Course guide
300013 - ET - Electronics for Telecommunications

Last modified: 01/06/2023

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

PRIOR SKILLS

No prior knowledge is required.

REQUIREMENTS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE 4 TELECOM. Students will acquire an understanding and a command of the basic concepts of linear systems, functions and related transfer functions, electric circuit theory, electronic circuits, the physical principle of semiconductors and logic families, electronic and photonic devices, materials technology and its application to engineering problems. (CIN/352/2009, BOE 20.2.2009)

Generical:
7. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 1: Using instruments, equipment and software from the laboratories of general or basic use. Realising experiments and proposed practices and analyzing obtained results.

Transversal:
2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
5. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
6. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

TEACHING METHODOLOGY

The course combines the following teaching methods:

- Lectures to present the course topics in the large group sessions.
- Independent and cooperative learning, and self-assessment and co-assessment in some activities: resolution of exercises and preparation and execution of lab work.
- Project-based learning: a team project is undertaken during the last two sessions of the course.
- Experimental-based learning: 40 % of the sessions are carried out in the labs in small groups.

LEARNING OBJECTIVES OF THE SUBJECT

1. To describe an electrical signal and its relationship with the transmission of information.
2. To describe electrical potential difference, current, power, and resistance, their units, and the corresponding multiplier factors.
3. To describe the sign convention of the passive and active elements.
4. To describe the following circuit elements and their voltage-current relationship: resistor, independent voltage source, independent current source, short-circuit and open-circuit.
5. To analyse moderately complex electrical circuits made up by the circuit elements listed in Item 4 using Ohm's law and the following circuit analysis techniques: Kirchoff Voltage and Current Laws (KVL and KCL); serial and parallel associations; superposition theorem; Thévenin' and Norton's theorems; reference node.
6. To describe semiconductor material, donor and acceptor impurities, and PN junction.
7. To describe the diode (general purpose and LED), its two main operation modes (forward and reverse biasing) and its corresponding electrical models in DC (or low frequency).
8. To analyse basic circuits with diodes.
9. To describe the bipolar junction transistor (BJT, both NPN and PNP), its three main operation modes (forward biased, saturation, and cut-off) and the corresponding electrical models in DC (or low frequency).
10. To analyse basic circuits with BJTs.
11. To describe the operational amplifier (op amp), its three operation regions (linear, positive or high saturation, and negative or low saturation), and the corresponding ideal models.
12. To qualitatively describe the negative and positive feedback concepts applied to circuits with op amps.
13. To analyse two main types of circuits with op amps: amplifiers (negative feedback with resistors) and comparators (without feedback).
14. To describe voltage and current linear controlled (or dependent) sources.
15. To explain the concept of electrical amplifier and to describe the four amplifier types (voltage, current, transconductance, and transresistance) as well as the corresponding linear models which include the input and output resistances and the gain.
16. To model as electrical amplifiers, amplifier circuits implemented with op amps using their ideal model in the linear region).
17. To apply dependent sources for modelling op amps (or BJTs) in its linear (or forward biased) region and to perform the subsequent analysis in amplifier circuits implemented with op amps (or BJTs), including the model as electrical amplifier.

STUDY LOAD

Type	Hours	Percentage
Hours large group	36,0	24.00
Self study	84,0	56.00
Hours small group	24,0	16.00
Guided activities	6,0	4.00

Total learning time: 150 h

CONTENTS

Basic circuit analysis

Description:
1. Introduction
2. Kirchhoff's laws
3. Analysis of circuits
4. Superposition theorem
5. Thévenin's and Norton's theorems

Specific objectives:
1. To describe an electrical signal and its relationship with the transmission of information.
2. To describe electrical potential difference, current, power, and resistance, their units, and the corresponding multiplier factors.
3. To describe the sign convention of the passive and active elements.
4. To describe the following circuit elements and their voltage-current relationship: resistor, independent voltage source, independent current source, short-circuit and open-circuit.
5. To analyse moderately complex electrical circuits made up by the circuit elements listed in Item 4 using Ohm's law and the following circuit analysis techniques: Kirchoff Voltage and Current Laws (KVL and KCL); serial and parallel associations; superposition theorem; Thévenin' and Norton's theorems; reference node.

Related activities:
Activity 1: Resolution of exercises
Activity 2: Exams and controls
Activity 3: Laboratory

Full-or-part-time: 75h
Theory classes: 18h
Laboratory classes: 12h
Self study : 45h

Electronic components and circuits

Description:
1. Diodes
2. Bipolar junction transistors
3. Operational amplifiers
4. Dependent sources and amplifier modelling

Specific objectives:
6. To describe semiconductor material, donor and acceptor impurities, and PN junction.
7. To describe the diode (general purpose and LED), its two main operation modes (forward and reverse biasing) and its corresponding electrical models in DC (or low frequency).
8. To analyse basic circuits with diodes.
9. To describe the bipolar junction transistor (BJT, both NPN and PNP), its three main operation modes (forward biased, saturation, and cut-off) and the corresponding electrical models in DC (or low frequency).
10. To analyse basic circuits with BJTs.
11. To describe the operational amplifier (op amp), its three operation regions (linear, positive or high saturation, and negative or low saturation), and the corresponding ideal models.
12. To qualitatively describe the negative and positive feedback concepts applied to circuits with op amps.
13. To analyse two main types of circuits with op amps: amplifiers (negative feedback with resistors) and comparators (without feedback).
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16. To model as electrical amplifiers, amplifier circuits implemented with op amps using their ideal model in the linear region).
17. To apply dependent sources for modelling op amps (or BJTs) in its linear (or forward biased) region and to perform the subsequent analysis in amplifier circuits implemented with op amps (or BJTs), including the model as electrical amplifier.

Related activities:
Activity 1: Resolution of exercises
Activity 2: Exams and controls
Activity 3: Laboratory

Full-or-part-time: 75h
Theory classes: 18h
Laboratory classes: 12h
Self study : 45h

ACTIVITIES

RESOLUTION OF EXERCISES

Description:
The resolution of exercises has the goal of reinforce the theoretical concepts exposed by the teacher and prepare the students for the mid- and final-term exams. This activity is carried out both out and inside the large group classroom (30 min/session aprox.). Out of the clasroom, the students will do the proposed homework (self-learning and optionally cooperative if the work in groups). This homework can be self-assessed as the exercises collection includes the solutions. It is also recommend that student do the rest of exercises. In the large group sessions some of the proposed exercises will be reviewed by co-assessment and/or resolution by the teacher. During the session short exercises will also be proposed in order to reinforce the topics taught by the teacher. These activities are undertaken in the classroom and alternated with lectures. They include problems and other exercises that require the application of concepts presented by the lecturer, as well as group discussions of the students' solutions.

Specific objectives:
Apply the concepts presented in the lectures.

Material:
Problem statements and solutions of exercises and exams available in the Digital campus
Circuit simulation software

Delivery:
The recommended homework must not be delivered but it is recommended to do it in order to appropriately follow the topics of the course.

Related competencies :
. CE 4 TELECOM. Students will acquire an understanding and a command of the basic concepts of linear systems, functions and related transfer functions, electric circuit theory, electronic circuits, the physical principle of semiconductors and logic families, electronic and photonic devices, materials technology and its application to engineering problems. (CIN/352/2009, BOE 20.2.2009)
07 AAT N1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

Full-or-part-time: 54h
Theory classes: 18h
Self study: 36h

EXPERIMENTAL AND APPLIED SESSIONS

Description:
This activity consist on guided lab work and an additional project which will be carried out in the small group sessions (in groups of 2 or 3 people). The guided lab works consists on a preliminary study and an experimental work, which will be performed before and during the face-to-face session with the instructor, respectively. The project will be carried out during the last two sessions of the course and will consist on the implementation and testing of a measurement and control system prototype.

Specific objectives:
Reinforce the theoretical concepts seen in the large group sessions and use appropriately the instruments, equipment and software from
the laboratories. Carry out the proposed experiments and analyse the results.

Material:
Electronic instruments
Electronic material
PC and circuit simulation software
Support documents available on the digital campus

Delivery:
Each group will keep a laboratory notebook in which their activity is recorded, both of the preliminary and the experimental work. This notebook can be required by the teacher during the course (for example at mid-semester and by the end of the course). This assignment will be assessed in the Laboratory section in the course infoweb. The instructor will provide more details of the assessment in the first session of the lab.

Related competencies :
01 UEQ N1. EFFICIENT USE OF EQUIPMENT AND INSTRUMENTS - Level 1: Using instruments, equipment and software from the laboratories of general or basic use. Realising experiments and proposed practices and analyzing obtained results.
. CE 4 TELECOM. Students will acquire an understanding and a command of the basic concepts of linear systems, functions and related transfer functions, electric circuit theory, electronic circuits, the physical principle of semiconductors and logic families, electronic and photonic devices, materials technology and its application to engineering problems. (CIN/352/2009, BOE 20.2.2009)
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
07 AAT N1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
04 COE N1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
06 URI N1. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

Full-or-part-time: 60h
Laboratory classes: 24h
Self study: 36h

GRADING SYSTEM

The ones defined in the course infoweb.

BIBLIOGRAPHY

Basic:
- Carlson, A. Bruce. Teoría de circuitos : ingeniería, conceptos y análisis de circuitos eléctricos lineales. Madrid: International Thomson, 2002. ISBN 8497320662.
- Hayt, William Hart; Kemmerly, Jack E; Durbin, Steven M. Análisis de circuitos en ingeniería [on line]. 8a ed. México: McGraw Hill, 2012 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8725. ISBN 9786071508027.
- Prat Viñas, Lluís; Bragós Bardia, Ramon. Circuits i dispositius electrònics : fonaments d'electrònica [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 15/04/2020]. Available on: http://hdl.handle.net/2099.3/36163. ISBN 8483015749.
- Thomas, Roland E.; Rosa, Albert J.; Toussaint, Gregory J. The Analysis and design of linear circuits. 6th ed. Hoboken, NJ [etc.]: John Wiley & Sons, 2009. ISBN 9780470383308.

Complementary:
- Storey, Neil. Electronics : a systems approach [on line]. Sixth edition. Harlow: Pearson Education, 2017 [Consultation: 10/10/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5186355. ISBN 9781292114064.
- Cembranos, Florencio J. Electrónica general. Madrid: Paraninfo, 2000. ISBN 8428327092.
- Bugg, David Vernon. Electronics : circuits, amplifiers and gates. 2nd ed. Boca Raton [etc.]: CRC Press Taylor & Francis Group, 2006. ISBN 0750310375.
- Nilsson, James W.; Riedel, Susan A. Circuitos eléctricos [on line]. 7ª ed. México [etc.]: Pearson Educación, 2005 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=1294. ISBN 8420544582.
- Pallás Areny, Ramón. Instruments electrònics bàsics. Barcelona: Marcombo, 2008. ISBN 9788426714848.
- Mims, Forrest M. Getting started in electronics. 4th ed. Niles, Illinois: Master Publishing, 2000. ISBN 9780945053286.

RESOURCES

Other resources:
Support material available on the digital campus: slides, sets of exercises and exams, project and guided lab scripts, electronic components datasheets.
Instruments manuals in electronic format.
Proteus software for electronic circuit simulation.