ORIE 3510 / 5510 — Summer 2017

Introductory Engineering Stochastic Processes I

Mon-Fri, 11:30 AM - 12:45 PM, Phillips 307

Instructor: Andrew Daw — amd399@cornell.edu — Rhodes 257
TA: Sergio Palomo — sdp85@cornell.edu

Prerequisites: ORIE 3500 or equivalent.

Credit Hours: 4

Recitation: Tues. & Thurs., 2:30 PM - 4:30 PM, Hollister 320

Course Description & Objectives:

From the official class roster description, this course uses basic concepts and techniques of random processes to construct models for a variety of problems of practical interest. This means that we are going to use the ideas for handling randomness that we know from probability to develop models and perform analysis of systems subject to uncertainty. As in the other facets of Operations Research (OR), we are interested in a "mathematical poetry" in which we translate scenarios, environments, and problems from the real world into a collection of algebraic terms and statements in order to achieve a better understanding of the problems and scenarios we face.

In modeling, we seek to find a valid translation of reality to math and in analysis we seek to find insights in those translations, with the goal of making observations we may not have seen originally. These methods can be applied to virtually any situation in which randomized acts are observed repeatedly, including in hospitals, financial markets, and manufacturing plants, but also in daily life, such as in public transportation commute, rental option comparisons, and deal negotiations. Thus, with these things in mind, the objectives for this course are

- To have strong knowledge of the mathematics behind uncertainty
- To be able to use stochastic models to model, solve, and evaluate problems
- To understand how probability is used in OR and the role it plays in the real world

This will draw upon some prior fundamental knowledge of probability, linear algebra, and calculus, but many key topics will be reviewed and/or will have references provided. Some programming knowledge can be useful for analysis, particularly through linear algebra friendly languages like MATLAB, Octave, and R; however these problems could also be tackled with more general software such as Excel or Google Sheets.

Course Text:

Introduction to Modeling and Analysis of Stochastic Systems, V.G. Kulkarni (PDF free via Springer! Access that here: `goo.gl/xR7rlD`).

This will be the required text for the class, as we will have examples and exercises from it throughout the semester. It's a good read, so it's also a nice way to augment your understanding before or after the material is covered in lecture. It won't ever be necessary for you to have anything but a digital version of it, however, so you do not need to purchase a hard copy. If you're interested in other books on the subject, *Introduction to Stochastic Processes* and *A First Course in Probability*, both by Ross, are good references. These are not required, however, so please don't buy the book unless you actually want to. (But if you do want to, that's great!). Advanced treatments of these subjects beyond the level of this class can be found in two great books by ORIE's own Sid Resnick: *A Probability Path* and *Adventures in Stochastic Processes*. Additionally, an understanding of probability is best built on a solid foundation of sets and logic. This course's suggested reference is *How to Prove It* by Velleman (available free here: `goo.gl/ZdG46j`).

Course Communication:

All class documents, announcements, and grades will be handled through the Cornell Blackboard website: `blackboard.cornell.edu`. All classwide digital communication will be handled through Blackboard, although individual messages via email are fine. In fact, email may be checked more frequently.

Office Hours:

Instructor office hours will be from 1:30 PM - 2:30 PM on Tuesday and Thursday afternoons and 2:00 PM - 3:00 PM on Mondays, Wednesdays, and Fridays. TA office hours are held as needed during the second half of the recitation time slot. Additionally, I am often in my office and I am happy to talk whenever I am there. Feel free to stop by or to send me (or the TA) an email whenever issues arise.

Course Outline:

- Probability review
- Discrete Time Markov Chains
- Point Processes and Poisson Processes
- Continuous Time Markov Chains
- Birth-Death Processes
- Queuing Theory
- Brownian Motion
- Martingales
- Renewal Theory

Note that these are subject to change based on time, interest, direction, etc, and also likely will not be presented in that order in lecture. While we may not get to everything, the objective of this course is to provide a mastery of the core topics underlying stochastic processes, and these will be covered in the review of probability concepts and in the study of Markov chains (both discrete and continuous) and of point processes, particularly the Poisson process. For these topics, the goal is to leave this course *knowing* them rather than *knowing of* them. We'll aim for parallel levels of understanding in the other topics, but in those we will accept as much knowing as the pace of the semester permits.

Grading & Assignments:

Homework:	40%
Prelim:	30%
Final:	30%

There will be at least 6 total homeworks, possibly more depending on time and content. Homework will be collected in lecture and late submissions will not be accepted. Exams will be held in class or in discussion based on the estimated duration of the problems. The prelim will be held in recitation on July 25th. The final will be held on the last day of class for students in undergraduate sections of the course and beforehand for those enrolled in the master's section. There will be practice exams and solutions provided on Blackboard. There will also be occasional in class exercises called Minute Models that are short motivating questions. These are ungraded but factor into a sense of participation used in the homework policy described below.

In general, the homework score will be the average of the score on all 10 assignments. However, if you complete the final course evaluation, regularly attend lecture and participate in the Minute Models, and make a conscientious attempt at each assignment, the homework average will be calculated as

$$\min\left\{100\%,\ \frac{1}{9}\sum_{i=1}^{10}\text{Homework Score}_i\right\}.$$

In either case, homework cannot be worth more than 40 points of your final course grade.

Academic Honesty, Cornell Community, & Group Work:

All students are expected to be abide by Cornell's Code of Academic Integrity, which can be found at this link: `goo.gl/FMt3kX`.

To promote discussion and development of ideas, there will be optional group work sessions for students to form group to think, study, and work with. These will be held during the recitations. However, any solution or assignment that is submitted must be solely by the author alone, and so this group work must be done on chalk/whiteboards with note taking prohibited. When in doubt over acceptable levels of collaboration, consult the instructor or TA. Copying of answers is prohibited, and will result in failed assignments as well as potential further academic integrity review and disciplinary consequences. As a simple rule of thumb, if you didn't do it, don't turn it in.

Finally, the course as described here includes some elements (flexible grading, homework calculation, textbook PDF link, etc.) that are designed to be advantageous resources for students and representatives of the understanding that sometimes, simply, life happens. In the event that your circumstances require more support than these provide, Cornell has made it a mission to be a caring community, and it has made sure that there are resources available to you. If you'd like to learn more those resources, visit `caringcommunity.cornell.edu` or reach out to the other Cornellians (faculty, staff, and students) around you. Please contact me whenever I can be of help.