Program	09TT- Engineering in Telecommunication Technologies and Services

Course number and name	
Number	95000022
Name	Fields and Waves in Telecommunications Campos y Ondas en Telecomunicación
Semester	Y2-S4

Credits and contact hours	
ECTS Credits	4.5
Contact hours	45

Coordinator's name	Lambea Olgado, Manuel Mª

Specific course information		
Description of course content		
Basic concepts of electrodynamics applied to the transmission of energy and information. The plane waves, as solution of the Maxwell equations: Polarization, dispersion, attenuation, propagation velocity, reflection coefficient, impedance, etc. The basic characteristics of the electromagnetic field in conductors. The general characteristics of the communication over a physical media, and particularly, the transverse electromagnetic mode (TEM) and the transmission line.		
List of topics to be covered		
1. Introduction to electrodynamics. Electromagnetic energy transfer. 2. Homogeneous plane waves. Polarization. 3. Normal incidence of plane waves. 4 Fields in conductors. Skin effect. 5 Communication over physical media. Transmission Lines.		
Prerequisites or co-requisites		
Recommended previous courses: Vector Analysis (95000007). Electromagnetism (95000013).Other advisable student background includes: Linear systems and their related functions and transforms. Basic modulation concepts. Basic electric circuits concepts.		
Course category in the program		
_X_ R (required)	**__ E (elective)**	**__ SE (selective elective)**

Specific goals for the course
Specific outcomes of instruction
RA1: Quantitative and qualitative knowledge of the basic mechanisms of the electromagnetic waves propagation and its iteration with obstacles, in free space and in the simplest guided systems. RA2: The matter apprenticeship gives the student the required knowledge to understand the propagation and transmission mechanisms of the electromagnetic and acoustic

waves, and the corresponding transmitters and receptors devices. RA3: Understand the concepts associated with reflection and transmission (reflection and transmission coefficients, wave impedance and standing wave diagram). Understand the energy transmission phenomenon. RA4: Know the mathematical description of media in the macroscopic model. Know and handle the expressions of the electromagnetic energy and its transfer: transmission and losses. RA5: Know the properties and energy transfer characteristics of the homogeneous plane wave. Understand the wave polarization and its relevance in telecommunications. Understand the different physical phenomena associated with the different propagation velocities and its consequences in signal transmission: distortion and delay. RA6: Handle the aforementioned concepts in the resolution of problems with stratified media. Grasp the concept of impedance matching. RA7: Understand the concept of total reflection in normal incidence over a perfect conductor. Understand the differences with the case of a real conductor. Grasp the Leontovich approach and the concept of surface impedance in a real conductor, along with the impedance per square. Understand the generalization for other conductor geometries and its use. RA8: Know what a transmission line, is and understand the concept of TEM mode. Understand the concepts of voltage and current waves as derived from the electromagnetic field. Handle the transmission line and its description through different parameters. Know the short-line equivalent circuit and its limitations. Be able to estimate losses level due to conductors.
Student outcomes addressed by the course
CECT4, CECT5, CECT8, CG2, CG4, CG5, CG9, CG12

Bibliography and supplemental materials
· V.V. Nikolski, "Electrodinámica y propagación de ondas de radio", Ed. URSS, 1973. · S. Ramo, J.R. Whinnery, T. Van Duzer, "Fields and waves in communication electronics", John Wiley & Sons , Third Edition, 1994. · C.T.A. Johnk, "Teoría Electromagnética", Limusa, 1981. · J.D. Kraus, "Electromagnetismo", McGraw-Hill, 1986 · C.R. Paul, "Transmission Lines in Digital and Analog Electronic Systems: Signal Integrity and Crosstalk", John Wiley and Sons, Inc., 2010. · C.W. Davidson, “Transmission lines for communications”, MacMillan, 1989. · David K. Cheng, “Fundamentos de electromagnetismo para ingeniería”, Addison-Wesley Iberoamericana, 1997. · L.Solymar, "Lectures on electromagnetic theory", Oxford University Press, 1984. · H.A. Haus, J.R. Melcher, "Electromagnetic fields and energy", Prentice-Hall, 1989. · Grupo de Electromagnetismo y Teoría de Circuitos. "Ecuaciones y relaciones energéticas de la electrodinámica", "Ondas Planas", "Ondas Guiadas", "Problemas de Campos y Ondas en Telecomunicación", Electronic PDF books at students' disposal http://oa.upm.es/. · Moodle server at http://wad.etc.upm.es

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