PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
ABET COURSE SYLLABI

IEE2113 ELECTROMAGNETIC THEORY

Credits and contact hours: 10 UC credits/10 hours (3 Lecture hours per week ; 1.5 problem session hours per week and 5.5 hours of Independent learning experience per week).

Instructor's name: Marcelo Guarini

Course coordinator's name To be defined

Textbook: Matthew N. O. Sadiku, Elementos de Electromagnetismo, Oxford University Press, tercera edicion, 2003.

Course Catalog Description: The course focuses on different aspects of the electromagnetic theory to train the student in the analysis and basic design of: wave propagation in different materials, transmission lines, guided waves and electromagnetic field radiation through simple antennas.

Prerequisite Courses: FIS1533 Electricity - Magnetism; MAT1640 Differential Equations

Co-requisite Courses: To be defined

Status in the Curriculum: Required

Course Learning Outcomes:

1. To comprehend the different forms of the Faraday's Law and to apply them to determine the emf in diverse scenarios of time varying magnetic fields and/or moving closed trajectories.
2. To determine the expressions of electromagnetic waves and their associated power for free propagation in different materials and in the case of normal and oblique incidence at planar boundaries between two or more media.
3. To distinguish the equations and the meaning of a general transmission line and the simplifications for the lossless, low loss and distortion-less cases
4. To design parallel wire, coaxial and microstrip transmission lines given a characteristic impedance, and to use the Smith Chart to determine impedance, voltage and current along the line, and to compensate the line to avoid wave reflection.
5. To design rectangular waveguides given a propagation mode and a frequency range.
6. To understand the field equations and the radiation pattern for a differential monopole and for a half-wavelength dipole.

Relation of Course to ABET Criteria:

a. Knowledge of mathematics, science and engineering
b. Design and conduct experiments: analyze and interpret data
c. Design a system, component, or process
e. Identify, formulate, and solve engineering problems
k. Techniques, skills, and modern tools for engineering practice.

Topics covered:

1. Review of Electrostatic and Magnetostatic
   1.1 Colomb's Law, electric field, electric flux and electric flux density, Divergence and Stokes Theorem.
   1.2 Electric potential, Poison and Laplace Equations and their numerical solution.
   1.3 Biot-Savart and Ampère´s Laws, magnetic flux and magnetic flux density
   1.4 Scalar and Vector magnetic potential, Poison and Laplace equations for magnetic fields.
2. Time Varying Fields and Maxwell Equations.
   2.1 Faraday induction law, general form.
   2.2 Displacement current.
   2.3 Maxwell Equations, integral and differential form, boundary conditions
3. Electromagnetic Waves
   3.1 Free space wave equation and its general solution.
   3.2 Wave equation - sinusoidal case, free space solution, solution for partially conducting media, solution for perfect dielectrics, solution for good conductors, skin depth.
   3.3 Interface conditions at normal and oblique incidence, Snell's Laws, critical angle, perpendicular and parallel polarization, standing waves.
   3.4 Power and the Poynting Vector.
4. FDTD method for 1D wave propagation in different media
5. Transmission Lines
   5.1 Distributed parameters, incremental model-voltages and currents, transients on transmission lines
   5.2 Sinusoidal steady-state excitation, lossless and distortion-less lines, the $\lambda/4$ impedance transformer.
   5.3 The Smith Chart, development, impedance matching.
6. Guided Waves
   6.1 Waves between parallel conductive planes, TE, TM and TEM modes, propagation speed and attenuation.
   6.2 Rectangular guides, TE and TM modes.
7. Antenna Fundamentals
   7.1 Antenna types, polarization and directivity
   7.2 The differential monopole
   7.3 The half-wavelength dipole