ECE 350 - Fields and Waves II

Instructors:

In fall 2009, Prof. Cangallaris and Prof. Kudeki taught this course. Both sections follow the same syllabus and have the same homework. Prof. Cangallaris is the course coordinator and Prof. Kudeki wrote the notes for the class. An additional text written by Rao is included as supplementary material, and it is an excellent reference text with challenging example problems. The textbook is not strictly required, as none of the homework or lecture notes are taken directly from the book by Rao.

Prerequisites:

The only formal prerequisite for the course is ECE 329, but the course requires mastery over integral calculus as well.

When to take it:

If you liked ECE 329 (Fields and Waves I), then you'll probably like this course. Make sure you understand concepts such as transmission line theory, wave interaction with dielectric media and Maxwell equations (plus boundary equations), as these core concepts are built upon in ECE 350. The new course focuses on antennas and electromagnetic (EM) wave propagation and wave interactions, so ECE 350 will feel like an extension of ECE 329.

Take this course to satisfy 3 out of 5 credit or if you have an avid interest in antennas, wireless communication, or electromagnetic fields. The best time to take this course is directly after taking ECE 329. Take this class as early as possible, as it is truly a fundamental course in EM.

Class Content:

The current course content has been entirely reworked by Prof. Kudeki and Prof. Cangallaris, among others. The course begins with a review of Maxwell's equations, basic mathematics, field potentials, wave equations and a discussion of gauges. The core material of the course is then divided into a couple major topics. The first major topic is the idea of a Hertzian dipole and radiating antennas. You will learn how to formulate and approximate complex antenna radiation equations using the Hertzian dipole. You will also discuss the ideas of radiated power, resistance and gain. The discussion of the simplified antenna nicely transitions into the topic of wave interference, where you will explore beam patterns of antenna arrays. You will explore the ideas of near and far field radiation and you will learn how and when to make approximations regarding plane waves and their propagation patterns. A discussion of the Rayleigh distance is also covered in this section. The following section covers a new topic, reflected and transmitted waves. You will learn about reflectors, the Doppler effect and total internal reflection. You will also review TE and TM wave polarizations. You will follow up these topics with the ideas of wave propagation in dispersive media, and you will gain some insight into real world problems with wireless communication networks. The penultimate topic is the concept of waveguides. You will discuss guided modes, 1D, 2D, 3D cavity waveguides, dielectric waveguides, and their respective resonant modes. You will conclude the semester by coming full circle, and studying antenna reception. These concepts all contribute to the big picture of learning how EM waves are transmitted and received in communication networks.

Work:

The class consists of weekly homework that is a good reflection of the exams. The homework is challenging, but it will cover the absolute essentials and "common knowledge" that all must have in an introductory EM course. To solve the homework problems, you will need to understand the intuitive concepts and then apply their mathematical groundwork. Some of the problems are very difficult to understand conceptually, so I would suggest starting early so you can attend office hours. Reading the notes is absolutely essential and they directly compliment the lectures. There are some interactive java applets available online that help to develop and intuitive understanding of the materials.

Life After:

For those of you who want more than a sample of these topics, you can specialize in wireless communications or electromagnetic waves or photonics. If you found the section on antennas interesting, take the follow up course ECE 454 (Antennas) to further your understanding. If you would rather learn about designing radio systems to send and receive information, you can take ECE 453 (Wireless Communication Systems). If you need a lab, you can take ECE 451 (Advanced Microwave Measurements). In this course you will learn how to take high frequency measurements. On the other hand, if you're looking for ECE 329 part 3 then take ECE 452 (Electromagnetic fields), which builds off of ECE 329 and ECE350 by covering Maxwell's equations and waveguides, but takes it one step further by introducing optical modulation schemes and coupled waveguides. Taking ECE 452 directly sets you up to take ECE 520, which is basically ECE 329 part 4 (it never ends...). Otherwise, if you like lasers, take ECE 455 (Optical Electronics) and learn how optical lasers work. There are also a number of specialized courses, such as ECE 447 (active microwave circuit design), ECE 458 (applications of radio wave propagation), and ECE 457 (microwave devices and circuits).