Northwestern University

Department of Electrical Engineering and Computer Science

EECS 510: Probabilistic Techniques in Communication and Computation — Spring 2009

Information Sheet:

Instructor:

Prof. Randall Berry
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Office Hours: By appointment

Time and Place:

T/Th 3:30pm - 4:50pm, Room L170 Tech

Prerequisites

- Good understanding of basic probability (e.g. ECE 302)

Text:

- Robert Gallager, Discrete Stochastic Processes, Springer, 1995.

Reference Texts:

- Michael Mitzenmacher and Eli Upfal, *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*, Cambridge University Press, 2005.
- Sheldon Ross, *Stochastic Processes*, Wiley, 1996.

Course Overview:

Probabilistic techniques play an important role in both communication and computation. For example, in studying communication networks, probabilistic models are widely used for performance analysis as well as simulation. For computation, probabilistic techniques are used both in the study of randomized algorithms as well as to study the complexity of deterministic algorithms. This course will provide an introduction to several fundamental classes of probabilistic techniques used in these areas. We will discuss the theory underlying these techniques as well as give a few example applications.

Course Handouts:

Handouts not picked up during class and other announcements will be available on the course web site at http://www.ece.northwestern.edu/~rberry/EECS510_09/

Problem Sets:

Problem sets will be assigned on a quasi-weekly schedule. In making up the exams it will be assumed that you have worked all the problems. Working together in small groups on the problem sets is encouraged, however each person should write up their own solution to hand in.

The problem sets are intended to help you learn the material and whatever maximizes learning for you is desirable. Problem sets must be handed in by the end of the class in which they are due. Late problem sets will not be accepted.

Exams:
There will be a one midterm exam and one final exam.

Course Grade:
Your final grade in the course is based upon our best assessment of your understanding of the material. The weightings used to determine the final grade are:

Midterm	35%
Final	45%
Problem Sets	20%

Syllabus (tentative):

1. **Introduction and probability review**
   - Probability spaces, random variables.
   - Expectation, Jenson's inequality, conditional expectation
   - Example applications: queueing models, expected run-time of quick-sort
2. **Basic inequalities**
   - Markov's inequality, Chebyshev's inequality
   - Chernoff bounds
   - Application: randomized routing
3. **Markov chains**
   - State classification
   - Peron-Forbenius theory
   - Markov chains with rewards –expected first passage time.
   - Application: queueing models
   - Coupling and card shuffling
4. **Renewal Process**
   - Strong law for renewal processes
   - Wald's equality
   - Blackwell's theorem, renewal-reward processes.
   - Application: M/G/1/ queue
5. **Martingales**
   - Stopping times.
   - Wald's inequality
   - Tail inequalities, Azuma-Hoeffding
   - Application: Chromatic number of a random graph.