30314 - Communication Theory

Información del Plan Docente

Academic Year	2018/19
Subject	30314 - Communication Theory
Faculty / School	110 - Escuela de Ingeniería y Arquitectura
Degree	438 - Bachelor's Degree in Telecomunications Technology and Services Engineering 330 - Complementos de formación Máster/Doctorado
ECTS	6.0
Year	---
Semester	Indeterminate
Subject Type	ENG/Complementos de Formación, Compulsory
Module	---

1.General information

1.1.Aims of the course

This course and its expected results are consequence of the following approach and goals:

The *raison d'être* of the course is to provide future telecommunications professionals with the most fundamental knowledge and methodologies to deal with communications systems. Because of fhe fundamental nature of the course, key general aspects and issues associated with communications are considered (distortion, statistical characterization of signals and noise, etc.) and a wide range of systems are addressed (baseband and passband including analog and digital techniques). Special attention is given to systems and techniques of present relevance.

1.2.Context and importance of this course in the degree

The course *Teoría de la comunicación* belongs to the subject **Señal y Comunicaciones** of the Módulo común Rama de Telecomunicación. The course is closely related to the courses included in the same subject and therefore, it receives basis from the course *Señales y sistemas* and provides foundation to the course *Comunicaciones digitales*.

Due to its multidisciplinary nature, in order to make academic progress in this course, it is desirable that students master some fundamental concepts taught previously in the courses *Probabilidad y procesos*, *Circuitos y sistemas*, *Matemáticas* and *Fundamentos de física*. In addition, due to its basic nature in the communications field, it provides basis to an important number of courses compulsory to all students as well as courses from the different specialization plans.

1.3.Recommendations to take this course

This course is taught by faculty from the area of Signal Theory and Communications.

Before taking this course, it is recommended that students have made academic progress in the following first year courses of the curriculum: *Signals and systems*, *Probability and processes*, *Circuits and systems*, *Mathematics* and *Fundamental physics*.

30314 - Communication Theory

2.Learning goals

2.1.Competences

This course makes students more skilled at...

C4: Problem solving and decision making with initative, creativity and critical reasoning.

C6: Using Engineering techniques, abilities and tools required for its practice.

C9: Acquiring abilities related to information management, as well as mastering and appying technical and legal specifications required for Engineering practice.

C10: Continuous learning and development of autonomous learning strategies.

C11: Applying of information and communications technologies in Engineering.

CRT1: Autonomous acquisition of new knowledge and techniques for conceiving, development or exploitation of systems and services of telecommunications.

CRT2: Using communication and computer applications (office software, databases, advanced calculation, project management, plotting, etc.) in order to support the development and exploitation of networks, services and applications of telecommunications and electronics.

CRT4: Analyzing and stating of the key parameters of communications systems.

CRT5: Evaluating the benefits and drawbacks of different alternative technologies for the deployment and implementations of communications systems taking into account the concept of signal space, the effect of noise and other impairments as well as the use of analog and digital modualtion techniques.

2.2.Learning goals

When completing this course, students will have acquired the following knowledge...

R1: Understanding of the concept of random signal, how it can be represented and characterized, its properties and how it is transformed through linear systems.

R2: Knowledge of the concepts of noise, interference and distorsion, as well as the key elements of communications systems. Capability of analysis and specification of the fundamental parameters in communications systems.

R3: Knowledge of the basic concepts of baseband digital communications, commanding and applying the concept of matched filter and understanding the properties of transmission through bandwidth-limited channels. Concept of intersymbol interference.

R4: Knowledge of the Hilbert Transform together with its basic properties and command of the concepts of analytical signal, envelope and instantaneous frequency.

R5: Ability to properly apply the mathematical tools to represent passband signals, systems and random processes. Knowledge of the concepts of complex envelope, phase and quadrature components.

R6: Understanding of the modulation process and the motivation for its introduction. Knowledge of different analog and digital modulation formats and ability to analyze their performance.

2.3.Importance of learning goals

This is the first course of the degree focused on the key concepts of it: communications systems. As a consequence, the learning outcomes of the course are fundamental in the following areas:

1. In the academic area for the progress in the degree.

2. In the area of personal development.

3. In the area of professional practice.

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

The achievement of the learning goals of the course will be assessed according to the following evaluation activities

E1: Written exams (60%):

60% of the final grade will correspond to the weighted arithmetic mean of the grades obtained in three written tests to be taken during the course. Students must obtain a minimum grade of 5 out of 10 in this part in order to pass the course.

- **First midterm exam (20%):** written exam of 1 hour of duration to be taken in November. Grade from 0 to 10 (out of 10).
- **Second midterm exam (20%):** written exam of 1 hour of duration to be taken in January. Grade from 0 to 10 (out of 10).
- **Final Exam (20%):** written exam of 1 hour of duration to be taken during the official exam period. Grade from 0 to 10 (out of 10).

Students that have reached the minimum grade of 5 in any of the midterms will have the chance of discarding that grade in order to improve it by repeating the exam the same day of the final.

In any case, the grade for each part of the course will be that obtained the last time the student took the associated exam.

On the other hand, students that have not reached the minimum grade of 5 in any of the midterms must take the corresponding exam the same day of the final.

In order to average the grades corresponding to this evaluation activity (40% midterms + 20% final), students must have a minimum grade of 4 out of 10 both in the first ones and in the final exam.

Passing the exam proves that students have achieve learning outcomes R1, R2, R3, R4, R5 and R6, so that the grade denotes the depth of those learning outcomes.

The teaching staff will assess students' ability to understand the concepts of random signal, noise, interference and distortion, as well as their ways representation and characterization through measurements such as signal to noise ratio; their properties and the way they are transformed through linear systems. In addition, the knowledge acquired by students about basic elements of communications systems will be evaluated, as well as the students' capacity to analyze these systems stressing the ability to specify their fundamental parameters. Knowledge of the basic concepts of baseband digital communications will be assessed, as well as mastering and application of the concepts of matched filters and intersymbol interference in band-limited channels. Also, understanding of the concept and motivation of introducing modulation techniques will be evaluated, as well as some mathematical tools as the Hilbert Transform, analytical signal, complex envelope and instantaneous frequency.

E2: Guided assignments/projects (20%)

20% of the final grade will be obtained from the assessment (from 0 to 10, out of 10) of the deliverables and meetings associated with guided assignments to be completed during the course. Students must obtain a minimum grade of 5 out of 10 in this part in order to weight this grade with the rest and pass the course.

The grade denotes the level of acquisition of learning outcomes R2, R3, R5 and R6.

The teaching staff will value the analytical and critical capacity of students for medium-size problem solving using the required theoretical and software tools, their response to the questions and issues set out and the presentation and interpretation of the obtained results. Students' initiative to address novel solutions will be very positively valued.

E3: Laboratory sessions (20%)

20% of the final grade will come from the grades (from 0 to 10, out of 10) assigned to the laboratory sessions. Students must obtain a minimum grade of 5 out of 10 in this part in order to weight this grade with the rest and pass the course.

Assessment of laboratory sessions will be performed by evaluation of the required documentation (pre-lab and post-lab reports) and of the performance and attitude observed during the sessions.

The grade obtained in this part denotes the level of acquisition of learning outcomes R2, R3, R5 and R6.

In the laboratory sessions, the teaching staff will evaluate the capacity of students to apply the acquired knowledge to a practical problem closely related to the theoretical concepts of the course, the skills of students to use software calculus and simulation tools, answer lecturer's questions and communicate and transmit their knowledge and abilities.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The teaching methodologies that will be applied in order to achieve the proposed learning outcomes are as follows:

- **M1: Participative lecture**

Presentation and explanation by the lecturer of the main contents of the course.

- **M8: Problem solving**

Proposal and solving of problems related to the theoretical contents of the course.

- **M4: Guided assignments/projects**

Team problem solving of real-world cases associated with different parts of the course contents.

- **M11: Supervision of guided assignments/projects**

During the fulfillment of the guided assignments, the different student groups will have periodic meetings with the lecturer for supervision purposes, including the evaluation of the progress of the project and clearing up of doubts and questions.

- **M9 and M15: Laboratory sessions**

It consists in onsite laboratory classes (M9) and some pre-lab and post-lab work that help to better understand the concepts of the course (M15).

4.2.Learning tasks

The learning process devised for this course is based on the following set of learning activities:

- **M1: Participative lecture (40 hours)**

Presentation and explanation by the lecturer of the main contents of the course. This is an onsite activity that takes place in the classroom. In this part of the learning process students are provided with the theorical concepts in order to achieve all the learning outcomes of the course as well as all specific competences except for CRT1 and CRT2.

- **M8: Problem solving (10 hours)**

Proposal and solving of problems related to the theoretical contents of the course. Sometimes the problems will be proposed previously, so that some previous work will be required (M13). This activity is designed to gradually progress towards all the course learning outcomes and competences.

- **M4: Guided assignments/projects (14 hours)**

As the course progresses, the lecturer will propose real-world problems to be solved by teams of students. Results will be assessed in the form and date established by the teaching staff. This activity is designed to consolidate all the course learning outcomes and specific competences; the development of this activity and the associated results form one of the evaluation activities (E2).

- **M11: Supervision of guided assignments/projects (1 hour)**

During the fulfillment of the guided assignments, the different student groups will have periodic meetings with the lecturer for supervision purposes, including the evaluation of the progress of the project and clearing up of doubts and questions. The learning outcomes and competences acquired by student through this activity are the same as those of activity M4.

- **M9 (10 hours) and M15: Laboratory sessions**

It consists of 10 hours of onsite laboratory classes (M9) allocated in 5 sessions with 2 hours of duration. Academic progress in lab sessions also requires some pre-lab and post-lab work that help to better understand the concepts of the course (M15). Through theses activities all the course learning outcomes and competences become established and strengthen. Laboratory assignments for each session will specify the results to be obtained and the way students must show the level of acquisition of the corresponding learning outcomes and competences; in fact, assessment of labs forms one of the evaluation activities of the course (E3).

4.3.Syllabus

The contents of the course are as follows

1. INTRODUCTION

2. RANDOM SIGNALS AND NOISE

2.1. Stochastic processes

2.2. Random signals

2.3. Noise

3. ELEMENTS OF COMMUNICATION SYSTEMS

3.1. The channel: transmission impairments

- Distortionless transmission

- Linear and non-linear distortion

- Transmission loss

- Noise and crosstalk

3.2. Fundamentals of digital communications

- Line coding

- Signal detection with noise

- Signal space

- Intersymbol interference

4. REPRESENTATION OF BANDPASS SIGNALS

4.1. Analysis tools

- Analytical signal, envelope and instantaneous frequency

- Hilbert Transform

4.2. Bandpass signals, systems and random processes

- Complex envelope. In-phase and quadrature components: phasor representation

- Equivalent lowpass filter. Phase and group delay.

5. BANDPASS COMMUNICATION SYSTEMS

5.1. Analog modulation

- Linear modulation techniques

- Angular modulation techniques

5.2. Digital modulation

- Coherent binary modulation techniques

- Non-coherent detection of binary-modulated signals

- Coherent M-ary modulation techniques

- Non-coherent detection of M-ary-modulated signals

- Spectral efficiency of digital modulations

4.4.Course planning and calendar

30314 - Communication Theory

The course calendar, that specifies classroom teaching as well as laboratory sessions, will be determined by the school calendar established for the present year.

The course is taught during the first semester of the second year of the degree. Some of the teaching activities planned include theoretical lectures, problem description and solving approaches, laboratory sessions and development of guided assignments/projects.

The start and end dates of the theoretical, problems, as well as lab classes will be determined by the EINA. Delivery dates and monitoring of guided assignments will be announced timely in class and on the website of the course: https://moodle2.unizar.es/add/

4.5.Bibliography and recommended resources

- 1. Carlson, A. Bruce. Communication systems : an introduction to signals and noise in electrical communication / A. Bruce Carlson, Paul B. Crilly, Janet C. Rutledge . - 4th. ed., International ed. Boston [etc.] : McGraw-Hill, cop. 2002
- 2. Sklar, Bernard. Digital communications : fundamentals and applications / Bernard Sklar . - 2nd ed., repr. with corr. Upper Saddle River, New Jersey : Prentice-Hall PTR, 200
- 3. Proakis, John G.. Digital Communications / John G. Proakis . - 4th ed., International ed. Boston [etc.] : McGraw-Hill, 2001
- 4. Proakis, John G.. Communication systems engineering / John G. Proakis, Masoud Salehi Englewood Cliffs, New Jersey : Prentice Hall, cop. 1994