Digital Communications

Academic Year: (2019 / 2020) **Review date: 04-05-2020**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: LAZARO TEJA, MARCELINO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Systems (Second year, first semester)
Communication Theory (Second year, second semester)

OBJECTIVES

Knowledge and management of the different techniques of digital communications (linear and non-linear, multi-carrier and spread spectrum), the structure of receivers and the basic techniques for protection against errors in digital communications.

Therefore, the subject has the goal of allowing the student to acquire the following general competences:

- Knowledge and development of technical skills required in the telecommunications field with emphasis in the analysis and mathematical characterization of a digital communication system.

To achieve this goal, the student must acquire the following Program Outcomes (PO): a, b, c, e, g, k.

In particular, the following specific competences:

- Acquisition of the knowledge of mathematics and statistics that will be used as a tool to solve engineering problems in the context of digital communication systems. (PO a, PO e, and PO k)
- The ability to design and conduct experiments, as well as to analyze and interpret data and results. (PO b)
- Design of a communication system with realistic constraints given by critical parameters such as cost, consume of power, bandwidth, transmission rate, and complexity. (PO c)
- Ability of effective communication of information, in speech and in writing. (PO g)

DESCRIPTION OF CONTENTS: PROGRAMME

1.- Introduction
  1.1.- Introduction to digital communication systems
  1.2.- Digital communication model
  1.3.- Objectives and organization of the course

2.- Linear modulations
  2.1.- Baseband PAM modulations
  2.2.- Bandpass PAM modulations

3.- Detection under intersymbol interference
  3.1.- Problem statement
  3.2.- Memoryless symbol-by-symbol detector
  3.3.- Maximum likelihood sequence detector
  3.4.- Channel equalizers

4.- Non-linear modulations (phase and frequency modulations)
  3.1.- QPSK and OQPSK modulations
  3.2.- Differential phase modulations (DPSK)
  3.3.- Frequency modulations (CPFSK and MSK)
  3.4.- Continuous phase modulations (CPM)

4.- Multipulse modulations
4.1.- Spread spectrum modulations (DS-SS, FH-SS)
4.2.- Frequency division multiplex modulations (FDM, OFDM)

5.- Channel coding for error protection
5.1.- Introduction to channel coding and some definitions a la codificación y definiciones
5.2.- Linear block codes
5.3.- Convolutional codes

LEARNING ACTIVITIES AND METHODOLOGY

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

The ECTS credits include in all cases the personal work and group work to be carried out by the student.

THEORETICAL CLASS AND EXAMPLES (3 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 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 (2 ECTS)
Basic concepts learnt during the course are applied in the laboratory and by means of simulation. The student should participate actively on 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. In the laboratory, by means of communication trainers and generic communication instrumentation (waveform generators, channel emulators, oscilloscopes, and spectrum analyzers), and by means of computers, the basic simulation tools in communications are introduced.

ASSESSMENT SYSTEM

The final exam will determine 60% of the total course grade (6 points). (PO a, PO c, PO e, PO g, and PO k)
The rest of the grading 40% (4 points) is obtained along the academic year as follows:

1. At the end of some course chapters there will be a partial exam where one or several practical exercises have to be solved in class. (PO a, PO c, PO e, PO g, and PO k)
2. Some of the exercises proposed in class will be solved by the students. (PO a, PO c, PO e, PO g, and PO k)
3. Laboratory exercises. These laboratory exercises are MANDATORY. (PO b)

The detailed rules and weights for the grading of each part will be provided at the beginning of the course

It is necessary to obtain a minimun grade of 4 of 10 points in the final exam.

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

BASIC BIBLIOGRAPHY

- J. G. Proakis Digital Communications, cuarta edición, McGraw-Hill, 2001

- S. Benedetto y E. Biglieri Principles of Digital Transmission with Wireless Applications, Kluwer, 1999

ADDITIONAL BIBLIOGRAPHY

- B. Sklar Digital Communications : Fundamentals and Applications, Prentice Hall, 1988
- S. Haykin Digital Communications, Prentice Hall, 1988