ECE 332: Engineering Electromagnetics II

Catalog Description

Maxwell's equations for time-varying fields; plane wave propagation and reflection; waveguide structures; radiation and antennas. Topics in wave propagation include scattering, optics, principles of radar, signal integrity and mathematical solution techniques; weekly lab.

Credit hours: 4

Goals

Students will have the ability to use mathematics and physics to formulate, and solve engineering electromagnetics problems. With the accompanying laboratory assignments, students will use modern engineering equipment and tools to solve practical electromagnetic problems.

Prerequisites

ECE 331

Corequisite: ECE 332L

Course Coordinator and Committee

Martin Siderius (coordinator)
Jonathan Bird
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Textbooks

Fundamentals of Applied Electromagnetics, (7th edition) by Fawwaz T. Ulaby and Umberto Ravaioli, Pearson Prentice Hall, ISBN-13: 978-0133356816.

The course instructor may choose to use a different textbook. Please check with your instructor before purchasing.

Learning Outcomes

At the end of this course, students will be able to:

1. Ability to apply Maxwell's equations to analyze time-varying electromagnetic problems.
2. Ability to analyze plane wave propagation problems.
3. Ability to compute reflection and transmission properties of plane waves on plane boundaries at normal and oblique incidence.
4. Ability to analyze radiative emissions problems (including antennas).
5. Perform experiments using antennas, radars, waveguides and optical components.
6. Write technical lab reports, analyze and summarize results.
7. Ability to use Matlab/Python as a tool for engineering electromagnetic problem solving.

Topical Outline

- Maxwell's equations for time-varying fields.
- Faraday's law for computing voltage from coils in time-varying magnetic fields, electromagnetic generators, and displacement current.
- Mathematical description of TEM waves, polarization properties of electromagnetic waves, current in conductors, resistance, power carried by an electromagnetic wave.
- Transmission properties of optical fibers.
- Characterization of the reflection and transmission of plane waves on plane boundaries at normal and oblique incidence.
- Characterization of wave propagation in rectangular waveguides and behavior of rectangular resonant modes.
- Fields radiated from a dipole antenna.
- Antenna radiation patterns, directivity, beamwidths and radiation resistance for antennas. Friis transmission formula for communications systems.
- Radiation patterns for antenna arrays.
- **Laboratory experiments**:
- **Lab 1 Optics**: Explore basics of optical systems including diffraction and refraction phenomena, Young's double slit experiment and Snell's law.
- **Lab 2 Waveguides**: Measure characteristics of rectangular waveguides including standing wave patterns.
- **Lab 3 Antennas**: In this lab students characterize horn antennas and explore the concepts of antenna field patterns, beamwidth, gain, polarization and the range dependence of received power.
- **Lab 4 Applications of radars**: This lab uses radars to explore concepts of monostatic radar returns and Doppler frequency shifts.

Course Structure

The class meets for two 90-minute lectures each week plus four 180-minute labs during the term.The grade is based on class participation (in-class activities, quizzes), lab participation and reports, homework assignments and exams. Grading criteria may vary with the instructor. Please refer to the individual instructor's syllabus for information on the grading breakdown (i.e., percentage weight for each category) and grading scheme.

Relevant Student Outcomes

The following program outcomes are supported by this course:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Course learning outcomes 1-4, 7

(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. Course learning outcomes 4-7

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