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: Sara Mouradian

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. *Identify* the polarization properties of an electromagnetic plane wave.
6. *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.

Prerequisites by Topic:

1. Fundamental physics (PHYS 123 or PHYS 143), including concepts of power, energy, force, electric current, electric fields and waves.
2. Fundamental electrical engineering circuit analysis (EE 215).

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 two 110-minute OR 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.

Laboratory Resources: Laboratories require network analyzers.

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.

Religious Accommodation Policy:

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

Accommodations and Access:

If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between the student, instructor, and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Academic Integrity:

Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the College of Engineering Statement of Principles. Any student in this course suspected of academic misconduct (e.g., cheating, plagiarism, or falsification) will be reported to the College of Engineering Dean's Office and the University's Office of Community Standards and Student Conduct to initiate the student conduct process. Any student found to have committed academic misconduct may receive a zero for their grade on the impacted academic work (e.g., assignments, project, or exams), and academic consequences, with the possibility of expulsion.

Title IX:

UW, through numerous policies, prohibits sex- and gender-based violence and harassment, and

we expect students, faculty, and staff to act professionally and respectfully in all work, learning, and research environments. For support, resources, and reporting options related to sex- and gender-based violence or harassment, visit UW Title IX's webpage (https://www.washington.edu/titleix/), specifically the Know Your Rights & Resources guide (https://www.washington.edu/titleix/files/2020/08/KYRR-guide-8-10-2020-LINKED.pdf).

If you choose to disclose information to me about sex- or gender-based violence or harassment, I will connect you (or the person who experienced the conduct) with

resources and individuals who can best provide support and options. You can also access those resources directly:

- Confidential: Confidential advocates (https://www.washington.edu/sexualassault/support/advocacy/) will not share information with others unless given express permission by the person who has experienced the harm or when required by law.
- Private and/or anonymous: SafeCampus (https://www.washington.edu/safecampus/) provides consultation and support and can connect you with additional resources if you want them. You can contact SafeCampus anonymously or share limited information when you call

Please note that some senior leaders and other specified employees have been identified as "Officials Required to Report." (https://www.washington.edu/titleix/title-ix-officials-required-to-report/) If an Official Required to Report learns of possible sex- or gender-based violence or harassment, they are required to call SafeCampus and report all the details they have in order to ensure that the person who experienced harm is offered support and reporting options (https://www.washington.edu/titleix/resources/).

Prepared By: Sara Mouradian

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