Last update: 05-07-2019

# 230018 - ICOM - Introduction to Communications

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish

## Teaching staff

Coordinator: Josep Sala Alvarez, Margarita Cabrera Bean

Others: Margarita Cabrera Bean, Juan Antonio Fernández Rubio, Meritxell Lamarca Orozco, Alba Pagès Zamora, Ana Isabel Pérez Neira, Josep Sala Álvarez, Rafael Valle Alarcón, Javier Villares Piera, Antonio Pascual Iserte

## Prior skills

Probability
Fourier Transform
Convolution integral
Signals and Systems

## Requirements

Probability and Statistics - Prerequisite
Signals and Systems - Prerequisit

## Degree competences to which the subject contributes

Generical:

12 CPE N2. They will be able to identify, formulate and solve engineering problems in the ICC field and will know how to develop a method for analysing and solving problems that is systematic, critical and creative.

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## Teaching methodology

Application lectures
Lectures
Lab lectures
Group work
Personal work
Short answer test (Test on Basic Concepts)
Exams with exercises (Controls and Final Exam)
Lab sessions.

## Learning objectives of the subject

Digital bandpass communication systems. Interference and noise in communications. Communication channels. Signal-to-Noise Ratio (SNR). Linear Digital Modulations (ASK,QAM,PSK). Evaluation of the error probability (BER and SER).

## Study load

| | | | |
|---|---|---|---|
| Total learning time: 150h | Hours large group: | 52h | 34.67% |
| | Hours small group: | 13h | 8.67% |
| | Self study: | 85h | 56.67% |

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## Content

### Lesson 1. Introduction

Learning time: 1h

Theory classes: 1h

Description:

Presentation of the most characteristic elements of a communication system, emphasizing digital bandpass modulations as the most general case.

1.1 Presentation of the subject.
1.2 Digital bandpass communication system.
- Analog and Digital information source.
- Communication system composed of transmitter, channel and receiver.
- Bandwidth and bit rate.
- Parameters of quality: SNR, BER and SER.

### Lesson 2. Bandpass signals and systems.

Learning time: 18h

Theory classes: 9h
Self study : 9h

Description:

Deterministic approach: introduction to bandpass signals and systems.
Review of concepts: random process, stationarity and cyclo-stationarity.
Stochastic approach: correlation and Power Spectral Density (PSD) of bandpass modulations.
Throughout this lesson: emphasis on the analysis of bandpass communication systems in terms of their equivalent lowpass system.

II.1 Deterministic bandpass signals
- Bandpass signal and equivalent lowpass signal
- IQ modulation and demodulation
- Equivalent lowpass system

II.2 Bandpass random processes
- Characterization of a random process: correlation and PSD
- Random processes through linear systems
- Bandpass modulations: correlation and PSD
- Noise in communications: correlation, PSD and Signal-to-Noise Ratio (SNR)

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| Lesson 3. Digital Transmission Systems. | Learning time: 26h<br>Theory classes: 11h<br>Self study : 15h |
|---|---|

Description:
Digital baseband modulations (PAM) as well as linear digital bandpass modulations (QAM,PSK). Performance evaluation for these modulations in both AWGN and bandlimited channels. Definition of the equivalent discrete channel and its application (emphasized) to the performance analysis of digital transmission systems.

III.1 Digital modulator
- Symbol encoding and pulse shaping.
- Power Spectral Density (PSD) of digital modulations.

III.2 Digital demodulator
- Matched Filter (MF)
- Inter-Symbol Interference (ISI)
- Nyquist pulses

III.3 Equivalent discrete channel
- Channel characterization
- Characterization of the noise signal

III.4 Equalization
- Zero-forcing

III.5 MAP detector and error probability
- MAP criterion and decision regions
- Symbol and bit error rate (SER and BER)
- The Union Bound

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## Planning of activities

| (ENG) Midterm exams | Hours: 3h<br>Theory classes: 3h |
|---|---|
| Description:<br>1 or 2 controls | |

| (ENG) Pràctica de laboratori | Hours: 6h 40m<br>Laboratory classes: 6h 40m |
|---|---|
| Description:<br>Lab Sessions I "Basic Operation of a Spectrum Analyzer based on the swept Superheterodyne Receiver Principle", II "Characteristic parameters of a communications receiver".<br>Support materials:<br>Lab Guide | |

| Session Labs. Part II | Hours: 6h 40m<br>Laboratory classes: 6h 40m |
|---|---|
| Description:<br>Lab Sessions III "Principles and Operation of a Vector Signal Analyzer", IV "Generation of digital signals with the Lavicad Simulator, and their analysis using a Vector Signal Analyzer" and V"Inter-symbol Interfernce and Baseband Equalization"<br>Support materials:<br>Lab Guide | |

| Final exam | Hours: 3h<br>Theory classes: 3h |
|---|---|
| Description:<br>Final Exam | |

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## Qualification system

The completion of all lab sessions and presentation of the corresponding reports during the semester in which the course is taken are mandatory and, therefore, a necessary condition for passing the course. Failure to do so, the student will get a "No Presentat" (NP) for the course without considering the percentages set forth below. Those students satisfying the lab recognition rules are exempt from execution and presentation of the lab work. The lab recognition rules will be published at the beginning of the semester.

1 or 2 control tests consisting of exercises. (30%)
Follow-up of the work in the lab (10%)
1 Final exam (60%)

This course will assess the generic skill:
- Ability to identify, formulate and solve engineering problems (Intermediate Level)

The re-assessed final mark of the course is computed from a final exam (90%) and from the non-re-assessed laboratory part (10%)

## Bibliography

Basic:

Proakis, J.G.; Salehi, M. Communication systems engineering. 2nd ed. Upper Saddle River, New Jersey: Prentice Hall, 2002. ISBN 0130617938.

Carlson, A.B.; Crilly, P.B. Communication systems: an introduction to signals and noise in electrical communication. 5th ed. New York: McGraw-Hill, 2010. ISBN 9780071263320.

Others resources:

Lab Guide.
Collection of unsolved exercises.
Solved final exams.