Course guide
320112 - ER - Transmitters and Receivers

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

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

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

LECTURER

Coordinating lecturer: Ignacio Gil

Others:

PRIOR SKILLS

It is recommended to have a background on Analog and Digital Electronics in order to take the course

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE10-ESAUD. Ability to evaluate the advantages and disadvantages of different technological alternatives for the deployment or implementation of communications systems, from the point of view of signal space, disturbances and noise, and analog and digital modulation systems. (Common module for the telecommunications branch)
CE13-ESAUD. Ability to understand the mechanisms of propagation and transmission of electromagnetic and acoustic waves, and their corresponding emitting and receiving devices. (Common module for the telecommunications branch)

Generical:
CG05-ESAUD. Knowledge for the realization of measurements, calculations, valuations, appraisals, expert opinions, studies, reports, task planning, and other similar work in their specific field of telecommunications.

TEACHING METHODOLOGY

- Face-to-face lecture sessions.
- Face-to-face practical class work sessions.
- Face-to-face practical laboratory work sessions.
- Independent learning and exercises.
- Preparation and completion of group activities subject to assessment.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.

Practical class work will be covered in three types of sessions:
a) Sessions in which the lecturer will provide students with guidelines to analyse data for solving problems by applying methods, concepts and theoretical results (80%).
d) Sessions in which students give presentations of group work (8%).
d) Examination sessions (12%).

In the laboratory work sessions, the lecturer will provide students with guidelines in order to analyse, simulate and solve transceiver circuits/systems.

Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.

In groups of five, students will carry out projects and present them publicly in applied sessions.

LEARNING OBJECTIVES OF THE SUBJECT

In this subject, students gain an understanding of the main transceiver architectures and their constituent blocks. They will also become familiar with the main wireless communication standards. On completing the subject, students will be able to design high-level transmission/receiver systems to satisfy a given set of specifications. They will learn how to approach open-ended problems that involve the various basic parameters of transceivers. They will use Agilent Advanced Design Systems (ADS) software to simulate the behaviour of certain blocks at the circuit and transceiver levels, as well as at the system level. They will build on the specific transversal competencies associated with coursework, as described below.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	22,5	15.00
Self study	90,0	60.00
Hours medium group	22,5	15.00

Total learning time: 150 h

CONTENTS

UNIT 1: BASIC CONCEPTS

Description:
- Fundamental units: dB,dBm, dBW, dBμV
- Radiation fundamentals
- Gain and linearity
- Noise. Noise Figure
- Sensitivity and Dynamic Range
- Cascaded stages impact

Related activities:
Laboratory: Introduction to ADS. Simulation of the budget in a RF superheterodyne receiver, with a given specifications, in order to receive a Digital Video Broadcasting-Terrestrial (DVB-T) signal.

Full-or-part-time: 9h
Theory classes: 3h
Practical classes: 3h
Laboratory classes: 3h

UNIT 2: ANALYSIS TECHNIQUES

Description:
- Transmission line concept
- Smith Chart
- Impedance matching
- S-parameters

Related activities:
Laboratory: Coaxial transmission line analysis. Simulation and experimental of the impact of the load, multi-reflection. Evaluation of delay time.

Full-or-part-time: 18h 30m
Theory classes: 7h
Practical classes: 7h 30m
Laboratory classes: 4h

UNIT 3: TRANSCEIVER ARCHITECTURES/STAGES

Description:
- Heterodyne Receivers
- Homodyne Receivers
- Direct-conversion Transmitters
- Radio software
- Filters
- Low-Noise Amplifiers (LNA)
- Mixers
- Voltage-Controlled Oscillators (VCO)
- PLL
- Power Amplifiers (PA)

Related activities:
Laboratory: Evaluation and simulation of the performance of a commercial LNA. Design of a matching network for a GSM application. Evaluation and simulation of the performance of a commercial mixer. Analysis of linearity, conversion gain, consumption and optimization.

Full-or-part-time: 23h
Theory classes: 8h
Practical classes: 9h
Laboratory classes: 6h

UNIT 4: ANTENNAS

Description:
- Antenna as an electromagnetic transducer
- Main characteristics
- Types

Related activities:
Laboratory: Electromagnetic simulation of a patch antenna for RFID application. Redesign and optimization of antenna performance.

Full-or-part-time: 8h
Theory classes: 3h
Practical classes: 3h
Laboratory classes: 2h

UNIT 5: COMMUNICATION WIRELESS STANDARDS

Description:
- Wireless PAN: Bluetooth, Zigbee
- Wireless LAN: 802.11
- Wireless MAN; WiMAX
- Others

Related activities:
Directed Activity: Coaching focused on projects based on unit 5.

Full-or-part-time: 7h 30m
Theory classes: 1h 30m
Guided activities: 6h

GRADING SYSTEM

- First examination: Ex 1 35%
- Second examination: Ex 2 40%
- Laboratory work: Lab 15%
- Projects: Act 10%

Assessment (AF):

AF=0.35*Ex1+0.40*Ex2+0.15*Lab+0.10*Act

If AF>=5 -> Final Assessment=AF
If AF=5 i Lab>=5) -> Final Assessment=5
Other cases -> Final Assessment=AF

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

In order to take this course, students are expected to have passed Signals and Systems and Analogue and Digital Communications (second year).

BIBLIOGRAPHY

Basic:
- Razavi, Behzad. RF microelectronics. Upper Saddle River: Prentice Hall, 1998. ISBN 0138875715.
- Golio, Mike. The RF and microwave handbook. Boca Raton: CRC Press, 2001. ISBN 084938592X.
- Berenguer Sau, Jordi. Radiofreqüència: una introducció experimental [on line]. Barcelona: Edicions UPC, 1998 [Consultation: 14/05/2020]. Available on: http://hdl.handle.net/2099.3/36367. ISBN 8483012685.

Complementary:
- Davis, W. Alan. Radio frequency circuit design [on line]. 2nd ed. New York: John Wiley & Sons, 2011 [Consultation: 30/09/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=624507. ISBN 9780470575079.
- Pozar, David M. Microwave engineering. 2nd ed. New York: John Wiley & Sons, 1998. ISBN 0471170968.
- Vizmuller, Peter. RF design guide : systems, circuits and equations. Boston: Artech House, 1995. ISBN 0890067546.