COURSE DATA

Data Subject	
Code	34791
Name	Electronic and Photonic Devices
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1402 - Degree in Telecommunications Electronic Engineering	School of Engineering	2	First term

Subject-matter

Degree	Subject-matter	Character
1402 - Degree in Telecommunications Electronic Engineering	3 - Electronic and photonic components and circuits	Basic Training

Coordination

Name	Department
NAVARRO ANTON, ASUNCION EDITH	242 - Electronic Engineering

SUMMARY

This 6 ECTS subject is given in the first four-month period of the second course of the Grade of Telecommunication Electronics 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. 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 and Electronic Circuits courses 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.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1402 - Degree in Telecommunications Electronic 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.
- G5 - Knowledge to carry out measurements, calculations, assessments, evaluations, loss adjustments, studies, reports, task planning, and other analogous work in the specific field of telecommunications.
- 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 (RD 1393/2007) // NO CONTENT (RD 822/2021)

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 and 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 and B4)
- Known the different materials used to manufacture the devices and their basic characteristics. (G3, G4, G5 and B4)
- Linearize the different devices and obtain its equivalent circuits to understand its operation. (G3, G4, G5 and B4)
- Be able to recognize the basic electronic and photonic components and simple electronic circuits. (G5 and 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: The junction diode. IV characteristic and its applications. (6 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 BJT for common emitter configuration. (3 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. (3 hours)
PRACTICE 4: Switching bipolar and unipolar transistor: Comparative. (3 hours)

5. Families and logic gates

Topic 11: Logic gates.

PRACTICE 5: Logical gates. (3 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. (3 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 “Aula Virtual”. Aula Virtual is an application developed by the University of Valencia that make easy and direct the access to the different teaching and administrative resources. Competencies G3 and B4 are worked.

PROBLEM CLASSES.

The problem classes will be 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 average theory (multiple choice test) and problems the mark must be at least 5 in multiple choice test and 5 in problems test. (G3, G4, G5 and B4)

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)

If first exam notification is faliled, the tests made during the year will have a 25% rate on second call (if the average mark of all test is greater than 3, otherwise the second exam notification will be like single assessment system) and problems test will have 75% rate.

- 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 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 obtained grades higher than five in (n-1) ot the laboratory sessions and in (n-1) of the tests made by the teacher previous to each laboratory session. Being 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 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.

Continuous Assessment System

Summary of the composition of the final grade for the Course

Activities or concepts to evaluate	***Assessment Method***	***Partial Assessment %***	***Final Assessment %***
Theory-Problems	First announcement: a) Tests b) Problems Second announcement: a) Tests b) Problems	 60% 40% 25% 75%	70 %
Laboratory sessions	1) Previous issues 2) Handouts 3) Individual exam	15% 35% 50%	30%
Total			**100%**

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.

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

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

Single Assessment System

Summary of the composition of the final grade for the Course

Activity or concepts to evaluate	***Assessment Method***	***% Final Assessment***
Teoria-Problemes	1) Final Exam: a) Theoretic-practical activities b) Problems	45 % 25 %
Laboratory sessions	Laboratory final exam Submitted reports	20 % 10 %
Total		**100%**

The final exam 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 will be governed by that established in the Reglament de Avaluació i Qualificació de la Universitat de València per a Graus i Màsters

(https://webges.uv.es/uvTaeWeb/MuestraInformacionEdictoPublicoFrontAction.do?accion=inicio&idEdictoSeleccionado=5639).

REFERENCES

Basic

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  Referencia b3:"Principios de Electronica".A.Malvino,D.J.Bates,Ed McGraw-Hill 2007,7ªEdición,ISBN 978-84-481-5619-0.
  Referencia b4: Semiconductor Devices". Kanaan Kano.Ed.Prentice-Hall International,Inc 1998,1ªedición,ISBN 0-02-361938-4.
  Referencia b5: "Semiconductor Decives.Physics and Technology".S.M.Sze.Ed.John Wiley&Sons 1985,ISBN 0-471-87424-8.
  Referencia b6: Solid State Electronic Devices. Ben G. Streetman. Ed. Prentice-Hall International, Inc. 1995, ISBN 0-13-436379-5.
  Referencia b7: Electronic Devices, Discret and Integrated, S.R. Fleeman, Ed. Prentice-Hall, 1990, ISBN 0-13-336181-0.
  Referencia b8: Circuitos electrónicos: Análisis, simulación y diseño, N.R. Malik, Ed. Prentice-Hall, 1997, ISBN 978-84-89660-03-8.
  Referencia b9: Optoelectronics. Endel Uiga. Ed. Prentice-Hall, Inc. 1995, 1ª edición, ISBN 0 02 422170-8.
  Referencia b10: "Fiber-Optic Communications Technology", D.K. Mynbaev, L.L. Scheiner, Ed. Prentice-Hall, 2001, ISBN 0-13-962069-9.

Additional

- Referencia c1: Microelectrónica: Circuitos y Dispositivos. M.N. Horenstein. Prentice-Hall Hispanoamericana, S.A., 2ª Edición, ISBN 968-880-707-9.
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  Referencia c3: El diodo PN de union. Gerold W. Neudeck. Ed. Addison-Wesley Iberoamericana 1993, ISBN 0-201-60142-7.
  Referencia c4: El transistor bipolar de unión. Gerold W. Neudeck. Ed. Addison-Wesley Iberoamericana 1994, ISBN 0-201-60143-5.

Referencia c5: Dispositivos de efecto de campo. Robert F. Pierret. Ed. Addison-Wesley Iberoamericana 1994, ISBN 0-201-60141-9.
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Referencia c7: Optoelectronics. An Introduction to Materials and Devices. Jasprit Singh. Ed. McGraw-Hill Companies, Inc. 1996, 1ª edición, ISBN 0-07-057650-5.
Referencia c8: Fundamentos de microelectrónica, nanoelectrónica y fotónica. J.M. Abella Martín, J.M. Martínez-Duart, F. Agulló-Rueda. Ed. Prentice-Hall-Pearson Education. 2005, 1ª edición, ISBN 84 205 4651-8.

ADDENDUM COVID-19

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

EVALUATION

In the problem area, all the evaluable activities proposed remain, only changes that their execution will be online through the virtual classroom and the BBC.

All students who have opted for continuous assessment may take a problem test consisting of 3 or 4 problems. This exam will be a maximum of 3 hours on the official date and time of the call. Each problem will be started on a new page and each problem will be scanned and uploaded to a different task for each problem no later than 10 minutes after completing the exam. The student's name and ID must clearly appear on all the scanned sheets.

For those students who have not taken ANY theory test, they will have the option of Single evaluation: they will be able to take an open-answer theory exam (with short questions to develop) that will be scanned to a specific task and a problem exam. It will consist of 3 or 4 problems. Each problem will be started on a new page and each problem will be scanned and uploaded to a different task for each problem no later than 10 minutes after completing the exam. The student's name and ID must clearly appear on all the scanned sheets. The duration of the exam will be a maximum of 3 hours on the official date and time of the exam.

In each part, of theory or problems, a minimum grade of 5 must be achieved to be able to average between them in both single assessment and continuous assessment.

To obtain the final grade for the course, the result of the theory-problems average, with the corresponding weights, will be averaged with the Laboratory Grade, only if the latter is a minimum of 5.

Laboratory:

- Continuous assessment:

The note will be calculated according to the following equation:

Laboratory Note = 0.7 * E + 0.1 * E1 + 0.2 * E2.

Where:

E is the average of all the tasks delivered through the virtual classroom

E1 is a test-type exam that will be done online through a virtual classroom on the date announced through a virtual classroom. There will be 10 questions about what was done in the practices, the incorrect answers will subtract 0.1 points.

E2 is a test-type exam that will be done online through a virtual classroom on the date announced through a virtual classroom. There will be 10 questions about what was done in the practices, the incorrect answers will subtract 0.1 points.

A minimum grade of 4 is required in each section (E, E1, E2) to be able to make an average. You can only measure with the theory part problems if LabNote is greater than or equal to 5.

- Unique evaluation:

Unique laboratory evaluation: one that has not made ANY session or delivery of laboratory. The note will be calculated according to the following equation:

Laboratory Note = 0.4 * E + 0.6 * T

Where:

E is the average of all the tasks that have been proposed during the course through a virtual classroom and that the student will have to deliver via email to the teacher of their group on the official date of the call

T is a task that the student will have to deliver on the official date of the call to the teacher of her group via email and that each student who chooses this call via email will be notified two weeks in advance.

A minimum grade of 4 is required in each section (E, T) to be able to make an average. You can only measure with the theory part problems if LabNote is greater than or equal to 5.

The theory / problems grade can only be averaged if the laboratory grade is greater than or equal to 5.

If a person does not have the means to establish this connection and access the virtual classroom, they should contact the teaching staff by email.

In the event of a closure of the facilities due to the health situation that totally or partially affects the classes of the subject, these will be replaced by non-presential sessions following the established schedules. If the closure affects any presential assessment test of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode through the tools with institutional support from the University of Valencia. The percentages of each evaluation test will remain unchanged, as established by this guide.