light-sensitive devices. Photoresistor. Photodiode. Phototransistor. Light-emitting devices. LED.

PRACTICE 6: Applications of photoresistors, leds and solar cells. (2.5 hours)
PRACTICE 7: Individual Test (2 hours).

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Attendance at events and external activities	1,00	0
Preparation of evaluation activities	50,00	0
Preparing lectures	9,00	0
Preparation of practical classes and problem	30,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

TECHNICAL LECTURES.

The technical lectures are master classes. During the master class the lecturer will ask some questions to the students to monitor the student progress in its self-organised work previous to each class. The master class will be supported by animated slides to improve the understanding of the abstract concepts involved in the devices junctions. All the support material used in the lectures (slides, papers, web links, bibliography, etc), will be available for the student in the online application “Aula Virtual”. Competencies G3 and B4 are worked.

PROBLEM CLASSES.

The problem classes will be held in the classroom with a smaller group of students that in the technical lectures. In the problem classes some of the more significant problems that appear in the Problem Sheet will be solved. The problems will be solved in the backboard by the professor or by the students. As in the technical lectures, all the teaching resources will be available in Aula Virtual. Competencies G4 and B4 are worked.

LABORATORY SESSIONS

The laboratory sessions will be held in the laboratories of the ETSE. During the first half an hour of each laboratory session, the professor will evaluate the student self-organised work about the contents of the scheduled session. This evaluation will be done through some short questions, time scheduled of 15 minutes, or through some individual questions to the students in those groups with fewer students. Competencies G3, G4, G5 and B4 are worked.

TUTORIALS

The students have a tutorial timetable to solve problems, doubts, work orientation, etc. The tutorial timetable is set at the beginning of the academic course. Competencies G3, G4, G5 and B4 are worked.

EVALUATION

THEORY-PROBLEMS EVALUATION.

The theory -problems part can be overcome by two methods, or continuous assessment or a final exam at the end of the semester.

• Continuous assessment system. At the end of each U.T. there will be a multiple choice test with only theory questions. The multiple choice exams will have a 60% on the total rate. The grade of each test will be added to the next to calculate the final grade. No make-up tests are made. If you have chosen the continuous assessment, on the official exam date you will have only a problems exam. This exam has a 40% rate on the total mark. To avegage theory (multiple choice test) and problems the mark must be at least 4 in multiple choice test and 5 in problems test. (G3, G4, G5 and B4). If the student fails one or both of this parts, he/she will have to pass again an exam of this part on the second announcement.

There will be a problems test (diodes only) at the end of the first thematic unit of one hour. If the mark obtained in this test is greater than 5, until 2 points will be added to the mark obtained in the final problems test (to be held on the official date), if the mark obtained in the final problems test is greater than 4 points. (G3, G4, G5 and B4)

• Single assessment system. Consist of a final exam that will take place at the end of the semester (G3, G4, G5 and B4). This final exam will consist in performing a single test divided into two blocks. The first block with theoretic-practical activities and the second block will correspond to problems. The average of the qualifications of the two thematic blocks will be considered only if both blocks have been passed.

It is mandatory to pass both blocks with a mark over 5.

Students who have choose, from the beginning of the course, the single assessment system should inform personally to the professor in charge.

LABORATORY EVALUATION.

The evaluation of the laboratory will be done, as in theory problems part, by two methods: continuous assessment and single assessment (final exam).

• Continuous assessment system. Continuous assessment is carried out attending at all laboratory classes and the resulting note will be the average of the individual final laboratory test with continuous assessment throughout the laboratory sessions. It is mandatory the attendance to all laboratory classes to pass the laboratory evaluation by using the continuous assessment system. Continuous assessment during the course will take into account the average grade obtained in the resolution of the laboratory handout and the grade obtained on the test prepared by the teacher previous to the resolution of the practice (with a rate of 35% and 15% respectively). This continuous assessment will be the 50% of the laboratory mark and the other 50% will be the mark obtained in the individual laboratory test scheduled in the last laboratory session (G3, G4, G5 and B4). The mark on this exam must be over 4.

• Single assessment system: the final exam. It consists of a laboratory final exam the same day scheduled for the final exam of theory-problems (G3, G4, G5 and B4). Students who has choose, from the beginning of the course, the single assessment system will also have to submit all the reports asked by the professor.

To pass the laboratory evaluation using continuous assessment system, the student should obtain grades higher than five in (n-1) out of the laboratory sessions and in (n-1) out of the tests made by the teacher previous to each laboratory session, beeing n the number of laboratory sessions.

The student who has chosen from the beginning of course continuous assessment and has not succeeded the laboratory assessment (average mark below 5) has to do the final laboratory exam. The mark obtained in this exam will be the laboratory mark.

Students who have choose from the beginning of the course the single assessment system should inform personally to the professor in charge.

COURSE EVALUATION.

The theory-problems rate is the 70% of the final mark and laboratory rate is the 30% in the final mark, being indispensable to pass both parts.

The composition of the final grade for the course for continuous assessment system and single assessment system can be seen in the next tables.

Students who have choose from the beginning of the course the single assessment system should inform personally to the professor in charge.

Continuous Assessment System

Summary of the composition of the final grade for the Course

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Activities or Concepts to evaluate	Assessment Method	Partial Assessment %	Final Assessment %
Theory-Problems	a) Test -	60%	70%
	b) Problems	40%	
Laboratory sessions	1) Previous issues	15%	
	2) Handouts	35%	30%
	3) Individual exam	50%	
Total			100%

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To avergage theory (multiple choice test) and problems the mark must be at least 5 in multiple choice test and 5 in problems test.

The student who has chosen from the beginning of course continuous assessment and has not succeeded the laboratory assessment, has to do the final laboratory exam. The mark obtained in this exam will be the laboratory mark.

The individual laboratory exam must be over 4 to average with the other issues.

Single Assessment System

Summary of the composition of the final grade for the Course

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Activities or Concepts to evaluate	Assessment Method	% Final Assessment
Theory-Problems	1) Final Exam:	
	a) Theóretic- practical activities	45%

	b) Problems	25%

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Laboratory sessions	1) Laboratory final exam	20%
	2) Submitted reports	10%

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Total	100%

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The final exam for single assessment system is divided into two blocks (theoretic-practical activities and problems). The average of the qualifications of the two blocks will be considered only if both blocks have been passed.

In any case, the evaluation system is managed by the Reglament de Avaluació i Qualificació de la Universitat de València for Degrees and Masters

(http://www.uv.es/graus/normatives/2017_108_Reglament_avaluacio_qualificacio.pdf).

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Basic

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Additional

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- El transistor bipolar de unión. Gerold W. Neudeck. Ed. Addison-Wesley Iberoamericana 1994, ISBN 0-201-60143-5.
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ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

The contents initially included in the teaching guide are maintained.

Workload and temporary teaching planning

The different activities described in the teaching guide are maintained with the planned dedication.

The material for the follow-up of the classes of theory/practices allows to continue with the professor of temporary planning so much in days as in schedule, so much if the teaching is face-to-face in the classroom or if it is not.

Teaching methodology

In classroom theory and practices, students will tend to have the maximum physical attendance possible, always respecting the sanitary restrictions that limit the capacity of the classrooms as indicated by the competent public health authorities to the estimated percentage of their usual occupation.

Depending on the capacity of the classroom and the number of students enrolled, it may be necessary to distribute the students into two groups. If this situation arises, each group will attend classroom theory and practical sessions with physical presence in the classroom by rotating shifts, thus ensuring compliance with the criteria for occupying spaces.

The rotation system will be established once the actual enrollment data is known, guaranteeing, in any case, that the attendance percentage of all the students enrolled in the subject is the same.

With respect to laboratory practices, attendance at sessions scheduled in the schedule will be totally face-to-face.

Once the actual enrollment data is available and the availability of spaces is known, the Academic Committee of the Degree will approve the Teaching Model of the Degree and its adaptation to each subject, establishing in said model the specific conditions in which it will be developed teaching the subject.

If there is a closure of the facilities for sanitary reasons that totally or partially affects the classes of the subject, these will be replaced by non-contact sessions following the established schedules.

Evaluation

The evaluation system described in the teaching guide of the subject in which the different evaluable activities have been specified as well as their contribution to the final grade of the subject is maintained.

If there is a closure of the facilities for health reasons that affect the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the Universitat de València.

The contribution of each evaluable activity to the final grade for the course will remain unchanged, as established in this guide.

Bibliography

The bibliography recommended in the teaching guide.