ECE/CS 3300: Fundamentals of Electromagnetics and Transmission Lines

Credits and Contact Hours: 4.0 Credit Hours
15 weeks: Three 50-minute lectures + one 3-hour lab per week

Instructor's Name: Steve Blair

Text Book(s) and/or Required Material:

- F.T. Ulaby, E. Michielssen, and U. Ravaioli, *Fundamentals of Applied Electromagnetics*, Sixth Edition, Prentice Hall, 2010

Catalog Description: Brief introduction to vector calculus, definition of electric and magnetic fields. Maxwell's equations in integral and differential forms, electromagnetic-wave propagation in free space and in material regions, Poynting theorem, and electromagnetic power. Transmission lines (transient and steady-state analysis), Smith chart, and impedance matching techniques.

Prerequisites: C- or better in:

- ECE 2240: Introduction to Electric Circuits; **and**
- ECE 2280: Fund. of Engineering Electronics; **and**
- PHYS 2220: Physics for Scientists & Engineers I; **and**
- Math 2250: Diff. Equations and Linear Algebra; **and**
- Full major status in Computer Engineering

Designation: Required

Contribution of Course to Meeting the Requirements of ABET Criterion 5: This course teaches engineering sciences and engineering design.

Specific Outcomes of Instruction: At the conclusion of this course, students should be able to:

1. Calculate voltages, currents, and impedances on TEM transmission lines. This will include time domain (TDR) analysis, frequency domain analysis (standing waves and Smith charts), and power analysis;
2. Calculate electric and magnetic fields from a plane wave impinging on a metallic or dielectric material from either normal or oblique incidence;
3. Design matching systems for transmission lines and plane waves;
4. Calculate the electric and magnetic fields from simple charge and current distributions; and
5. Compute the link budget for a simple wireless communication system and explain how the environmental affects the received power.

Relationship of the Course to the Program Outcomes:

(a) An ability to apply knowledge of mathematics, science, and engineering. This course emphasizes use of math and physics (waves) to solve electromagnetic problems related to control or determination of waves or fields.

(b) An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software. Lab component requires students to do extensive data analysis, and some design of their own experiments.

(e) An ability to identify, formulate, and solve engineering problems. Homework and test problems, and lab exercises, focus on understanding a problem and formulating a solution.

(f) An understanding of professional and ethical responsibility. Health and safety issues are discussed periodically in the course.

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. Economic implications of electromagnetic devices are discussed periodically throughout this course.

(i) A recognition of the need for, and an ability to engage in life-long learning. Students read several papers from technical journals throughout the semester, either as the impetus for discussion on health/safety/etc. or to gain an understanding of where the techniques they are learning fit into realistic engineering designs.

(j) A knowledge of contemporary issues. The papers handed out and discussed throughout the semester are often from current political or technical debates (such as if children should use cell phones), media coverage (about local zoning of antennas), etc.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. In the lab, students use modern lab equipment such as network analyzer and time-domain reflectometry instruments. They also use MATLAB throughout the course.

Topics Covered in the Course:

- Wave propagation
- Transmission lines
- Impedance matching
- Smith Charts and stub matching
- Electrostatics – Coulomb's Law, Gauss' Law, scalar potential
- Magnetostatics – Biot-Savart Law, Ampere's Law
- Maxwell's equations
- Plane waves in free space
- Lossy media
- Reflections from planar interfaces
- Wireless communication systems