

Course guide

300029 - ER - Transmitters and Receivers

Last modified: 01/06/2023

Unit in charge:	Castelldefels School of Telecommunications and Aerospace Engineering	
Teaching unit:	739 - TSC - Department of Signal Theory and Communications.	
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: 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

Linear circuits analysis (sinusoidal steady state)
Main characteristics and properties of analog electronic devices, both active and passive.
Knowledge of the properties and operation of the amplitude, frequency and phase modulation systems

REQUIREMENTS

To have followed a course on:
o Communications (analog and digital) fundamentals.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

1. CE 10 TELECOM. Capacidad para evaluar las ventajas e inconvenientes de diferentes alternativas tecnológicas de despliegue o implementación de sistemas de comunicaciones, desde el punto de vista del espacio de la señal, las perturbaciones y el ruido y los sistemas de modulación analógica y digital. (CIN/352/2009, BOE 20.2.2009.)
2. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

Transversal:

3. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
4. 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.
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.

TEACHING METHODOLOGY

The course syllabus is organized in a gradual way. First topics are theoretically introduced (intermodulation, noise,...) ending with a first theoretical introduction to the spectrum analyzer fundamentals and screen's reading.

Theoretical lectures are based on the professor's exposition, being the formal explanations combined with a continuous asking process, targeting to make easier for students the understanding of the course fundamentals. A good motivation for the study of new concepts and techniques is a critical starting point. So, they will be introduced from their utility to solve actual problems, avoiding as possible the simple study of subjects without a clear knowledge on their usefulness. In fact, the course is relatively short in credits, so the learning taxonomy has to be carefully selected. Hence, the presentation of the topics will be made at different speeds according to the objective, which will range from a complete operability to a simple overview. This may be also percept in the degree of complexity of the posted problems in the website, varied among the different course lectures.

In the lectures guided to improve practice in solving exercises and problems, students can work, depending on each particular lecture, individually or in groups of up to 3 members. The objective is to solve problems already advanced in the theoretical lectures. The professor will solve (or will give guidelines to do that) together with the students the critical parts of the problems; and additional problems to be solved at home will be proposed. It is important that the professor will not destroy the start-up of the problems, which is the most educational part of the way to the solution. Once started (or at least after elapsing a prudential time after the problem's proposal), the professor will give the abovementioned guidelines.

LEARNING OBJECTIVES OF THE SUBJECT

- To understand the operation of a communications channel and to describe and assess some effects of non-linearities and other distortions.
- To make some kind of quality assessment of the subsystems more sensitive to noise and distortion, especially in the radiofrequency front-end.
- To compute the link-budget in a radio link, with detail of the involved noise parameters
- To know the usual frequency bands as well as their common usage, along with some propagations aspects depending on the band.
- To know the basic operation and to choose into a catalogue usual components and subsystems in analog RF applications.
- To characterize the main kind of oscillators and mixers, and to assess the main characteristics.
- To know the main topologies for both emitters and receivers, based on the constitutive subsystems and their properties.
- To know what a PLL is and the main applications.
- To know the theoretical fundamentals of the spectrum analyzer
- To know basic analog structures for amplitude and phase modulation and demodulation.

STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	21.31
Guided activities	17,3	15.36
Self study	63,0	55.95
Hours medium group	8,3	7.37

Total learning time: 112.6 h

CONTENTS

(ENG) Títol contingut 1: Communications channel. Radiofrequency head

Description:

- Interferences
- Distortion. Kinds, effects. Indicative parameters.
- Noise in communications. Sources. Characterization. Noise factor and noise figure. Noise in chained subsystems. Noise reduction.
- Frequency bands. Use, applications. Propagation.
- Link budgets. Power and noise.

Related activities:

Activity 1: Workshop on intermodulation computations.
Activity 2: Workshop on noise computations
Activity 3: Workshop on link budgets
Activity 4: Workshop on regulatory bodies.
Activity 5: Workshop on spectrum analyzer fundamentals.
Activity 6: Short assesment on the communications channel.

Full-or-part-time: 49h 48m

Theory classes: 12h

Practical classes: 4h 30m

Guided activities: 9h

Self study : 24h 18m

(ENG) Títol contingut 2: RF devices and circuits.

Description:

REVISION ON:

- RF filters and applications
- Oscillators and mixers. Types, operation and descriptive parameters

At the end of the topic, the student has to be able to:

- Understand the operation and to use electronic devices in RF applications, considering the limiting effects such as non-idealities.
- To design and characterize the main kind of oscillators (LC and crystal) and mixers, to asses the properties and characteristics, as well as techniques to suppress the image frequency.

Related activities:

HALF SEMESTER EXAMINATION

Activity 8: Short assesment (RF circuits and devices)

Full-or-part-time: 34h 18m

Theory classes: 8h

Practical classes: 2h 45m

Guided activities: 6h 15m

Self study : 17h 18m

(ENG) Títol contingut 3: Emitters and Receivers

Description:

- Transmitters. Specifications. Structures. BW limitation techniques.
- Kinds of receivers. Quality parameters. Structures. Analog and SDR receivers. Noise and sensitivity.
- PLL. Main applications.
- Control circuitry: AGC, AFC.
- Modulators and demodulators: amplitude and phase.
- Linear and switched power amplifiers. Operation principles. Biasing. Selection criteria. Introduction to linearizers and power combiners.
- To know and to choose the power amplifier suitable for different applications.

Related activities:

FINAL EXAMINATION. (ALL THE COURSE CONTENTS)

Full-or-part-time: 28h 24m

Theory classes: 4h

Practical classes: 1h

Guided activities: 2h

Self study : 21h 24m

ACTIVITIES

WORKSHOP ON INTERMODULATION COMPUTATIONS

Description:

This activity will be carried out in groups of 20 students, and it will be based either on the proposal of additional activities or to solve issues appeared when resolving the proposed exercises.

The students can get individual tutoring to solve the doubts raised from the personal study of the proposed exercises, aiming at a better training for the mid semester examination.

Specific objectives:

Learning to compute intermodulation effects in communication receivers.

Material:

The necessary support will be given by the teacher along the session.

Delivery:

Proposed exercises on intermodulations.

Full-or-part-time: 6h

Guided activities: 2h

Self study: 4h

WORKSHOP ON NOISE COMPUTATIONS

Full-or-part-time: 7h

Guided activities: 2h

Self study: 5h

WORKSHOP ON LINK BUDGETS

Full-or-part-time: 4h

Guided activities: 1h

Self study: 3h



WORKSHOP ON REGULATORY BODIES

Full-or-part-time: 5h

Guided activities: 2h

Self study: 3h

WORKSHOP ON SPECTRUM ANALYZER FUNDAMENTALS

Full-or-part-time: 6h

Practical classes: 2h

Guided activities: 4h

SHORT ASSESMENT ON THE COMMUNICATION CHANNEL

Full-or-part-time: 1h

Guided activities: 1h

HALF SEMESTER EXAMINATION

Full-or-part-time: 1h 30m

Guided activities: 1h 30m

SHORT ASSESSMENT ON RF CIRCUITS AND DEVICES

Full-or-part-time: 1h

Guided activities: 1h

final semester examination

Description:

Includes all the course syllabus.

Full-or-part-time: 2h

Guided activities: 2h

GRADING SYSTEM

Defined in the infowet of the course.



BIBLIOGRAPHY

Basic:

- Tomasi, Wayne; Mata Hernández, Gloria. Sistemas de comunicaciones electrónicas [on line]. 4ª ed. México: Pearson Educación, 2003 [Consultation: 26/07/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=3801. ISBN 9702603161.
- Krauss, Herbert L. Solid state radio engineering. New York: John Wiley & Sons, 1980. ISBN 047103018X.
- Smith, Jack. Modern communication circuits. 2a. Boston: WCB McGraw-Hill, 1998. ISBN 0070592837.

Complementary:

- Pozar, David M. Microwave and RF wireless systems. New York [etc.]: John Wiley & Sons, 2001. ISBN 0471322822.
- Berenguer Sau, Jordi. Radiofreqüència : una introducció experimental [on line]. Barcelona: Edicions UPC, 1998 [Consultation: 15/04/2020]. Available on: <http://hdl.handle.net/2099.3/36367>. ISBN 8483012685.
- Sayre, C.W. Complete wireless design. New York: McGraw-Hill, 2001. ISBN 0071370161.

RESOURCES

Audiovisual material:

- Nom recurs. Resource

Other resources:

- Software. Computer aided design programs such as RFSim99, Smith, MDS,...