30310 - Electromagnetism and Waves

Syllabus Information

Academic Year: 2020/21
Subject: 30310 - Electromagnetism and Waves
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 438 - Bachelor's Degree in Telecomunications Technology and Services Engineering
581 - Bachelor's Degree in Telecomunications Technology and Services Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Basic Education
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

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

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The teaching/learning process is structured as follows:

1- Classroom lectures, in which the theoretical foundations of the subject are presented and where the student participation is encouraged. Multimedia and other bibliographic material can be accessed previously by the students on the official University digital repository.

2- Problem solving sessions, where the students show in the blackboard to their fellow colleagues how they have worked out exercises proposed by the teacher, individually or in small groups.

3- Laboratory sessions, with two separated relevant work packages. First, on the laboratory facilities, the students, organized in couples, will perform sets of experiments with test and measurement equipment and/or computer simulation software. Afterwards, they will produce a written report on a standardized format where they should present their data sets, analyze the results, compare them with theoretical models and draw the pertinent conclusions. A due date for each report will be fixed.

4- Small project work. The students will be organized in groups of four. Each group will have a proposed problem to work in. They should seek information to write a short paper with the relevant theoretical background needed to solve a specific problem. These very same theoretical foundations will be the basis to understand and explain the experimental results of a specific test that themselves will accomplish in the laboratory. A report with the data and its interpretation has to be produced, too.

5- Individualized tutoring by appointment in given dates

6- Assessment and evaluation exams

7- Student homework

4.2.Learning tasks

The program offered to the students to accomplish the desired learning objectives is organized in the following activities:

- Classroom lectures (active student participation is encouraged) (40 hours). Designed to gradually advance in the learning outcomes R1-R2-R3-R4 and R8

- Problem-solving sessions (10 hours). Designed to gradually advance in the learning outcomes R1-R2-R3-R4-R5-R6 and R8. To take place in the classroom

- Laboratory sessions (10 hours) Five mandatory sessions of two hours each in which the students will work in couples. To take place on the teaching laboratories of the Department of Electronic Engineering and Communications (Ada Byron building), oriented towards learning result R7.

- Small Project work in a group (14 hours). This mandatory activity is oriented to advance in all the proposed learning outcomes. Part of it will take place on the teaching laboratories of the Department of Electronic Engineering and Communications (Ada Byron building)

In addition to these programmed tasks, the student's homework should be devoted first to theory understanding and problem-solving and second to the production and writing of laboratory and project reports.

4.3.Syllabus

ELECTROMAGNETISM

T0: Introduction.

The electromagnetic model. Charge and current distributions. SI units and universal constants.

1 Electrostatics

Fundamental postulates of electrostatics in free space. Derivation of the classical experimental laws. Method of images.

The electric dipole. Dielectric materials. Polarization. Equivalent charge distributions.

Displacement vector. Permittivity. Modified postulates.

Boundary conditions for electrostatic fields. Electrostatic energy in dielectrics.

2 Steady electric current.

Conductors. Conductivity. Equation of continuity.

Boundary conditions for current density. Power dissipation and Joule's law.

3 Magnetostatics

Fundamental postulates of magnetostatics in free space. Vector magnetic potential. Derivation of the classical experimental laws.

The magnetic dipole. Magnetic materials. Magnetization. Equivalent current distributions.

Magnetic field intensity. Permeability. Modified postulates. Boundary conditions for magnetostatic fields.

4 Electromagnetic fields

Time-varying fields. Faraday-Lenz law. The magnetic energy in terms of field quantities. Displacement of current density.

Maxwell laws in differential and integral forms. Boundary conditions for electromagnetic fields.

Electromagnetic potentials. Wave equations for the potentials.

WAVES

5 Wave fundamentals.

One dimensional wave equation. Harmonic solutions.

Characteristic parameters of harmonic waves.

Waves in 3D. Doppler effect.

Wave superposition. Standing waves.

6 Electromagnetic waves in unbounded media

Retarded potentials. Time harmonic fields. The electromagnetic spectrum.

Plane waves in lossless media. Transverse electromagnetic waves.

Polarization of plane waves: linear, circular, elliptic.

Plane waves in lossy media: dielectrics and conductors. Characteristic impedance and propagation constant.

Phase and group velocity. Dispersion

The intensity of electromagnetic waves. Poynting vector and theorem.

7 Reflection and refraction of plane electromagnetic waves.

Normal incidence at a plane boundary. Reflection and refraction coefficients. Standing wave ratio.

Normal incidence at a plane conducting boundary.

Oblique incidence at a boundary plane. Snell's laws. Total reflection. Reflection and refraction coefficients for parallel and perpendicular polarized waves. Brewster's angle.

8 Waves on elastic media.

Transverse waves on a string. Phase velocity and intrinsic impedance. Standing waves.

Sound waves on air. Phase velocity and intrinsic impedance.

The acoustic intensity and sound pressure level. Decibels.

Standing waves in open and closed pipes.

LABORATORY SESSIONS

Five sessions, two hours each.

1- Experimental determination of the dielectric permittivity of common insulators.

2- Finite differences numerical solution of the Laplace equation.

3- Experimental verification of the Faraday-Lenz law. Electromagnetic shielding in hollow conductors.

4- Computer simulation of plane wave propagation in different media.

5- Ultrasound propagation in air.

SMALL PROJECT WORK IN GROUP

Fresnel laws. Theory and experimental verification.

A single laboratory session will be devoted to obtain experimental evidence.

4.4.Course planning and calendar

The course belongs to the first semester of the second year of the degree.

Classroom lectures, problem-solving and laboratory sessions will adopt the published official EINA calendar and schedule, both available online before the start of the course.

The due date for the reports of the first four laboratory sessions is the next session date. For the fifth session the due date will be the final examination date. The due date for the project work will be announced along the course with an adequate margin.

4.5.Bibliography and recommended resources

http://biblos.unizar.es/br/br_citas.php?codigo=30310&year=2019