Communication channels and systems

Academic Year: (2019 / 2020) **Review date: 19/03/2019 11:15:19**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: BOUSOÑO CALZON, CARLOS

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Systems, Communication Theory, Electromagnetic Fields

OBJECTIVES

The objectives of the course are
1) To address several key issues such as noise, bandwidth limitation, interference; and to investigate their effects on the performance of communication systems, through error probability analysis.
2) To analyze the different types of transmission media and their impairments.
3) To explore fundamental limits of communication systems, such as channel capacity.
4) To plan and analyze simple communication systems in terms of coverage and capacity.

To achieve these goals, the student must acquire the following ABET program outcomes:
a, c, d, e, g, i, k.
Related to the following competences:
1.- General competences
- Analysis and synthesis (PO: a)
- Problem solving (PO: a, e, k)
- Ability to apply theoretical concepts (PO: a, b, e, k)
- Ability to integrate knowledge (PO: a, c, d, k)
2.- Specific competences
2.1.- cognitive (PO: a, c, e, k)
- Transmission concepts
- Channel characterization and modelling.
- Quality measurement in communication channels
- Limits in Performance of physical channels.
- Design and planning of communication systmes
2.2.- Instrumental (PO: c, e, k)
- Programming with channel simulation software (Matlab)
- Using lab. equipment to understand the behaviour of communication systems and channels.
2.3 Attitude (PO: d, g, i, k)
- Individual and team work
- Decision making
- Abstraction ability.
- Oral presentation

DESCRIPTION OF CONTENTS: PROGRAMME

UNIT 1. Link Budget:
- Power and Attenuation
  Logarithmic Units: dB, dBW, dBm.
- Noise and other impairments.
- Probability of error: an introduction to communication quality.

UNIT 2. Propagation models
- Large scale and Log-normal models

- Small-scale radio propagation models: multipath.

UNIT 3. Signal models
- Multipath models
    - Power profile
    - Coherence bandwidth

- Doppler Effect.
    - Frequency shift
    - Coherence Time
- Channel Classification
- Statistical behavior of fading
    - Rayleigh and Rice models
    - Signal-to-Noise ratio: exponential

UNIT 4. Discrete Channel Models.
- Memoryless models: Binary Symmetric Channel (BSC)
- Channels with memory.
    - Markov models
    - Example of parameter estimation in the Gilbert's Model.

- Computation of the Bit Error Probability
    - Matrix Probabilities
    - Error patterns
    - Applications to system design.

LEARNING ACTIVITIES AND METHODOLOGY

The course consists of the following elements: lectures, exercises, project, and laboratories:
LECTURES (2 ECTS) (PO: a, i, k)
The lectures provide the students with explanation of the core material in the course.
Numerous examples of communication channels, their properties and behavior will be given using audiovisual support (slides, video, ...).
EXERCISES (2 ECTS) (PO: a, c, e, k)
In these sessions, students will be encouraged to organize themselves forming small groups that will have to solve some basic problems given in advance.
TUTORIALS (1 ECTS) (PO: a)
Lecture courses will be supported by tutorials given by the lecturer twice a month.
Tutorials are less formal than lectures and provide an excellent opportunity for students to discuss key topics, ideas and concepts.
The size of the tutorial group is limited to a maximum of 8/10 people; this allows students to actively participate in the discussion. This is valuable to students who want clarification, extra help or to ask questions that are not addressed in lectures. Attendance to tutorials is not mandatory but strongly recommended.
LABORATORIES (1 ECTS) (PO: a, c, d, e, g, k)
The laboratories provide the students with hands-on experience to understand the fundamentals of channel modelling and computer simulation. Students will also learn how to use some lab. equipment as signal generators and spectrum analyzers.

ASSESSMENT SYSTEM

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

Assessment includes:
- Homework and Quizzes (10 %)
- First and Second Exam (40 %)
- Final exam (50 %)
- The final examination is a standard closed-book three hours written examination. The examination will test knowledge and understanding of all major aspects covered in the course.

BASIC BIBLIOGRAPHY

- Bernard Sklar Digital Communications: Fundamentals and Applications, Prentice Hall.

- John C. Bellamy Digital Telephony, Wiley-Interscience; 3 edition (2000).

ADDITIONAL BIBLIOGRAPHY

- Carlos Bousoño, Francisco J. González Notas de la Asignatura, http://www.tsc.uc3m.es/docencia/SyCT.

- S. Benedetto and E. Biglieri Principles of Digital Transmission with wireless applications, Kluwer Academic, 1999

- William Turin Digital Transmission Systems: Performance Analysis and Modeling, Mcgraw-Hill (Tx); 2 Sub edition (November 3, 1998).