University of Illinois at Urbana-Champaign
Department of Electrical and Computer Engineering

ECE 434: Random Processes

Spring 2004

Information Sheet

Instructor:	Christoforos Hadjicostis 148CSL E-mail: chadjic@uiuc.edu Office Hours: Wednesday 3:00–5:00pm in 351CSL
Teaching Assistant:	Yue Lu 122CSL E-mail: yuelu@uiuc.edu Office Hours: Thursday 1:00-3:00pm in 351CSL
Time and Place:	Lectures: MWF 2:00–2:50pm in 260EL. Quiz, Midterm Exams and makeup lectures: Wednesday 5:00–7:00pm
Required Textbook:	B. Hajek, *An Exploration of Random Processes for Engineers.* Available for download at `http://comm.csl.uiuc.edu/~hajek/Papers/randomprocesses.html` and also available at the TIS Copy Shop.
Course Web Page:	`http://courses.ece.uiuc.edu/ece434/`

Grading and Exams: Homework (10%), Probability Quiz on 02/11 (10%), Midterm 1 on 03/17 (20%), Midterm 2 on 04/21 (20%) and Final Exam on 05/07 (40%). Exams are closed book; one 8.5"x11" sheet of notes (both sides) is permitted for Midterm 1, two sheets are permitted for Midterm 2, and three for the final. The Probability Quiz and the Midterm Exams will be from 5-7pm on the above dates.

Homework Policy: Collaboration on the homework is permitted but each student must write and submit independent solutions. Homework is due within the first five minutes of the class period on the due date. Late homework will not be accepted without prior arrangement with the instructor. The bottom homework grade will be dropped to accommodate one missed homework for every student.

List of recommended textbooks reserved at Grainger:

1. H. Stark and J. W. Woods, *Probability and Random Processes with Applications to Signal Processing.* Third Edition, Prentice Hall, 2001.
2. R. G. Gallager, *Discrete Stochastic Processes.* Kluwer, 1996.
3. H. Stark and J. W. Woods, *Probability and Random Processes with Applications to Signal Processing.* Second Edition, Prentice Hall, 1994.
4. W. B. Davenport, Jr. and W. L. Root, *An Introduction to the Theory of Random Signals and Noise.* McGraw Hill, 1987.
5. E. Wong and B. Hajek, *Stochastic Processes in Engineering Systems.* Springer Verlag, 1985.
6. A. Papoulis, *Probability, Random Variables and Stochastic Processes.* Second Edition, McGraw Hill, 1984.
7. E. Wong, *Introduction to Random Processes.* Springer Verlag, 1983.
8. B. D. O. Anderson and J. B. Moore, *Optimal Filtering.* Prentice Hall, 1979.
9. W. Rudin, *Principles of Mathematical Analysis.* Third Edition, McGraw-Hill, New York, 1976.
10. R. B. Ash, *Basic Probability Theory.* Academic Press, 1972.
11. L. Breiman, *Probability.* Addison-Wesley, 1968.
12. H. Cramer and M. R. Leadbetter, *Stationary and Related Stochastic Processes.* Wiley, 1967.
13. E. Parzen, *Stochastic Processes.* Holden Day, 1962.

Course Outline

I. Review of Probability Theory

1. Basic axioms; probability space and measure; sigma algebras
2. Conditional probability and independence
3. Random variable; probability distribution and density
4. Random vectors; conditional distributions and independence
5. Functions of random variables and random vectors
6. Expectation; conditional expectation and properties

II. Sequences of Random Variables

1. Notions of convergence
2. Limit theorems; large deviations

III. Random Vectors and Minimum Mean Squared Error (MMSE) Estimation

1. Linear MMSE and MMSE estimators
2. Orthogonality principle
3. Jointly Gaussian random variables and vectors
4. Kalman filtering

IV. Random Processes

1. Continuous- and discrete-time random processes
2. Stationarity and wide-sense stationarity (WSS)
3. Second-order processes; mean and correlation function spectrum
4. Markov processes and martingales; Gaussian, Wiener, and Poisson processes

V. Calculus for Random Processes

1. Continuity of random processes; differentiation and integration
2. Orthogonal representation of random processes (Karhunen-Loeve expansion)
3. Ergodicity

VI. Stationary Random Processes and Spectral Analysis

1. Power spectral density and its estimation
2. Random processes through linear systems
3. Spectral representation of random processes

VII. Minimum Mean Squared Error (MMSE) Estimation

1. MMSE estimation and linear MMSE estimation for random vectors
2. Discrete- and continuous-time Kalman filter
3. The Wiener filter; spectral factorization and applications