THE UNIVERSITY OF UTAH

ECE 5325/6325, Wireless Communication Systems, Spring 2013

Lecture:	Tuesday and Thursday, 9:10 AM - 10:30 AM in WEB 1250
5325 Pre-req:	C- or better in ECE 3300 (Fundamentals of Electromagnetics and Transmission Lines), ECE 3500 (Signals & Systems), ECE 3530 (Probability and Statistics), or equivalents. Students without these three tend to do poorly in the course.
6325 Pre-req:	In addition to the above, C- or better in ECE 5510 (Random Processes), or equivalent.
Credit:	3 hours
Instructor:	Neal Patwari
Office:	MEB 3120
Office Hours:	Thursday 10:40-12 pm, Monday 1:00-2:30pm, and by appointment
Email:	`npatwari@ece.utah.edu`
Phone:	(801) 581-5917
Grader:	Olutosin Fawole, `u0817412@utah.edu` TA office hours, Fridays, time t.b.a., in the ECE TA/Study lounge, across from MEB 2355 (the ECE Stockroom).
Web Page:	There are two. The main page is `http://span.ece.utah.edu/5325`. The other is Canvas, `http://uonline.utah.edu/`, which is used to post grades, some handouts, and for online submission of your work.
Textbook:	Andreas F. Molisch, *Wireless Communications*, Wiley, 2nd edition, 2010. Chapter 17 will be available as pdf on Canvas, in case you need more time for shipping. Required readings are posted on the class schedule online.
Grading	ECE 5325 and ECE 6325 homework and exams are different, and graded separately. However, the percentage assigned for each type of assignment is the same. Course grading will be calculated based on: Homework: 10% (lowest score is dropped) Exam 1-3 (in class): 23% each System Design Competition, Report and Presentation 21%

Exams: Exams 1, 2, and 3 are in class (**January 31, February 26, and April 4**), one hour exams (9:10-10:10). The final exam period, **Friday, April 26, 8–10am**, is your chance to retake any two of these exams. Three retake exams, corresponding to the same material covered in exams 1, 2, and 3, are offered during the final exam period. You may take none, one, or two of these during the final exam period; your final score on any exam is the maximum of the score you received for the in class exam and for the retake exam. (This is an exam system adapted from Prof. Furse). Also note that the exams for 5325 and 6325 differ – some questions will be on both exams, and others will appear on the 5325 but not the 6325 exam, and vice versa. I expect 6325 students to have a more in-depth understanding of the course material, with the ability to do some problems that 5325 students do not need to know how to do.

Portfolio: Each class you will be asked to answer questions associated with the lecture and/or do 2-4 related homework exercises. The question might be "How do you compute the required transmit power for a link?". Your writing in your homework for that day should include instructions (to yourself) on how to answer the questions and exercises, in addition to your solutions. The instructions (typically about a page) should be written so YOU can understand them. Your solutions are turned in, typically once per week on Tuesdays, and one or more problems graded. Homeworks can be submitted either on paper in the ECE locker, or online on Canvas. When returned, these solutions become part of your "portfolio" . Exams will be open portfolio, closed book, so include everything (problem statement, equations, description of terms, special cases, etc.) you need to solve the problems. Portfolios are paper documents – you may not use any electronic media during the exam, so if you prefer typing or scanning your homework, please also have a printout to put in your portfolio. You may include tables and figures copied from the text, but don't copy the text itself. **You are responsible for checking your own homework solutions**. Solutions will be posted on Canvas. A 3-ring binder is suggested to organize your solutions for easy access during exams.

Collaboration Policy: You are encouraged to work together on homework questions whenever possible. Discussing problem solving approaches and techniques is a great way to learn. After making a genuine attempt to solve the problems, you are encouraged to discuss the answers with other students currently enrolled in ECE 5510 to check the answers and compare solution approaches. However, after such a discussion, you should write your answers on your own, in a way that makes sense to *you*, without copying to the solutions of other students. Otherwise, your portfolio won't help you during an exam.

Team Design Competition: You will work in a team (3-4 members per team) to develop an end-to-end wireless communication system for a specific purpose. This semester, you will design a "system for text message communication after a major disaster", as described in detail on the course website. You will write a report on your system design, and do a 10 minute presentation in front of the class on the Competition Day.

Team Design Competition Day: Your 10 minute presentation on your design will be presented during on Design Competition Day, **April 18, 5-8 pm**. All presentations must be presented that day, as it is not fair to have one team be able to hear others' presentations and have time to change their own system design. In order to have time to do this, we will present them all during one evening session, April 18, from 5-8pm. The designs from all teams will be judged by your fellow students (5325 teams will be judged by 6325 students; 6325 teams will be judged by 5325 students.) The report and presentation will also be separately judged by the instructor. Your presentation grade will be based on your peer student rating.

6325 Info: The exams for 6325 share about 50-65% of questions with the exams for 5325 students. Projects for 6325 students are expected to include more detailed results, as compared to those from 5325. Students in 6325 are expected to complete additional homework assignments, which are listed on the web site as "6325-only HW".

Cheating Policy: Copying on exams, or plagiarism on projects, is cheating. Please see the cheating policy on the web site for more information. Plagiarism is copying or paraphrasing someone else's ideas from any source (book, article, web, ...) without citation. Please use citations when writing; there is no reason not to do so, and plagiarism will result in a grade of '0' on the assignment, and perhaps more serious penalties. Written reports are automatically checked using plagiarism detection software.

Reserve: Several books are at the library reserve desk for 2 hour / 1 day loan.

Tips:

1. Find another student or students to help you (or to help them) when you (they) have trouble with homework problems. Do that from the start!
2. Read the corresponding section in the book *before* lecture.
3. When you do not fully understand a topic in lecture or in the homework come to office hours **as soon as possible**. Topics build on each other, so you want to be sure not to fall behind – the longer you wait, the tougher it will be to catch up.
4. Do additional problems, beyond the homework.
5. Read ahead to topics that interest you, and plan ahead for your project.

Disability Accommodations The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

Learning Objectives:

1. Topics related to cellular systems and other wireless networks:
   (a) Understand how a cellular system functions.
   (b) Understand multiple access / duplex protocols (time division, frequency division, code division)
   (c) Compute the number of users a particular system can reliably accommodate.
   (d) Design / calculate a link budget and S/I ratio for a cellular system.
   (e) Design a system for increased capacity using trunking, cell splitting, directional antennas, downtilt, etc.
   (f) Understand basic multiple-access control (MAC) protocols
2. Topics related to physical multipath channels:
   (a) Understand transmission, diffraction, reflection, scattering, and large-scale fading
   (b) Understand multipath fading (small-scale, frequency-selective, temporal)
   (c) Understand and use Raleigh and Rician fading models
   (d) Understand the Doppler effect
   (e) Calculate the fading margin and diversity gain from combining schemes
3. Topics related to modulation techniques and diversity techniques: Describe, analyze, and understand engineering tradeoffs of the following with energy-limited devices and fading channels.
   (a) Digital modulations, including PSK, FSK, PAM, QAM; OQPSK, $pi/4$ QPSK, MSK, GMSK
   (b) Spread-spectrum systems (DS-SS, FH-SS)
   (c) Orthogonal frequency division multiplexing (OFDM) systems
   (d) Multiple antenna systems including MIMO
   (e) Understand how to implement block coding and cyclic redundancy checking