EE 381J Probability and Stochastic Processes (17145) **Fall 2009**
Instructor: Sujay Sanghavi **sanghavi@mail.utexas.edu**

Overview: This course is an intermediate, graduate level probability and random processes course for engineers. We will begin with an overview / review of probability basics, and then develop the more formal measure-theoretic foundations, as well as other concepts useful in subsequent courses. In addition we will discuss the most common probabilistic models and random processes and introduce basic techniques in estimation and detection, estimation,with a view on important applications in communications, control and signal processing, as well as other fields in engineering and computer sciences.

Pre-requisites: EE 351K (undergraduate level Probability, Statistics and Random Processes) or equivalent. Current undergraduates wanting to take this class please come and talk to the instructor.

Textbooks: 1. *An Exploration of Random Processes for Engineers,* by B. Hajek. Available on the web at `http://www.ifp.uiuc.edu/~hajek/Papers/randomprocesses.html`

2. *Probability and Random Processes*, G.R. Grimmett and D.R. Strizaker, Oxford, 3rd Edition,.

Class Hours: Class will be held on **Monday and Wednesday, 9:30 - 11:00 am** in **ENS 116**. Office hours will be decided on the first day of class.

Course Policy: Attendance is expected. You are responsible for material covered in the reading assignments (even if not covered in class) as well as material covered in class that is not in the book. Homework will be assigned roughly every ten days. Late homeworks **will not be accepted.**

You may discuss homework problems with other students, but you have to write the solutions individually: no copying. University disciplinary procedures will be invoked if any form of cheating is detected. Course and instructor evaluations will occur the last day of class.

"The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities." For more information, contact the Office of the Dean of Students at 471-6259, 471-4241 TDD or the College of Engineering Director of Students with Disabilities at 471-4321.

Web-based, password-protected class sites class sites are associated with all academic courses taught as The University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of these sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1.

Grading:

(i) Class Participation: 5%

(ii) Homework: 15%

(iii) Midterm Exam 1: 20%

(iv) Midterm Exam 2: 20%

(v) Final Exam: 40%

Syllabus

1. **Introduction and Probability Basics:** sigma algebra, probability axioms, independence, random variables, expectation and conditional expectation, pdf, cdf, moments, MGF
2. **Sequences of random variables:** Convergence of random variables – almost sure, mean-square, convergence in probability, convergence in distribution; Borel-Cantelli Lemma; Limit theorems – strong law of large numbers, central limit theorem; convex functions and Jensen's inequality; Chernoff bound and large deviations
3. **Random Vectors and Estimation:** The orthogonality principle, Gaussian random vectors, Minimum Mean Square and Linear Mean Square Estimators (MMSE, LMSE)
4. **Basic concepts of random processes:** definition and classification, stationarity and ergodicity, correlation functions, continuity, differentiation, and integration of random processes
5. **Countable State Markov Chains:** Discrete and continuous time, Structural properties (communication classes, periodicity, irreducibility), Stationary distribution, Positive/null recurrence, Transience, birth-death processes and random walks, elementary queueing, Foster's criterion
6. **Special Random Processes:** Random walk, independent increment processes, Brownian motion, Poisson process, Stationarity
7. **Martingales:** Definition, filtration, stopping times, optional stopping theorem, Azuma-Hoeffding inequality, Doob's backward martingale, martingale convergence theorem

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Other Reference Texts

(i) *Introduction to Probability,* Dimitri Bertsekas and John Tsitsiklis. (nice intro level book which we use for our undergraduate class)

(ii) *Stochastic Processes,* Sheldon Ross, Wiley.

(ii) Probability and Random Processes with Applications to Signal Processing, H. Stark and J. Woods, 3rd edition, 2002.