Course guide
330230 - CSR - Radio-Frequency Circuits and Systems

Last modified: 05/07/2023

Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: BACHELOR'S DEGREE IN ICT SYSTEMS ENGINEERING (Syllabus 2010). (Compulsory subject).

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

LECTURER

Coordinating lecturer: Moncunill Geniz, Francisco Javier

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Understanding and mastery of the basic concepts of linear systems, circuit theory, electronic and photonic devices and their application for solving engineering problems.
2. The ability to analyze and solve interference and electromagnetic compatibility problems. Knowledge of the principles and techniques that make long-distance signal transmission possible.
3. Knowledge of the principles and techniques that allow the transmission of signals at a distance.
4. The ability to define, analyze, design and evaluate communication circuits and systems, as well as knowledge of the principles and subsystems involved in communication systems via radio and optical signals.
5. The knowledge and ability to use existing tools and instrumentation for the analysis, design, development and verification of electronic, computer and communications systems.
6. The ability to perform the typical activities of the degree, taking into account the corresponding standards, rules and regulations.

Transversal:
9. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
7. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

The subject consists of face-to-face activities consisting of 3 hours per week of class and 2 hours per fortnight of laboratory practices.
The student carries out learning through various mechanisms. In the lectures and participative classes the contents of the subject are presented and the interaction between students and teacher is facilitated. Individual / group personal work activities are also proposed that should contribute to the understanding of the subject.
In laboratory classes, students carry out preliminary work that helps to put into context the work that is intended to be carried out in the laboratory. The laboratory activity itself is developed in groups, preferably of two students, and allows experimenting with certain aspects of the subject. The writing of the memory and the interaction with the teacher in the laboratory allows working on the oral and written communication skills.
From time to time, nomenclature is introduced in English to progressively start the student in learning this language.

LEARNING OBJECTIVES OF THE SUBJECT

Upon completion of the Radio Frequency Circuits and Systems course, the student will be able to:

- Understand and apply circuits and systems for the long-distance radio transmission of information.
- Define, analyze, design and evaluate moderately complex radio frequency circuits and systems.
- Understand the principles and subsystems involved in radio and optical communication systems.
- Become familiar with general software tools and apply them to the analysis and design of communication systems.
- Carry out work individually and on a team and present it collectively, and search for information for this purpose.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Self study	90,0	60.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

1. HIGH FREQUENCY CIRCUITS

Description:
This topic presents the operating principles of high-frequency circuits. The transmission line and tools used to create effective designs with these circuits are introduced. More specifically, the aim is for students to:
- Understand what a transmission line and its equivalent model is and use it in general circuit design.
- Understand the geometry of some transmission lines and the effects of the parameters on line characteristics, including those related to electromagnetic compatibility.
- Use graphical tools and software to analyze and design circuits containing transmission lines.

Related activities:
All.

Full-or-part-time: 50h
Theory classes: 15h
Laboratory classes: 5h
Self study : 30h

2. RADIO FREQUENCY SYSTEMS

Description:
In this topic, the aim is for students to:
- Become familiar with the dB scale and understand the most significant magnitudes in communications systems.
- Describe and interpret biports through their scattering parameters.
- Understand some radio frequency subsystems and design systems that include them.

Related activities:
All.

Full-or-part-time: 40h
Theory classes: 12h
Laboratory classes: 4h
Self study : 24h

3. ANTENNAS AND PROPAGATION

Description:
In this topic, the aim is for students to:
- Identify and remember the main magnitudes associated with electromagnetic waves.
- Learn the Friis Transmission Equation and perform range calculations under free space conditions.
- Gain notions of propagation in real environments.
- Understand the transmission and reception characteristics of a λ/2 dipole and use them to establish a radio frequency link.
- Understand the most significant features of the main types of commercial antennas.

Related activities:
All.

Full-or-part-time: 30h
Theory classes: 9h
Laboratory classes: 3h
Self study : 18h

4. FUNDAMENTALS OF OPTICAL TRANSMISSION

Description:
In this topic, the aim is for students to:
- Learn and remember the main magnitudes involved in optical systems.
- Understand the most common light emitting and receiving devices.
- Outline a free-space optical communication system.
- Remember the principles of fiber-optic communication.
- Explain the elements involved in a fiber-optic communication system and quantify the main associated magnitudes

Related activities:
All.

Full-or-part-time: 30h
Theory classes: 9h
Laboratory classes: 3h
Self study : 18h

ACTIVITIES

TITLE OF ACTIVITY 1: LECTURES WITH EXERCISES

Description:
Theoretical content will be presented during these sessions. Students will have the opportunity to participate and interact with the professor.

Specific objectives:
- Identify the parameters involved in a transmission line and know and remember the equivalent model of a transmission line.
- Qualitatively predict and numerically calculate the response of circuits that incorporate transmission lines.
- Use graphic tools and software for the analysis and design of circuits that incorporate transmission lines.
- Know the dB scale to relate the most significant quantities in communication systems.
- Describe and interpret biport by describing it with S parameter matrices.
- Know some radio frequency subsystems and design systems that incorporate them.
- Know and remember the main magnitudes associated with electromagnetic waves.
- Know the transmission equation, be able to perform range calculations in free space conditions and have notions of propagation in real environments.
- Know the transmission and reception characteristics of a lambda / 2 dipole and be able to use them to establish a radio frequency link.
- Know the most significant characteristics of the main types of commercial antenna.
- Know and remember the main magnitudes involved in optical systems.
- Know the most common light emitting and receiving devices
- Schematize an optical communications system in free space.
- Remember the principles on which fiber optic communication is based.
- Detail the elements involved in a fiber optic communication system and quantify the main associated magnitudes.

Material:
Published teaching material.
Recommended bibliography.

Delivery:
Occasionally some evaluable activity will be carried out, which will contribute in a proportional part to the EXE variable.

Full-or-part-time: 40h
Theory classes: 40h

TITLE OF ACTIVITY 2: LABORATORY SESSIONS

Description:
The practices to be carried out in the laboratory will be two hours a fortnight, in groups of two people. The student will have the statement of the practice that will have been posted in ATENEA. The laboratory will have the necessary material and equipment to carry out the work. In addition, each group must bring their personal material that will be described at the beginning of the course. At the end of each practice, each group will post a report in ATENEA where the work done and the knowledge acquired will be explained.

Specific objectives:
- Use software tools for the analysis and design of circuits that incorporate transmission lines.
- Know the main measuring instruments and carry out measurements in radio frequency circuits and systems.
- Experimental validation of radio frequency communication systems.
- Draft and present documents reflecting the design and validation process of radio frequency circuits.

Material:
Electronic equipment, components and computer with suitable software.
Statement of the practice and supporting information to carry out the work.

Delivery:
Before carrying out the practice, the students will deliver the previous individual study corresponding to the practice to be carried out.
During the session, the achievement of the objectives of each laboratory session will be assessed, taking into account the degree of understanding of the work demonstrated by each student.
At the end of the session, each working group will prepare a final report that reflects the main features of the actual work.
The grade obtained in these activities configures the LAB variable.

Full-or-part-time: 15h
Laboratory classes: 15h

TITLE OF ACTIVITY 3: INDEPENDENT STUDY AND EXERCISES

Description:
Students must complete certain activities on their own time in order to achieve the objectives of the subject.

Specific objectives:
All of the subject.

Material:
Published teaching material.
Recommended bibliography.

Delivery:
Individual / group personal work will be translated, in part, into exercises during the course. The grading of these exercises will contribute to the EXE variable.

Full-or-part-time: 50h
Self study: 50h

TITLE OF ACTIVITY 4: EXAM

Description:
There will be a midterm that students must take individually. At the end of the class, there will be a final exam on the overall knowledge acquired.

Material:
Test statements.

Delivery:
The control test score sets the variable CON.
The final test grade sets the FIN variable.

Full-or-part-time: 35h
Theory classes: 5h
Self study: 30h

GRADING SYSTEM

The final grade for the course will be obtained as follows:

Final grade = 0.15 * EXE + 0.25 * LAB + 0.20 * CON + 0.40 * FIN

Note 1. The qualification in a part or in the whole of the final test will replace, if it is higher and there is a coincidence in the evaluated aspects, the results obtained in other evaluation acts carried out throughout the course.
Note 2. When the results of the evaluation acts corresponding to individual activities are substantially lower than those obtained in group activities, the individual execution of activities similar to those carried out in groups may be required. The last qualification will replace the original ones.

EXAMINATION RULES.

In the case of laboratory activities for which a previous study has been established, it will be mandatory to submit it before accessing the laboratory.
Those activities that are explicitly declared as individual, whether in person or not, will be carried out without any collaboration from other people.
The dates, formats and other delivery conditions that are established will be mandatory.

BIBLIOGRAPHY

Basic:
- Pozar, David M. Microwave engineering [on line]. 4th ed. Hoboken: Wiley, 2012 [Consultation: 27/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=2064708. ISBN 9780470631553.

RESOURCES

Other resources:
- Teaching and support material published on the ATENEA platform.
- Open Courseware portal of the ITIC degree http://ocw.itic.cat