University of Massachusetts
Department of Electrical and Computer Engineering

ECE 603 - Probability and Random Processes
Fall, 2006

We see . . . that the theory of probabilities is at bottom only common sense reduced to calculation; it makes us appreciate with exactitude what reasonable minds feel by a sort of instinct, often without being able to account it . . .. It is remarkable that [this] science, which originated in the consideration of games of chance, should have become the most important object of human knowledge.

P. Laplace (1749-1827)

Objective: The objective of this course is to study the fundamentals of probability theory, random variables, and random processes at a level appropriate to support graduate coursework and research in electrical and computer engineering. Applications of the theory to engineering and the science problems will be emphasized, and random processes arising often in practical systems will be studied.

Course Format: Three 50-minute lectures (MWF 10:10, Marston 220)

Instructor: Dennis Goeckel, 215H Marcus Hall, Phone: 545-3514, e-mail: goeckel@ecs.umass.edu
Office Hours: Monday, 2:30-4:00 p.m.; Wednesday, 12:20-1:10 p.m.; or by e-mail appointment.

"Where Everybody Knows Your Name": Please come by my office hours during the first two weeks of the semester so that I can meet you.

Prerequisite: Some background in probability (equivalent to a standard ECE undergraduate course), Fourier analysis, and linear systems.

Textbook: H. Derin, *Probability and Random Processes for Engineers*, 2001.
Manuscript available at Collective Copies, 71 S. Pleasant St., Amherst.

Grading: Homework - 15 %
Midterm Exam 1 (October 16, 6:00-8:00 p.m., Marston 132) - 25 %
Midterm Exam 2 (November 13, 6:00-8:00 p.m., Marston 132) - 25 %
Final Exam - 35 %

All exams will be closed-book closed-notes, and **no** calculators will be allowed; however, a single **hand-written** formula sheet will be allowed. The final exam will be cumulative. Homeworks will be collected at the beginning of the lecture on the date (generally Fridays) that they are due. Homeworks will not be accepted after their solutions are distributed.

Ground Rules: You are allowed to work together on homeworks; however, each student must submit his own solutions. Also recall that homeworks are really only preparation for the exams, so do not rely too heavily on other students for help. **Academic dishonesty** (either taking or giving answers, use of extra crib sheets, etc.) on an exam will be dealt with harshly; you will receive an "F" for the course, and there may be further disciplinary action.

Reserve Books (Science and Engineering Library):

Munkres, *Topology: A First Course,* Prentice-Hall, 1974. (Note that pp. 14-21 and pp. 40-53 will be an excellent supplement for the first part of the course).

Leon-Garcia, *Probability and Random Processes for Electrical Engineering, Second Edition,* Addison-Wesley, 1994.

Peebles, *Probability, Random Variables, and Random Signal Principles, Fourth Edition,* McGraw-Hill, 2000.

Stark and Woods, *Probability, Random Processes, and Estimation Theory for Engineers,* Prentice-Hall, 1986.

A. Papoulis, *Probability, Random Variables, and Stochastic Processes, Third Edition,* McGraw-Hill, 1991.

Course Outline (Subject to Modification)

I. Preliminaries

Functions, sets and their cardinality - countable versus uncountable, basic ideas of measure.

II. Elementary Probability

Probability space: sample space, events, and probability, counting, conditional probability, total probability and Bayes theorem, independence.

III. Random Variables

Distribution and density functions, expectation, multiple random variables, conditional distribution and density functions, independence, functions of random variables, densities and distribution examples for common random variables, introduction to estimation and detection.

IV. Convergence and Limit Theorems

Convergence of sequences of random variables, laws of large numbers, central limit theorem.

V. Stochastic Processes

Basic definitions, finite-dimensional distributions, stationarity (strict sense), autocorrelation function, power spectral density, wide-sense stationarity, filtering of random processes, ergodicity, discrete-time random processes and systems.

VI. Special Random Processes

Gaussian processes, independent increment processes, the Wiener process, Markov processes, Markov chains, Poisson processes.