Master Course Description for EE-361 (ABET sheet)

Title: Applied Electromagnetics

Credits: 5

[UW Course Catalog

Description](http://www.washington.edu/students/crscat/ee.html#ee361)

Coordinator: Arka Majumdar, Associate Professor, Electrical and Computer Engineering

Goals: To develop a fundamental understanding of electromagnetic forces and fields and of the manner in which they propagate through materials, devices, and systems. Emphasis is placed applications, focusing on the manner in which electromagnetic forces propel charge through the devices and systems that reside at the heart of the broad discipline of electrical engineering.

Learning Objectives:

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

1. *Compute* wavelength, frequency, wavenumber, phase velocity, and characteristic impedance for waves in free space and two-conductor waveguides.
2. *Analyze* reflections and impedance transformations in transmission line circuits under steady-state excitation.
3. *Design* impedance matching circuits using quarter wave transformers and shunt admittances.
4. *Analyze* simple circuit transients using bounce diagrams.
5. *Analyze* more complex transmission line transient problems using SPICE/PSPICE
6. *Identify* the polarization properties of an electromagnetic plane wave.
7. *Compute* the propagation constants, power density, penetrations depth, and reflection coefficients for plane waves incident on planar boundaries.

Textbook: Fawwaz T. Ulaby et al., *Fundamentals of Applied Electromagnetics*, Prentice Hall, 6th edition, 2010.

Reference Texts: J. W. Nilsson and S. A. Riedel, *Introduction to PSPICE.*

Prerequisites by Topic:

1. Fundamental physics (PHYS 123), including concepts of power, energy, force, electric current, electric fields and waves.
2. Fundamental mathematics (MATH 126), trigonometric and (complex) exponential functions, introductory differential and integral calculus, first and second order linear differential equations.
3. Vector Calculus (MATH 324) (May be taken concurrently with EE 361).

4. Fundamental electrical engineering circuit analysis (EE 215 and EE 233).

Topics:

1. Notation, units, dimensions, the meanings of the fields, the intuitive concept of permittivity and the polarization of charge [0.5 week]
2. Review of phasors, fundamental properties of traveling waves [0.25 week]
3. Transmission lines with sinusoidal excitation [2.5 weeks]
4. Transmission lines with transient excitation [1.0 week]
5. Intuitive vector calculus, review of vector differential operators (div, grad, curl) and vector integration. Intuitive view of the fundamental theorems of vector calculus. [1.25 weeks]
6. What Maxwell's equations say about how the fields look [0.25 weeks]
7. Electrostatics, electrostatic potential [1.0 week]
8. Maxwell's equations and the foundations of circuit theory [0.5 weeks]
9. Maxwell's Equations: plane wave-solutions in free space [1.5 week]
10. Plane waves in lossy media [0.5 weeks]
11. Reflections of plane waves from planar interfaces with dielectrics and conductors [1.0 week]

Course Structure: The class meets for four 50-minute lectures per week. In addition, four laboratory exercises are conducted over the course of the quarter during an additional 3-hour meeting time each week. Homework is assigned weekly. Either one or two midterm exams are given, at the instructor's discretion, together with a comprehensive final exam.

Computer Resources: Computers capable ofrunning PSPICE are required.

Laboratory Resources: Laboratories require computers capable of PSPICE.

Grading: Suggested weights are: homework (25%), midterm exams (30% net), final exam (30%), laboratory (15%). These may be modified at the instructor's discretion.

Outcome Coverage:

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.* **(H)** This introductory course requires students to recognize different kinds of electromagnetic and electrostatic problems, and apply appropriate mathematical tools for their analysis.

(2) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.* **(M)** Students will need to understand and explain the results of their homework and laboratory assignments, and to apply the appropriate analytic or computational tools; for example, to distinguish between time- and frequency-domain analysis of transmission lines.

Prepared By:

Last revised: 18 January 2019