

Course guide

230018 - ICOM - Introduction to Communications

Last modified: 15/01/2024

Unit in charge:	Barcelona School of Telecommunications Engineering		
Teaching unit:	739 - TSC - Department of Signal Theory and Communications.		
Degree:	BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Compulsory subject).		
Academic year: 2023	ECTS Credits: 6.0	Languages: Catalan, Spanish, English	

LECTURER

Coordinating lecturer:	Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others:	Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Probability
Fourier Transform
Convolution integral
Signals and Systems

REQUIREMENTS

PROBABILITAT I ESTADÍSTICA - Precorequisit
SENYALS I SISTEMES - Precorequisit

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.

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).

Learning results:

- Be able to analyze and specify the fundamental parameters of a communications system.
- Evaluate the advantages and disadvantages of the different technological alternatives for the implementation of communications systems, taking into account the signal space, the disturbances, the noise and the analog and digital modulation schemes.
- State correctly the problem to be solved and identify the options for its resolution. Apply the most adequate methods to solve the problem and find its solution.
- Identify, model and state the problem based on open situations. Explore and apply the alternatives for the resolution. Be able to work with approximations.
- Know and use correctly and autonomously the tools and software available in the basic and advanced labs. Analyze and process correctly the collected data. Know how to work properly with the tools and their limitations.

STUDY LOAD

Type	Hours	Percentage
Hours small group	13,0	8.67
Hours large group	52,0	34.67
Self study	85,0	56.67

Total learning time: 150 h

CONTENTS

Lesson 1. Introduction

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.

Full-or-part-time: 2h

Theory classes: 2h

Lesson 2. Bandpass signals and systems

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)

Full-or-part-time: 52h

Theory classes: 22h

Self study : 30h

Lesson 3. Digital Transmission Systems

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

Full-or-part-time: 61h

Theory classes: 26h

Self study : 35h



ACTIVITIES

Midterm exams

Description:

1 or 2 controls

Full-or-part-time: 2h

Theory classes: 2h

Lab sessions (Part I)

Description:

Lab Sessions I "Basic Operation of a Spectrum Analyzer based on the swept Superheterodyne Receiver Principle", II "Characteristic parameters of a communications receiver".

Material:

Lab Guide.

Full-or-part-time: 14h 30m

Laboratory classes: 6h 30m

Self study: 8h

Lab sessions (Part II)

Description:

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", V "Inter-symbol Interference and Baseband Equalization".

Material:

Lab Guide.

Full-or-part-time: 18h 30m

Laboratory classes: 6h 30m

Self study: 12h

Final exam

Description:

Final Exam

Full-or-part-time: 3h

Theory classes: 3h

GRADING SYSTEM

The completion of all lab sessions, presentation of the corresponding reports and doing all the lab controls 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.

- CONT: 1 or 2 control tests consisting of exercises and/or tests. (30%)
- LAB: Laboratory: reports, previous works, controls, work in class. (10%)
- EXFIN: 1 Final exam. (60%)

The lab will always be taken into account in the final evaluation. The mark of the final exam will substitute the marks of the controls if it is better. Consequently, the final mark of the course will be calculated as follows:

$$\text{Final mark} = 0.1 \cdot \text{LAB} + \max \{ 0.6 \cdot \text{EXFIN} + 0.3 \cdot \text{CONT}, 0.9 \cdot \text{EXFIN} \}$$

This course will assess the generic skill:

- Ability to identify, formulate and solve engineering problems (Intermediate Level)

Those students who have not passed the course and that fulfill the conditions specified in the academic regulations will have the option to be re-evaluated by doing a final global exam with a weight equal to 90%. The remaining 10% will be the lab mark since it is an activity that cannot be re-evaluated. The final mark of the student will be calculated according to the current academic regulations.

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.

RESOURCES

Other resources:

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