Course guides
300032 - CET - Electronic Circuits for Telecommunications

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2021  ECTS Credits: 4.5  Languages: Catalan, Spanish

LECTURER

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

PRIOR SKILLS

- Analyze the voltage-current relationships in the ideal passive electronic components.
- Analyze linear circuits, both with resistive and reactive components, obtaining both the evolution over time and the frequency response of any of the electrical variables.
- Circuit analysis with ideal operational amplifiers and other active components (ideal diode, ideal transistor)
- Identify the types of filters that exist based on their response in the time and frequency domains
- Know the basic operation of elementary digital circuits: truth table, logic levels, multiplexers
- Know the basic architectures and subsystems that make up telecommunication systems.

REQUIREMENTS

Pre-requisite:
Electronic circuits aln supply systems
Co-requisite:
Emissores and receptors

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE 24 SIS. Capacidad para la selección de circuitos, subsistemas y sistemas de radiofrecuencia, microondas, radiodifusión, radioenlaces y radiodeterminación. (CIN/352/2009, BOE 20.2.2009.)

Generical:
4. 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. 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.
5. 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.
6. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
TEACHING METHODOLOGY

Considering the architecture of electronic systems for telecommunications as a leitmotif, the subject develops key concepts in high-frequency electronic design in both a theoretical and practical way. The teaching methodology is based on the following axes:

1. Prior preparation of each topic of theory (autonomous work)
2. Doubt resolution and application activities, carried out by students in theory class (face-to-face)
3. Consolidation activities, in the form of solving exercises (autonomous)
4. Activities of practical application, in the form of resolution of a project to develop along the term (autonomous work in hours out of class, and face-to-face in hours of laboratory class)

The syllabus is distributed in weekly videos that students must study independently, prior to each theoretical session (autonomous learning competence). The theory sessions will consist of a first activity to discuss the topics, where students will resolve all doubts regarding the previously prepared concepts. Then it will follow an activity of application of concepts, where the professor will propose a series of exercises to solve within class, with subsequent discussion of results. These activities will break the monotony of the explanations by making the student actively participate in the class, and will serve so that the student can have immediate information of his degree of achievement of objectives.

The material of the subject is mostly in English and students will be encouraged to present their work in English as well (third language competence).

The lab sessions are aimed at developing a project where many of the concepts studied will have to be applied, as well as integrating previous skills indicated at the beginning of this guide and looking for information regarding circuit solutions in each block of the project. (solvent use of information resources). Students will work in stable pairs during the semester (teamwork competence), and will document the whole project process: objectives, design, experiments, validation and discussion of results. This documentation will be done in an online lab notebook (via Google Docs). Teachers will be able to give feedback to each working couple using this tool. During the realization of these laboratory sessions will deepen in the knowledge of the typical instrumentation of the laboratories of communications and electronics (competition on the correct use of equipment and instrumentation).

The consolidation activities aim to revise, expand and apply the concepts that appeared in the classes and facilitate their assimilation. These are problems, reading and searching for information (autonomous learning skills and solvent use of information resources).

LEARNING OBJECTIVES OF THE SUBJECT

Upon completion of the subject Electronic Circuits for Telecommunications, students must be able to:

1. Identify the technologies and devices used in telecommunication systems, and be able, based on their specifications, to select the optimal one for each application.
2. Identify the design alternatives of high frequency circuits for both linear and nonlinear analog processing in telecommunication systems.
3. Identify the limitations of high frequency analog active and passive circuits.
4. Identify the different techniques of other frequency digitization and their relationship with the specifications and architecture of high frequency analog-to-digital converters.
5. Know different alternatives for generating analog signals.
6. Identify techniques to improve signal integrity in high frequency circuits.
7. To use in a methodical and critical way the usual instrumentation in the telecommunication laboratories.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>19,5</td>
<td>17.33</td>
</tr>
<tr>
<td>Guided activities</td>
<td>10,5</td>
<td>9.33</td>
</tr>
<tr>
<td>Hours large group</td>
<td>19,5</td>
<td>17.33</td>
</tr>
<tr>
<td>Self study</td>
<td>63,0</td>
<td>56.00</td>
</tr>
</tbody>
</table>

Total learning time: 112.5 h
Introduction to high frequency electronic systems

Description:
As an introduction to the subject, the student is given an overview of the architecture of electronic systems for telecommunications detailing the subsystems that make them up. From these subsystems, in this content a brief review is made of the basic concepts of signal digitization, signal multiplexing, analog signal processing circuits for signals and high frequency sensors, such as piezoelectric, complementing knowledge of previous subjects. Tools such as Bode diagrams are introduced, which will be used to describe the frequency response of passive and active components working at high frequencies.

Related activities:
Preparation activities
Classroom activities
Consolidation activities
Laboratory project
Control 1
Half-term exam

Full-or-part-time: 17h
Theory classes: 1h 30m
Laboratory classes: 3h
Guided activities: 1h
Self study: 11h 30m

High processing linear analog processing

Description:
The frequency response of VFA and CFA operational amplifiers, common in audio, video, and RF applications, is described. Its main advantages and limitations are identified as elements of analog processing within the signal chain. On the other hand, amplifiers with fully differential amplifiers and their frequency limitations are studied. There is also an introduction to the noise models of these amplifiers, and how to analyze them. The design of active (based on operational amplifiers) and passive analog filters is studied.

Related activities:
Preparation activities
Classroom activities
Consolidation activities
Laboratory project
Half-term exam

Full-or-part-time: 47h 30m
Theory classes: 9h 30m
Laboratory classes: 9h
Guided activities: 3h
Self study: 26h
A/D and D/A converters for telecommunications

Description:
Based on the basic knowledge of A-D conversion, we delve into oversampling techniques to improve SNR and subsampling in telecommunication systems, as well as the design of anti-Asian filters. The specifications of ac converters are introduced: SNR, SFDR, SINAD, THD, and their impact on the design of signal chains for telecommunication receivers. The main architectures of high-frequency analog-to-digital converters are introduced. As for high-frequency digital-to-analog converters, their ac specifications, architectures, and techniques for generating high-frequency carriers, including DDS, are studied. The main architectures and the application of softening filters to improve the SFDR are also studied.

Related activities:
Preparation activities
Classroom activities
Consolidation activities
Laboratory project
Control 2
Final semester exam

Full-or-part-time: 26h 30m
Theory classes: 6h
Laboratory classes: 3h
Guided activities: 1h
Self study: 16h 30m

Non-linear analog processing

Description:
The concepts to be treated will complement that of linear analog processing. We will study low- and high-frequency logarithmic amplifiers for telecommunications applications, diode-based circuits, multipliers, demodulators, and comparators.

Related activities:
Preparation activities
Classroom activities
Consolidation activities
Laboratory project
Final semester exam

Full-or-part-time: 21h 30m
Theory classes: 4h
Laboratory classes: 3h
Guided activities: 1h
Self study: 13h 30m

GRADING SYSTEM

Grade criteria will be published at the course's web

EXAMINATION RULES.

• Each laboratory session contributes to the continuous evaluation, so attendance at these sessions will be mandatory. The delivery of the evaluable orders must be made within the established time limit. Failure to attend a lab session or the delivery of a work out of time will result in a zero (0) grade in the evaluation of this activity.
• Following the current regulations, not appearing at any of the controls (1 or 2) will not have the option to recover.
• Documentarily justified non-attendance, for demonstrable work, medical or family reasons, may lead to the recovery of one of the exams, either the mid-term or the end of the term.
BIBLIOGRAPHY

Basic:

Complementary: