Electromagnetic Fields

Academic Year: (2023 / 2024) **Review date: 28-04-2023**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: AMOR MARTIN, ADRIAN

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I and Calculus II
Linear algebra
Physics.

OBJECTIVES

Through this course, the student will learn basic knowledge about the fundamentals of the mechanism of radiation and propagation of electromagnetic waves both in free space as well as in a guided medium. Besides, the most common procedures used in practice to apply the electromagnetic model will be introduced. To achieve this goal, the student will obtain a knowledge base and a set of skills.
In terms of knowledge, after this course the student will learn:

- To understand the basis of the propagation of electromagnetic waves and to know the parameters that describe this propagation.
- To know the global electromagnetic model including Maxwell equations and boundary conditions.
- To understand the main role of the medium supporting electromagnetic propagation. The student will learn how to characterize electromagnetically the different media.
- To know that the plane waves are a good approximation for many realistic situations, the characteristics of these plane waves, and how they propagate when there are discontinuities. Special attention will be paid to polarization.
- To know the fundamentals of electromagnetic wave propagation by physical support using waveguides, including transmission lines. In addition, the student will learn how to characterize and analyze these devices.
- To learn the fundamentals that determine the controlled radiation of the electromagnetic waves. This includes concepts related to antennas and the parameters that characterize them.
- To understand the role of the different elements in a radio-link to allow the radio-link evaluation.

In terms of the skills, we can classify them into specific skills and generic skills.

The specific skills include:

- To understand the meaning of the different parameters which characterize the propagation of electromagnetic waves in a homogeneous medium or by physical support.
- To interpret the polarization of a plane wave.
- To classify the media by their electromagnetic characteristics.
- To analyze what happens when a traveling electromagnetic wave propagating in a homogeneous medium finds a different medium. To correctly interpret the associated phenomena of reflection and transmission, including the particular case of good conductors.
- To analyze the characteristics of wave propagation in a waveguide, being able to calculate the waveguide cutoff frequency, attenuation, etc. Similarly, the student will be able of designing waveguides fulfilling required work specifications. This concerns both rectangular waveguides and transmission lines.
- To understand the meaning of the parameters used to characterize an antenna. To be able of selecting according to these parameters (directivity, polarization, radiation pattern) the best antenna for a particular type of radio communication.
- To evaluate radio links knowing the participating elements: transmitting and receiving antenna, distance, and so on.

DESCRIPTION OF CONTENTS: PROGRAMME

This is a basic course of applied electromagnetism whose purpose is to establish and analyze the basic concepts that constitute the core of the descriptive model of electromagnetic radiation and propagation, both in free space and in a guided medium. Besides, the most usual concepts in practice to the application of the electromagnetic model will be introduced in the course.

The program is divided into four parts:

1. The electromagnetic model
2. Propagation in homogeneous medium: plane waves
3. Guided propagation
4. Radiation

LEARNING ACTIVITIES AND METHODOLOGY

The following activities will be combined as described in the detailed program of the course:

1- Theory lectures on the blackboard and with slides. Resolution of small exercises
2- Problems
3- Labs

ASSESSMENT SYSTEM

Global exam with 40% of the final grade, whereas the continuous assessment is 36% for two exams and 24% for the laboratory.

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

BASIC BIBLIOGRAPHY

- C.A. Balanis Advanced Engineering Electromagnetics, Wiley, 2012.
- D. Fleisch A Student's Guide to Maxwell's Equations, Cambridge University Press, 2008
- D.K. Chen Fundamentos de Electromagnetismo para Ingeniería, Addison Wesley.
- Luis E. García-Castillo Electromagnetic Model: Maxwell's Equations, xxxx, 2013
- S. Ramo, J.R. Whinnery, T. Van Duzer Fields and Waves in Communication Electronics, John Wiley and Sons.