ORI 390R.5 - Applied Stochastic Processes

Unique 16785

- **Time & Place:** Tue & Thurs 9:30-11:00am, ETC 5.132
- **Instructor:** John J. Hasenbein
- **Office:** ETC 5.128B
- **Phone:** 471-3079
- **Email:** *jhas@mail.utexas.edu* (This is the best way to contact me.)
- **Class Web Page:** `http://www.me.utexas.edu/~has/Stoch.html`
- **Office Hours:** Mondays 2:30-4pm & Wednesdays 10am-Noon. You can also email me for an appointment.
- **Required Text:** *Modeling and Analysis of Stochastic Systems* by Vidyadhar W. Kulkarni (Chapman & Hall).
- **Grading:** Problem sets will be assigned every one or two weeks. There will be one mid-term exam and one final exam. Each exam will be worth 30% of your grade. Your homework average will comprise the other 40% of your grade.

  For the problem sets, you may discuss problems with your classmates and in fact are encouraged to do so. However, you should understand and write-up your own solutions. A good rule of thumb is that you should be able to explain to me the solutions you have submitted.
- **Final Exam:** Take-home final will be given.
- **Prerequisites:** Students should have taken a good introductory graduate or undergraduate course in applied probability, roughly equivalent to ORI 390R.1 - *Applied Probability*. Students should have a good knowledge of such introductory topics as: conditional probability, combinatorial probability, independence, expectation and variance, distribution functions, and basic limit theorems.
- **Students with disabilities:** The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities.
- **Course Evaluation:** Near the end of the course you will have an opportunity to anonymously evaluate the course and instructor using the standard College of Engineering evaluation form.

Course Topics

The goal of this course is to introduce the fundamental stochastic models which are commonly used in engineering and economic applications. With this in mind, we will cover the basic theory of such processes, along with an introduction to some simple applications.

The primary models of interest to us are: discrete-time Markov chains, Poisson processes, continuous-time Markov chains, renewal processes, and Brownian motion. Applications of these models include queueing theory, telecommunications, manufacturing systems, gambling models, genetics, finance, and economics. We will not have time to throughly investigate all the application areas, this course is intended as a springboard for those interested in further exploring these areas. In general, the problem sets will involve the modeling, computational, and theoretical aspects of the topics discussed in class.

Additional References

- *Stochastic Processes*, by Sheldon M. Ross (2nd Edition, Wiley 1996).
- *A First Course in Stochastic Processes*, by Samuel Karlin and Howard M. Taylor (2nd Edition, Academic Press 1975).
- *Adventures in Stochastic Processes*, by Sidney I. Resnick (First Edition, Birkhauser 1992).
- *Introduction to Probability Models*, by Sheldon M. Ross (3rd Edition, Academic Press 1985).

Course Outline

I. Introduction to Stochastic Modeling

- Typical models, applications.
- Gambling models, queueing systems, stock market, computer performance, manufacturing, telecommunications.

II. Discrete-time Markov Chains

- Introduction and applications.
- Transient behavior.
- Computation of matrix powers.
- Limiting behavior - classification of states.
- Transience, recurrence, null recurrence, and aperiodicity.
- Ergodic theorems.
- Markov chain models with costs and rewards.

- Reversibility.

III. Poisson Processes

- Introduction and applications.
- Review of the exponential distribution and properties.
- Alternate definitions of a Poisson process.
- Useful properties: the order statistics property, splitting, and superposition.
- Nonhomogeneous Poisson processes.
- Compound Poisson processes.

IV. Continuous-time Markov Chains

- Introductions and examples.
- Limiting behavior of CTMCs - classification of states.
- Recurrence and transience, ergodicity.
- CTMCs with costs and rewards.
- Reversibility.

V. Renewal Processes

- Introduction and examples.
- The renewal function.
- Solving renewal equations.
- Blackwell's renewal theorem and the Key renewal theorem.
- Recurrence times.
- Alternating renewal processes.
- Renewal processes with costs and rewards.
- Regenerative processes.

VI. An introduction to Brownian motion (if we have time)

- Introduction and applications.
- Definition and properties of Brownian motion.
- Variations of Brownian motion.
- Brownian motion with drift.
- Reflected Brownian motion with applications to queueing networks.