

# Course guide 230018 - ICOM - Introduction to Communications

Last modified: 05/06/2024

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: 2024	ECTS Credits: 6.0	Languages: Catalan, Spanish, English	

## **LECTURER**

Coordinating lecturer:	JOSE SALA ALVAREZ - ANTONIO PASCUAL ISERTE
Others:	Primer quadrimestre: M. MERITXELL LAMARCA OROZCO - 15 CARLOS ALEJANDRO LOPEZ MOLINA - 11, 14 JOSE SALA ALVAREZ - 11, 12, 13, 14, 15
	Segon quadrimestre: ANTONIO PASCUAL ISERTE - 41, 42, 43 JOSE SALA ALVAREZ - 13 ANNA UMBERT JULIANA - 11, 12, 14 NEMESIO JAVIER VILLARES PIERA - 11, 12, 13, 14, 42

# **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 communciations 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**

Туре	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: 49h

Theory classes: 19h 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:**

Two lab sessions focused on the knowledge and utilization of the equipment available at the communications lab and the basic fundamentals of the bandpass communication systems.

#### Material:

Lab guide.

### **Full-or-part-time:** 14h Laboratory classes: 6h Self study: 8h

### Lab sessions (Part II)

#### **Description:**

Three lab sessions focused on aspects related with the bandpass transmission of digital information such as the signal generation, the analysis of the quality in the detection process, the frequency selective channels, and the equalization.

#### Material:

Lab guide.

**Full-or-part-time:** 19h Self study: 12h Laboratory classes: 7h

#### **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 and will be specific for each concrete 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:

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

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.