

TITLE OF COURSE: Signals and transmission systems

PROGRAM TITLE: Enginyeria Tècnica de Telecomunicació Sistemes de Telecomunicació, 1st grade

CODE: 41042 program of Enginyeria Tècnica de Telecomunicació Sistemes de Telecomunicació

TYPE: T **YEAR:** 2nd year **SEMESTER:** Not available

CREDITS (hours/week): 9.00

ECTS CREDITS: 7.50

LECTURER: A. Nadal, G. Nicolau, I. Gutiérrez, X. Sevillano

LANGUAGE: Catalan

PREREQUISITES: None

PREVIOUS KNOWLEDGE: Basic tools of mathematical calculus

SUBJECTS TO BE STUDIED SIMULTANEOUSLY: Not available

COURSE DESCRIPTION:

This course presents the basic notions regarding signal processing and transmission, elements which constitute the basis of telecommunications technologies.

This course is based on mathematical grounds, as both signals and the processes they are subjected to are described by means of mathematical language. Although this course does not involve practical works, its relationship with the techniques employed in the field of telecommunication is clear; therefore, the lectures are illustrated with several examples which relate the methods described with the technologies used in practice.

The course is divided into three parts which have thematic entity by themselves. The first part introduces the basic elements which will be under study throughout the whole course: signals and systems, alongside with their mathematical modelling in time domain. The next step consists in studying a fundamental notion in the context of signal processing such as the Fourier transform, a basic tool which allows to represent, both signals and systems, in the frequency domain.

The second part of the course is devoted to studying several analog transmission techniques, ranging from baseband transmission through wire networks to frequency modulation strategies used by commercial radio stations and satellite communications and the design of radiocommunications receivers.

Finally, the third part of the course is focused on the description of analog-to-digital conversion, introducing the fundamental tools which allow the study of digital signal processing and transmission, which are the predominant techniques in the current telecommunication framework.

COURSE OBJECTIVES:

The objectives of the course entitled Signals and Transmission Systems are focused on providing the students with knowledge of basic concepts regarding signal processing and transmission, as they constitute central notions in the field of telecommunications. The achievement of these objectives relies on the development of the following skills and competences:

1. Basic general knowledge on signal processing and transmission.
2. Problem solving.
3. Capacity to learn.
4. Capacity for analysis and synthesis.
5. Capacity to adapt to new situations.
6. Will to succeed.

CONTENTS:**PART I: ANALOG SIGNAL PROCESSING**

1. Introduction

1.1 Transmission system and objectives

1.2 Mathematical tools

2. Analog signals and systems

2.1. Definitions and notation

2.2. Signals properties

2.3. Systems properties

3. Impulse response

3.1. System characterization in time domain

3.2. Convolution integral

3.3. LTI systems properties according to their impulse response

4. Transfer function

4.1. Eigenfunctions of LTI systems

4.2. The Fourier series

5. Fourier transform

5.1. From the Fourier series to the

5.2. properties

5.3. Frequency analysis of LTI systems

5.4. Fourier transform on periodic signals

PART II: ANALOG SIGNAL TRANSMISSION

6. Analog signal transmission

6.1. Elements of a communications system

6.2. Problems and limitations in transmission

6.3. Baseband analog transmission

7. Transmission of modulated analog signals

7.1. Concepts and classification of modulations

7.2. Bandpass signals and systems representation

7.3. Bandpass transmission

7.4. Amplitude analog modulations: DSB, AM, SSB

7.5. Angular analog modulations: FM

8. Transmitters and receivers

8.1. Block diagrams and typical circuits

8.2. The superheterodyne receiver

PART III: DIGITAL SIGNAL PROCESSING AND TRANSMISSION

9. Sampling. Analog pulse modulations

- 9.1. Ideal sampling
- 9.2. Nyquist theorem
- 9.3. Real sampling
- 9.4. Analog pulse modulations

10. Quantization and coding. Pulse code modulation

- 10.1. Quantization and coding
- 10.2. Pulse code modulation (PCM)
- 10.3. Time division multiplex (TDM)

11. Discrete signals and systems

- 11.1. Discrete signals properties
- 11.2. Basic discrete signals
- 11.3. Operation on the discrete axis
- 11.4. Discrete systems properties
- 11.5. Impulse response and discrete convolution

12. Frequency representation of discrete signals and systems

- 12.1. Introduction
- 12.2. Discrete signal Fourier transform

METHODOLOGY:

Several activities regarding the impartation of the course are undertaken:

1. Class lectures.

The lecturer explains the theoretical concepts of the course by means of class lectures. During these classes, the teacher solves problems consisting in the direct application of the concepts explained. The percentage of time dedicated to both tasks is 75% to theory and 25% to problem solving.

2. Classes dedicated to individual or collective problem solving.

During the 10% of the class hours the lecturer proposes theoretical exercises for the students to solve them in the classroom. This problem solving task can be performed individually or in small groups. At the end of the class, the lecturer solves the proposed exercises, stimulating the students to contribute with the solutions found by them.

3. Homework.

Besides the problems proposed during class time, the student must solve other problems as homework. These exercises could have been proposed by the lecturer or problems belonging to a problem collection generated by the lecturers of the course. Moreover, a collection of previous years solved exams is available to the students. The objective of these exercises is consolidating the theoretical concepts explained during the classes.

4. Personal consulting.

In order to help the student to follow the course, the lecturers offer a personal consulting service. The inquiries may be referred to the theoretical contents of the course or the solution of the proposed problems, besides several aspects relating the planning of study tasks.

5. Matlab demos

A set of Matlab applications which illustrate several concepts explained during the classes have been developed. By means of graphical user interfaces, the student can execute

practical examples which can enhance the comprehension of theoretical aspects of the course.

EVALUATION:

In order to evaluate whether the student has achieved the objectives of the course, several means for obtaining data on his/her performance are used:

A. Exams.

Three main exams are conducted throughout the course. Each exam coincides with one of the three parts of the course described earlier.

D. Homework.

The problems proposed during the classes are susceptible of being evaluated. Additionally, the personal consulting service allows the lecturers to evaluate the work conducted by the student on the solved problems collection by the student.

J. Classroom participation.

The lecturer tracks the classroom attitude and participation of the students.

PERFORMANCE CRITERIA:

- Objective 1: The student should demonstrate basic general knowledge regarding signal processing and transmission, besides the relationships and mutual implications between the different concepts described. [A, D, J]
- Objective 2: The student should demonstrate ability to solve problems, being capable to propose adequate solutions to theoretical and practical exercises. [A, D]
- Objective 3: The student should demonstrate ability to learn and understand the concepts explained throughout the course. [A, D]
- Objective 4: The student should demonstrate analysis and synthesis abilities, being capable of analyzing the confronted problems and choosing the optimal solution. [A, D, J]
- Objective 5: The student should demonstrate ability to adapt to new situations, being capable of extrapolating acquired knowledge to different environments. [A, D]
- Objective 6: The student should demonstrate motivation for achieving new goals, besides showing motivation for the concepts of the course and their practical application in the real world. [D, J]

TEXTBOOKS:

- G. Nicolau, X. Sevillano, Solved exercises collection on Signals and Transmission Systems, Enginyeria i Arquitectura La Salle, 2004
- A.V. Oppenheim, A.S. Willsky, Signals and systems, Prentice Hall, 1998
- A.B. Carlson, Communication systems, McGraw-Hill, 1988

OTHER REQUIRED MATERIAL:

- S. Haykin, B. Van Veen, Signals and systems, Wiley, 2002
- S. Haykin, Communication systems, Wiley, 2002
- M. Schwartz, Information transmission, modulation and noise, McGraw-Hill, 1983

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REMARKS:

In the actual Spanish educational system the duration of courses can be one or two semesters. This fact was fixed for each curriculum when it was approved by the Spanish government and published in the Official Bulletin of the State (BOE). To continue to have the Spanish recognition it is necessary to maintain the structure approved by the Ministry.

Nevertheless, all our degrees have a structure that allows us to have global evaluations of the knowledge acquired by the student at the end of each semester. So, for those foreign students that spend only one semester in our university, under Erasmus or other international programs in which Ramon Llull University is involved, these evaluations will serve the student to achieve the credits allocated during such a semester.