IE 503 Stochastic Processes
Fall 2024

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Office Hours: by appointment

Lecture Hours:

- Tuesday 10.40 – 11.30 (FENS G029)
- Thursday 12.40 – 14.30 (FENS G029)

Course Description: In this course, we will review the fundamental concepts of the theory of probability and learn about a variety of stochastic processes and we will also discuss some of their applications in engineering. The main objective of this course is to enable students to "think probabilistically," and to develop and analyze probability models that capture the effects of randomness on systems under consideration.

Assessment Plan:

- Midterm I (25%) November 7, 2024 in class
- Midterm II (35%) December 5, 2024 in class
- Final exam (40%)

Textbook: Introduction to Probability Models, Sheldon M. Ross, 9th Edition, 2006, Academic Press, ISBN-13: 978-0125980623.

Detailed Course Content:

1. **Introduction to Probability Theory (Chapter 1)**
   - Sample Space and Events
   - Elementary Probability: Axioms, conditional probability, independence, total probability theorem, Bayes' theorem

2. **Random Variables (Chapter 2)**
   - Discrete and Continuous Random Variables
   - Expected Values: Properties of expectations, variance and standard deviation, covariance and correlation
   - Jointly Distributed Random Variables
   - Moment Generating Functions
   - Limits Theorems
   - Stochastic Processes

3. **Conditional Probability and Conditional Expectation (Chapter 3)**
   - Discrete and Continuous Cases

- Computing Expectations, Variances and Probabilities by Conditioning

4. Markov Chains **(Chapter 4)**

- Chapman-Kolmogorov Equations
- Classification of States
- Limiting Probabilities
- Mean Time Spent in Transient States
- Time Reversible Markov Chains
- Markov Decision Processes

5. The Exponential Distribution and the Poisson Process **(Chapter 5)**

6. Continuous-Time Markov Chains **(Chapter 6)**

- Continuous-Time Markov Chains
- Birth and Death Processes
- Limiting Probabilities
- Time Reversibility

7. Renewal Theory (if time permits) **(Chapter 7)**

- Distribution of the number of renewals by time t (N(t))
- Limit Theorems and Their Applications
- Renewal Reward Processes
- Regenerative Processes
- Semi-Markov Processes

Some Reference Books:

An introduction to stochastic modeling: S. Karlin & H. M. Taylor, NY Academic Press, 1998.

Stochastic Processes, Sheldon Ross, 2nd Edition, NY John Wiley and Sons Inc., 1996.