300013 - ET - Electronics for Telecommunications

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING/BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING - NETWORK ENGINEERING (AGRUPACIÓ DE SIMULTANEÏTAT) (Syllabus 2015). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: 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)

General:
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 INFORMATION 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.
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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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>36h</th>
<th>24.00%</th>
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</thead>
<tbody>
<tr>
<td>Hours small group:</td>
<td>24h</td>
<td></td>
<td>16.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>6h</td>
<td></td>
<td>4.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>84h</td>
<td></td>
<td>56.00%</td>
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</table>
## Content

### Basic circuit analysis

**Learning time:** 68h  
Theory classes: 15h  
Laboratory classes: 12h  
Guided activities: 3h  
Self study: 38h

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

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

### 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.
### Electronic components and circuits

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 82h</th>
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<tbody>
<tr>
<td>1. Diodes</td>
<td>Theory classes: 21h</td>
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<tr>
<td>2. Bipolar junction transistors</td>
<td>Laboratory classes: 12h</td>
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<tr>
<td>3. Operational amplifiers</td>
<td>Guided activities: 3h</td>
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<tr>
<td>4. Dependent sources and amplifier modelling</td>
<td>Self study : 46h</td>
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</table>

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

**Specific objectives:**
1. To describe semiconductor material, donor and acceptor impurities, and PN junction.
2. 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).
3. To analyse basic circuits with diodes.
4. 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).
5. To analyse basic circuits with BJTs.
6. 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.
7. To qualitatively describe the negative and positive feedback concepts applied to circuits with op amps.
8. To analyse two main types of circuits with op amps: amplifiers (negative feedback with resistors) and comparators (without feedback).
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11. To model as electrical amplifiers, amplifier circuits implemented with op amps using their ideal model in the linear region.
12. 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.
**RESOLUTION OF EXERCISES**

<table>
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<tr>
<th>Description:</th>
<th>Hours: 36h</th>
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| 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 classroom, 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 lecturers, as well as group discussions of the students' solutions. | Theory classes: 12h  
Self study: 24h |

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<tr>
<th>Support materials:</th>
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<tbody>
<tr>
<td>Problem statements and solutions of exercises and exams available in the Digital campus</td>
<td></td>
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<tr>
<td>Circuit simulation software</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Descriptions of the assignments due and their relation to the assessment:</th>
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<tbody>
<tr>
<td>The recommended homework must not be delivered but it is recommended to do it in order to appropriately follow the topics of the course.</td>
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<table>
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<tr>
<th>Specific objectives:</th>
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<tr>
<td>Apply the concepts presented in the lectures.</td>
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**EXPERIMENTAL AND APPLIED SESSIONS**

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<tr>
<th>Description:</th>
<th>Hours: 51h</th>
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| 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. | Guided activities: 3h  
Laboratory classes: 24h  
Self study: 24h |

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<tr>
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<tr>
<td>Electronic instruments</td>
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<td>Electronic material</td>
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<tr>
<td>PC and circuit simulation software</td>
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<tr>
<td>Support documents available on the digital campus</td>
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<table>
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<tr>
<th>Descriptions of the assignments due and their relation to the assessment:</th>
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<tbody>
<tr>
<td>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-semestet 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.</td>
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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.

EXAMS

<table>
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<tr>
<th>Hours: 15h</th>
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<tbody>
<tr>
<td>Guided activities: 3h</td>
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<tr>
<td>Self study: 12h</td>
</tr>
</tbody>
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Description:
Two exams will be carried out at mid- and end-semester.

Support materials:
Sets of exercises and exams available at the Digital Campus

Descriptions of the assignments due and their relation to the assessment:
The exams and controls, all them with a duration of 90 minutes, will be delivered at the end of the corresponding session. They will be taken into account, respectively, in the section "Exams" of the assessment criteria of the course infoweb.

Specific objectives:
To assess the worked topics during the large group sessions and reinforced in the small group sessions.

Qualification system
The ones defined in the course infoweb.
# Bibliography

## Basic:


## Complementary:


## Others 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.