Communication Theory

Academic Year: (2024 / 2025) **Review date: 17-01-2025**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: LAZARO TEJA, MARCELINO

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Statistics (First year, second semester)
Systems and Circuits (First year, second semester)
Linear Systems (Second year, first semester)

LEARNING OUTCOMES

CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG3: Knowledge of basic and technological subject areas which enable acquisition of new methods and technologies, as well as endowing the technical engineer with the versatility necessary to adapt to any new situation.
ECRT5: Ability to weigh the advantages and disadvantages of different alternative technologies for development and implementation of communication systems, from the point of view of signal space, perturbations and noise, and analog and digital modulation systems.
RA1: Knowledge and understanding of the general fundamentals of engineering, scientific and mathematical principles, as well as those of their branch or specialty, including some knowledge at the forefront of their field.
RA2: Analysis. Graduates will be able to solve engineering problems through an analysis process, identifying the problem, recognising specifications, establishing different methods of resolution, selecting the most appropriate one and implementing it correctly. They must be able to use various methods and recognize the importance of social constraints, human health, safety, the environment, as well as commercial constraints.
RA5: Applications. Graduates will have the ability to apply their knowledge and understanding to solve problems, conduct research, and design engineering devices or processes. These skills include knowledge, use and limitations of materials, computer models, process engineering, equipment, practical work, technical literature and information sources. They must be aware of all the implications of engineering practice: ethical, environmental, commercial and industrial.

OBJECTIVES

Knowledge and management of the basic concepts and techniques for digital and analog communication such as noise, modulation and demodulation processes in digital communications, the information theory as a tool to establish the limits in communication systems and the fundamental techniques for analog communications.

Therefore, the subject has the goal of allowing the student to acquire the following general skills:
- Knowledge and development of technical skills required in the telecommunications field with emphasis in the analysis and mathematical characterization of a communication system.

The same way than the following specific skills:
- Acquisition of the knowledge of mathematics and statistics that will be used as a tool to solve

engineering problems in the context of communication systems.
- The ability to design and conduct experiments, as well as to analyze and interpret data and results.
- Design of a communication system with the constraints given by its critical parameters such as cost, consume of power, bandwidth, transmission rate, and complexity.
- Ability of effective communication of information, in speech and in writing.

DESCRIPTION OF CONTENTS: PROGRAMME

Introduction
- Definition of a communication system
- Functional elements of a communication system
- Digital and analog communication systems
- Design of a communication systems
- Objectives and organization of the course

Noise in communication systems
- Review: probability, random variables, and random processes
- Random processes in the frequency domain
- Statistical model for thermal noise

Analog modulations
- Introduction to the modulation concept
- Amplitude modulations
- Angle modulations
- Effect of noise in analog modulations

Modulation and detection in gaussian channels
- Introduction to digital communication systems
- Geommetric representation of signals
- Digital communication model
    - Encoder
    - Modulator
    - Demodulator
    - Detector

Basic bounds in digital communications
- Probabilistic models for information sources
- Probabilistic models for channels
- Quantitative information measurements
- Channel capacity

LEARNING ACTIVITIES AND METHODOLOGY

Three teaching activities are proposed: Theoretical classes, exercise classes and laboratory exercises.

THEORETICAL CLASS AND EXAMPLES (3.5 ECTS)
The theoretical class will be given in the blackboard, with slides or by any other means to illustrate the concepts learnt. In these classes the explanation will be completed with examples. In these sessions the student will acquire the basic concepts of the course. It is important to highlight that these classes require the initiative and the personal and group involvement of the students (there will be concepts that the student himself should develop).

CLASS EXERCISES (1.5 ECTS)
Before the exercise class, the student will have available the exercise formulation. The student should solve the exercises proposed in order to assimilate the concepts obtained in the theoretical class in a more complex environment and to self-evaluate his knowledge.
In the exercise class one student will have to present the exercise proposed solving and the rest of students should give feedback on this particular problem solving. This will encourage the opinion exchange between students and the professor and among students

LABORATORY EXERCISES (1 ECTS)
Basic concepts learnt during the course are applied in the laboratory and by means of simulation. The

student should participate actively the exercise implementation; the level of the student involvement in this work grows from the first exercise to the last one where the student will be encouraged to propose and solve the problem.

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

Grade for continuous assessment will determine the 40% of the total grade (4 points).
This part of the grade is obtained along the academic year as follows:

1. At the end of the basic course chapters, students will have to solve one or several practical exercises.
2. Some of the exercises proposed in class will be solved by the students.
3. Laboratory exercises. These laboratory exercises are MANDATORY.

The detailed rules and weights for grading of each part for that topic will be given at the beginning of the course.

The final exam will determine 60% of the total course grade (6 points).
It is necessary to obtain a minimun grade of 4 of 10 points in the final exam.

BASIC BIBLIOGRAPHY

- Amos Lapidoth A Foundation in Digital Communication, Cambridge University Press, 2009

- J. G. Proakis, M. Salehi. Communication Systems Engineering, 2nd Edition, Prentice-Hall, 2002

- S. Haykin Communication Systems, 4th Edition, Wiley, 2001

ADDITIONAL BIBLIOGRAPHY

- A. Artés, F. Pérez, J. Cid, R. López, C. Mosquera, F. Pérez Comunicaciones Digitales, Pearson Educación, 2007

- Carlson, A.B. New York, , 1986. Communication Systems, McGraw-Hill, 1986

- J. Proakis Digital Communications, 3rd, McGraw-Hill, 1995

- T. M. Cover and J.A. Thomas Elements of Information Theory, Wiley, 2006