EE 372 Engineering Electromagnetics II

Credits: 3

Categorization of credits: engineering topic

Instructors or course coordinator: Zhengqing Yun

Textbook and Other Required Materials: Magdy F. Iskander, "Electromagnetic Fields and waves" and David H. Staelin, Ann W. Morgenthaler, and Jin Au Kong, "Electromagnetic Waves."

Designation: Elective (required for EP track students)

Catalog Description: Engineering Electromagnetics II (3) Solution of Maxwell's equations under various boundary conditions. Introduction to radiation, guided waves, antennas, and high frequency method. Pre: 371 and PHYS 274 (or concurrent); or consent.

Pre-and Co-requisites: EE 371 (Engineering Electromagnetics I) and PHYS 274 (General Physics III)

Class/Lab Schedule: 3 lecture hours per week

Topics Covered:

- Review of principles of wave motion: Transverse Waves, Longitudinal Waves; Plane Waves, Cylindrical Waves, Spherical Waves (2 hours)
- Maxwell's Equations: Faraday's Law, Ampere's Law, Gauss's Law; Electromagnetic Waves, Field and Energy, The Electromagnetic Spectrum (4 hours)
- Solution of Boundary Value Problems: Wave Equation, Helmholtz Equation; Boundary Condition, Initial Condition; Continuity of Fields across Material Interfaces; Plane Waves (4 hours)
- Reflection and Transmission of EM Waves: Definition of Polarization; Reflection and Transmission Coefficients; Normal and Oblique Incidence (4 hours)
- Interference of waves: Superposition Principle, Conditions for Interference, Fading in Wireless Communications (4 hours)
- Reflection of plane waves from a PEC plate; two-plate waveguide (4 hours)
- Introduction to Wave Guides: Modes; Rectangular Waveguides; Resonators (8 hours)
- Antennas: Principle of Radiation; Dipole Antennas; Linear Antenna Arrays; Ground effect (Image Method) (4 hours)
- Introduction to High Frequency Method: Ray Optics, EM Wave Propagation in Urban and Indoor Environments (4 hours)

Course Objectives and Their Relationship to Program Objectives:

The student should understand (i) the characteristics of EM waves, (ii) the wave propagation in media and across material interfaces, (iii) the radiation and guidance of EM waves, (iv) the fundamentals of antennas, and (v) the basic high frequency method for solving wave propagation problems in large and complicated environments. The student should be able to design waveguide structures that allow particular modes; design simple antennas

according to the frequency; and predict fading in a wireless communications system. [Program Objectives this course addresses: 1, 2, and 4.]

Course Outcomes and Their Relationship to Program Outcomes:

The following are the course outcomes and the subset of Program Outcomes (numbered 1-7 in square braces "[ ]") they address:

- Understand different waves and Maxwell's equations [1]
- Understand boundary value problems (BVP's) and solution procedure for simple BVP's [1].
- Understand polarization and wave interference [1]
- Understand principles for guided wave structures and antennas [1, 4]
- Design waveguides and antennas and predict fading in wireless communications systems [1, 2, 4, 5]

Contribution of Course to Meeting the Professional Component

Engineering Topics: 100%

Computer Usage:

Matlab and Python programming languages and software will be used in solving EM problems, visualizing and animating the wave effects to (1) interpret key concepts, (2) demonstrate wave behaviors, and (3) simulate EM fields in complicated environments.

Design Credits and Features:

EE 372 has 0.5 design credit.

Person Preparing Syllabus and Date: Zhengqing Yun, Sept. 29, 2014. Modified by A. Ohta, Jan. 18, 2021.