

Syllabus  
Stochastic Processes  
960:580:01  
Spring 2005

**Instructor:** Farid Alizadeh

Last updated January 24, 2005

### Text book

**Required:** Sheldon Ross *“Introduction to Probability Models”* Eighth edition.

**Please Note:** Older editions of this text may also be used.

Additional material not covered in the text may be required. In that case relevant handouts will be posted on the webCT site page.

### Course Web Site and E-mail

We will use the webCT system on Rutgers. To access the course web site go to <http://webct.rutgers.edu>. Click on the *login* link and when prompted use your university netID and password. Your university netID is usually the same as your eden or pegasus user id. Once you have logged in you will see a list of courses you are eligible to navigate, in particular you should see the Operations Management course link. Click on it and you are in the course web site.

To reach me by e-mail use webCT and click on the Mail link. Write my name, `alizadeh`, for receiver. You can also send other students in the class e-mail in this way.

**Caution about sending e-mail:** You should only use e-mail to contact me on private and personal issues. If you have a question regarding homeworks, text, or you wish to point out problems such as broken links, typos, etc. **you should post your question/comment on the discussions section of the homepage.** You are also most certainly welcome to answer questions and provide comment and advice to your fellow students on that page if you wish to do so. E-mails that should have been posted on the discussion page may not be replied promptly.

## Office hours and online hours

Thursdays from 11 AM to 1:00 PM.

I will try to monitor the discussions page and the e-mail of the class two or three times a week, but I will definitely monitor that page on Tuesdays from 1:30-2:30.

## Prerequisites

- School of Business PhD or Master of Finance standing
- Introductory probability based on calculus covering basic concepts (for instance 960:575).

## Course Overview:

In this course we will cover the basic concepts of stochastic processes with emphasis on applications in various fields of business and economics. On the topical side we start with finite homogeneous Markov chains and continue on continuous time discrete state processes and finally to continuous time continuous state processes. These topics will be accompanied by numerous examples from queuing theory to inventory theory to mathematical finance (especially derivatives pricing).

## Homeworks, Exams and Grading Policy

1. **Homeworks:** There will be one final exam accounting for 50% of your grade.
2. There will be several homework assignments and projects. Some of these assignments will include solving problem; others may involve modeling real applications, and some may involve computer projects. Homeworks will make up 50% of your grade.

## List of topics

### Review of basic concepts of probability theory

Random variables, density and cumulative distribution functions, expectation, conditional probability, generating and characteristic functions (One week)

## **Introduction to simulation**

Random number generation, generation of random deviates with given distribution functions, inverse function method, rejection method, generation of normal deviates, Review of some software for simulation (One week)

## **Discrete time homogeneous Markov chains**

Recurrent and transient states, periodic and ergodic chains, Matrix and graph representations, stationary distribution and eigenvalues and eigenvectors, reversible chains and discrete random walks, harmonic functions, fair gambling systems and martingales, some applications: Simulation of Markov chains and Metropolis algorithm, Markov decision processes, Hidden Markov chains and applications Introduction to binomial lattices and applications to options. pricing. (Four weeks)

## **Continuous time discrete state processes**

Review of the exponential and gamma distributions, the Poisson Process, Compound Poisson process, nonhomogenous Poisson process, birth and death processes, Renewal processes, Little's formula, continuous time Markov processes. Applications in Queues: Concepts of queuing theory, and applicability of various continuous time discrete state processes, average queue length and queue waiting time, Applications to inventory models and policies, (Three weeks)

## **Continuous time continuous state processes**

The concept of a continuous time stochastic process, Basics of Brownian motion (Weiner processes), the notion of stochastic differential equation, Ito calculus and Ito processes, continuous state and time Martingales, applications to mathematical finance: options pricing, Black-Scholes formula. (Five weeks)