Advanced Communications

Academic Year: (2019 / 2020) **Review date: 26/04/2019 15:32:30**

Department assigned to the subject:

Coordinating teacher: MARTÍNEZ OLMOS, PABLO

Type: Electives ECTS Credits : 6.0

Year : 1 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

In this course the students should use basic notions of:
- Communication Theory,
- Digital Communications
- Linear Algebra and
- Statistics.

OBJECTIVES

Generic skills to be acquired are listed below. When matching some of the program outcomes of the Bachelor Degree, this is indicated within brackets.
1. Ability to analyze and synthesize.
2. Ability to apply knowledge of mathematics, statistics, science, telecommunication technologies and engineering.
3. Ability to identify, formulate and solve engineering problems.
4. Ability to effectively communicate information in speech, presentation and in writing.
5. Ability for team work.

Specific technical skills:

1. Ability to understand the limitations of classic channel coding techniques.
2. Ability to implement iterative algorithms for approximate inference. Application to LDPC channel decoding problem.
3. Ability to analyze the characteristics of wireless channels and understand the consequences in the design of digital communications systems over such channels.
4. Ability to synthesize when reading and analyzing scientific papers on wireless communications.
5. Ability to apply concepts of signal processing and linear algebra to analyze and design MIMO systems.

DESCRIPTION OF CONTENTS: PROGRAMME

This course consists in advanced digital communications with a focus on the encoding and decoding techniques that allow us to approach the limits set by the information theory, and the analysis of these limits in the case of wireless communications, relating the physical characteristics of the channels and setting the receptors with the achievable transmission rate. The course will address at least the following content:

Finite-length information theory

Inference in Graphical Models
-Sum Product Algorithm. Bethe approximations.
-Variational Inference
-Expectation Propagation
-Monte Carlo Methods

Advanced coding techniques: LDPC codes.
-Iterative decoding algorithms: Graphs and trees.
-Message passing algorithms: Belief Propagation.
-LDPC decoding.

Synchronization Techniques and Channel Estimation

LEARNING ACTIVITIES AND METHODOLOGY

Three types of activities are used: lectures, seminars and practical projects. The assessment of these activities is complemented with two short written exams. Details on the evaluation and grading are given in next section.

LECTURES

Lectures are used to expose the major theoretical concepts, combined with exercises consisting of the design of illustrative algorithms. The instructor uses the blackboard (for mathematics) combined with specific audio-visual presentations for specific topics.

SEMINARS

The student will participate by solving different problems. In this way, the student can assimilate the concepts addressed in the lectures and self-assess his/her progress. The list of problems to be studied in each seminar will be available before hand.

We consider two types of problems:

There will be two types of problems to be studied in these sessions.
· "Closed problems": They are the classical problems and exercises with a clearly defined solution that the solutions should work out individually.
· "Open problems": They admit several solutions. They require that the students identify, formulate and propose solutions for several interacting subproblems. The students will tackle these problems working in teams. The teacher will collect some of these open problems for evaluation.

LABORATORY PROJECTS

Three projects are conducted during the course, related to the contents of LDPC coding and simulation of a simple MIMO channel.

Both projects are done in teams of two or three students. Include the design, simulation and measurement (using numerical software) of some of the algorithms in the lectures and problems. Each team delivers simulation code and a brief written report and make a brief presentation of the projects to the teacher and other students.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

The final grade for the course will consist of a weighted sum of the grades obtained by students in the practical proyects

BASIC BIBLIOGRAPHY

- Andrea Goldsmith Wireless Communications, Cambridge University Press, 2005

- David Tse, Pramod Viswanath Fundamentals of Wireless Communication, Cambridge University Press, 2005

- Todd K. Moon Error Correction Coding: Mathematical Methods and Algorithms, Wiley-Interscience, 2005

- Tom Richardson, Ruediger Urbanke Modern Coding Theory, Cambridge University Press, 2008