Program	09TT- Engineering in Telecommunication Technologies and Services

Course number and name	
Number	95000013
Name	Electromagnetics Electromagnetismo
Semester	Y2 - S3

Credits and contact hours	
ECTS Credits	4.5
Contact hours	45

Coordinator's name	Miguel Calvo Ramón

Specific course information
Description of course content
The course content is oriented to provide the tools and procedures to solve electromagnetic problems at macroscopic level from the Maxwell equations framework.
List of topics to be covered
1. Introduction: Review of vector algebra: Coordinate Systems, Gradient, divergence and curl. Theorems of Gauss and Stokes. The Nabla operator. 2. Electromagnetic General Equations.- Charge density. Current density. Continuity equation. Maxwell Equations. Characterization of materials. Ohm's law. Relaxation constant. Definition of the fields E and B. Energy. Boundary conditions. 3. Electrostactics: Equations of electrostatics. Gauss' law. Charge density distributions with spherical, cylindrical or planar symmetry. Defining potential. Poisson and Laplace equations. Boundary conditions for the potential uniqueness. Integration of Poisson's equation for a point charge. Potential of a point charge. Potential overlap and expression of infinitesimal contributions. Field E and the potential of a spherical charge distribution using the method of Gauss, integration of Poisson's equation and infinitesimal contributions. Potential on the axis of a uniform disk load. Exercise of calculating the potential of a line of uniform load. Potential of bidimensional distributions. Potential average theorem; Potential and field of Multipolar distributions; Dipole, multipole expansion of the potential. Method of images. Electrostatic conductors systems. Capacity coefficients; Reciprocity theorem. Capacity and shielding. Capacitor. Electrostatic energy. Energy of an electrostatic conductors system. Energy of formation and interaction. 4 Stationary currents (Stationary field equations; Properties of stationary currents; Generators; Electromotive force; Perfect driver; Boundary conditions at interfaces; Resistance; Examples; Duality R / C; Exercises. 5. Stationary Magnetic Equations of magnetostatics; Definition of the magnetic vector potential; Magnetic vector potential solution; Biott and Savart law; Exercises. Field of a

circular coil; Cylindrical solenoid of finite length. Ampere's law: Application to the indefinite line current, the current wire and coaxial cable; Application to indefinite solenoid and to the current sheet. Vector potential in far field points; Magnetic moment; Magnetic field at distant points; Magnetic moment of flat current loops. Magnetostatic field energy; Line current systems and induction coefficients; Induction coefficients of a cylindrical wire; Internal and external inductance of a current distribution; Magnetic forces. 6. Electrodynamics and slow time variations: Equations of electrodynamics; Electro-dynamic potential; Potential of a point current; Forward and backward waves; Delay; Slow time variation; Faraday's law; Kirchoff laws.
Prerequisites or co-requisites
Physics; Vector Analysis
Course category in the program

X **R (required)**	**__ E (elective)**	**__ SE (selective elective)**

Specific goals for the course
Specific outcomes of instruction
RA1: Understanding and mastery of the basic concepts involved in the laws of electromagnetism and its application for solving engineering problems. RA2: Ability to scientifically reasoning and problem solving from the basic laws of electromagnetism. RA3: Acquisition of qualitative and quantitative knowledge of basic electromagnetic concepts, essential to start learning the electromagnetic phenomena of greater complexity. RA4: Understanding of natural phenomena that are the basic knowledge needed for actual technologies.
Student outcomes addressed by the course
CG-1, CG-2, CG-4, CG-5, CEB-3

Bibliography and supplemental materials
- M.Calvo, J.L.Fernández Jambrina, L.de Haro, F. Las Heras. “Apuntes de Electricidad y Magnetismo”. ETSIT-UPM 1996. - Carl T.A. Johnk. “Ingeniería electromagnética. Campos y Ondas”. Limusa, 1992 - P. Lorrain, D. Corson. “Campos y Ondas Electromagnéticas”. Selecc. Científicas, 1972. - S. Ramo, J.R. Whinnery, T. Van Duzer. “Field and Waves in Communication Electronics”. Wiley, - W.H. Hayt “Engineering Electromagnetics”. McGraw-Hill, 1989.

Teaching methodology			
X **lectures**	X **problem solving sessions**	**__ collaborative actions**	**__ laboratory sessions**
Other:			