COURSE SYLLABUS
ECE 816 Electromagnetic Scattering from Random Media and Rough Surfaces
Spring Quarter 2009

Instructor:	Prof. Joel Johnson
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Office Hours:	By appointment
Course web page:	http://eewww.eng.ohio-state.edu/~johnson/ece816/ece816.html
Text:	Ishimaru, Wave Propagation and Scattering in Random Media, IEEE Press, 1997
References:	Tsang, Kong and Shin, Theory of Microwave Remote Sensing, Wiley, 1985
	Ulaby, Moore, and Fung, Microwave Remote Sensing: Active and Passive, vols 1-3, 1986.
	Stark and Woods, Probability, Random Processes, and Estimation Theory, Prentice--Hall, 1994.

Subject Matter:

In ECE 816, we will study classical models for scattering from statistically described media such as "random media" or "randomly rough" surfaces. These models are based on a combination of approximate methods for electromagnetic scattering and classical statistical techniques to provide insight into the behavior of electromagnetic waves propagating in complex media. We will consider the theories of independent scattering, radiative transfer, analytical wave theory, and the Kirchhoff and small perturbation methods for rough surface scattering in the course. An understanding of these theories is crucial for the design of sensors and algorithms for microwave remote sensing of the Earth, and also for clutter reduction tools in statistical signal processing of radar data. Of course, understanding the limitations of these theories is also important, since all are based on an approximate description of the physical environment and the scattering process.

Prerequisites:

Students in 816 should have completed a graduate sequence in electromagnetic wave theory (such as ECE 719 and 810) and should also have at least some undergraduate or graduate experience in probability theory. These topics will be reviewed briefly in the first lectures, but both scattering and probability theory will be extensively applied throughout the remainder of the course. Having an text on probability theory handy may be useful! It will also be useful to review solution of systems of first order differential equations.

Grading:

Grades for the course will be based upon an in-class midterm examination, a final exam, homework quizzes, and a computer project. Weights are assigned as follows:

Midterm	30%
Final exam	30%
Homework + quizzes	15%
Research project	25%

Refer to the attached schedule and calendar for exam and quiz dates. Make-up examinations will be given only in the case of an emergency. All exams and quizzes will be open book and open notes, and are subject to Honor code rules.

Homework and Homework Quizzes:

Five problem sets will be assigned through the course webpage, each of these has an associated in-class homework quiz. Solutions to the homework problems are also provided. Turning in the homework assignments is optional (although turning in project updates is required, see below), but students who turn in completed homeworks will have 25 points added to their homework quiz score (maximum possible score on a quiz remains 100%). Quizzes will occupy approximately the first fifteen minutes of class. Working the problem sets without use of the solutions will be the best method for quiz preparation; practice quizzes are also available on the course website.

Computer project:

Each student is required to complete a project comparing a more "exact" numerical scattering problem solution with the results of one of the course approximate theories, and discussing the results and implications of this study in a written report. A standard project will be suggested and developed as the course progresses, but some students may wish to pursue their own projects and should arrange their topic with the instructor. A basic archive of numerical codes for rough surface scattering is available at http://ceta.mit.edu/emwave**. Due dates for updates on project progress are indicated on the course calendar and in the homework assignments.**

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Tuesday	Thursday
Mar 31 Introduction, Chapter 1	April 2 Review probability theory, Basic EM theory Appendix A, Sect. 2-1 to 2-4
7 Rayleigh scattering, remote sensing measurements Sect 2-5, 2-9 to 2-14	9 Characteristics of media Chapter 3
14 **Quiz #1** Independent scattering, Sect. 4-1 to 4-3	16 Coherent and incoherent fields, Moving particles Sect. 4-4 to 4-8
21 Examples	23 **Proj topic, Quiz #2** Introduction to RT theory Sect. 7-1 to 7-5
28 RT formulations Sect. 7-6 to 7-8	30 Tenuous medium solution Sect. 8-1 to 8-3
May 5 **Midterm exam**	7 **Proj update** Plane parallel problem Sect. 11-1 to 11-8
12 Continuous medium theory Sect. 16-1 to 16-5	14 Temporal variations Sect. 16-6 to 16-10
19 **Quiz #3** Introduction to surface scattering, Sect. 21-1	21 **Proj result** Perturbation theory Sect. 21-2 to 21-8
26 Kirchhoff approximation Sect. 21-9	28 **Quiz #4** Kirchhoff cross sections Sect. 21-10 to 21-11
June 2 Summary of surface scattering	4 Project discussions **Project due June 5th**
June 9 ------------------------------------	11 --------- EXAMS---------------