

Applied Stochastic Processes

Course Syllabus

Instructor	Office	email	Telephone
Glen Takahara	Jeffery 407	takahara@mast.queensu.ca	533-2430

Lectures Tues. 8:30 – 9:20 , Wed. 10:30 – 11:20, Fri. 9:30 – 10:20

Location Jeffery 110

Required Text *Introduction to Probability Models, 9th Ed.* by Sheldon M. Ross, Academic Press, 2006. At Queen's bookstore (<http://www.campusbookstore.com>) the text sells for \$112.43 (new) or \$84.50 (used). The 8th Edition can also be used for the course (on homework problems I will also give the corresponding 8th Edition problem numbers when they exist, and when they don't exist I will write the problem out on the homework sheet). Two copies of the text will be on reserve in the Engineering and Science Library for 3 hour loans. If you have real financial difficulty purchasing this book then please come see me.

Course Web Page <http://www.mast.queensu.ca/~stat455/>

Tutorials Wednesdays 1:30 – 2:20. The purpose of the tutorial is to be an hour during which you can work on homework problems in the company of classmates during which I will be present as a resource to answer questions and provide whatever help I deem appropriate. The tutorial time may also be used to review concepts from class and to work out practice problems. The tutorial time will not be used to present new material.

Office Hours Wednesdays 9:30 – 10:30, Fridays 10:30 – 11:30 or by appointment.

Purpose and Course Description

Purpose: Many systems evolve over time with an inherent amount of randomness. The purpose of this course is to develop and analyse probability models that capture the salient features of the system under study to predict the short and long term effects that this randomness will have on the systems under consideration. The study of probability models for stochastic processes involves a broad range of mathematical and computational tools. This course will strike a balance between the mathematics and the applications.

Description: This course is intended for first or second year graduate students with some background in probability (Stat 855) and upper year undergraduate students in mathematics and engineering, statistics, or mathematics. The lectures are the same for all students but the work load will differ for graduate and undergraduate students. The plan for the course is to cover

- Conditional Probability and Conditional Expectation.
- Markov Chains in discrete time.
- The Poisson Process.
- Markov Processes in continuous time.

These topics are covered in Chapters 3, 4, 5, and 6, respectively. We will also cover generating functions and their application to the analysis of stochastic processes. Material in Chapter 10 on Brownian Motion and weakly stationary processes may be covered as time permits.

Prerequisites Stat 353 or Stat 351 (or equivalent) with permission of the instructor.

You should have an operational familiarity with the following basic probability concepts: *sample space, events, probability axioms, basic rules of probability, independence, equally likely outcomes and counting arguments, conditional probability, Bayes' Theorem, random variable, probability density function (pdf), probability mass function (pmf), cumulative distribution function (cdf), expected value, moments, moment generating function, variance, standard deviation, covariance, correlation, conditional distribution*. You should also have heard of the following families of distributions: *Geometric(p), Bernoulli(p), Bin(n, p), Negative Binomial(r, p), Poisson(λ), $N(\mu, \sigma^2)$, Exponential(λ), Gamma(α, β), Uniform(a, b).* In addition, *proof by induction, Taylor series expansion, Geometric series, Law of Total Probability, Central Limit Theorem, Law of Large Numbers*.

From time to time our analysis of stochastic processes will require some basic results from linear algebra, differential equations, analysis, and number theory that I will review or introduce as required.

Required Work and Grading Criteria The required work consists of homework problems, one midterm exam, and one final exam. The breakdown of marks is:

Assignments 40% , Midterm 20%, Final 40%.

Homework Assignments: There will be 6 or 7 homework assignments based on the material presented in the lectures. Check the **announcements** link on the course web page for due dates of homeworks.

Doing the homework problems is an integral part of the course. Experience has shown that doing the problems can require some careful thought, sometimes over a period of several days. **Do not start homeworks The day before they are due.** The homeworks will be available on the course web page through the **assignments** link. I encourage discussion of homework problems with your classmates, but all assignments must be written up individually. I will accept one late assignment without deducting marks, as long as the assignment is handed in before solutions are posted. Additional late assignments will be accepted if there is a valid medical reason. No assignments will be accepted after solutions have been posted.

Midterm Exam: There will be a 2 hour midterm exam, to be scheduled. The midterm exam is closed-book. A non-programmable calculator and one $8\frac{1}{2} \times 11$ inch sheet of

paper with whatever you like on it (both sides) can be used in the midterm. It should be possible to reschedule the midterm exam in the event of unresolvable scheduling conflicts. Please let me know of any such scheduling conflicts you have as soon as possible. If you miss the midterm exam, I will give you a makeup exam *if you have a debilitating medical reason documented by the University*.

Final Exam: There will be a 3 hour final exam to be scheduled by the exams office. Check the *announcements* link on the course web page for up-to-date information on the time and place of the final exam. Like the midterm exam, the final exam is closed-book, and you may bring one $8\frac{1}{2} \times 11$ inch sheet of paper and one non-programmable calculator (*NB: Students in applied science will require a gold sticker on their calculator. Go to <http://appsci.queensu.ca/policy/calculator.php> for information on how the Faculty of Applied Science categorizes calculators for use in examinations and how to obtain a gold sticker if you don't already have one*). The final exam is *cumulative*, so it will cover all the material from the beginning of the course. However, I will provide more detailed information on specific sections to study for the final exam during the final week of class. If you miss the final exam, I will give you a makeup exam *only if you have a debilitating medical reason documented by the University*.

Books on reserve in the Engineering and Science Library

1. *Fundamentals of Probability with Stochastic Processes, 3rd Ed.* by Saeed Ghahramani, Prentice Hall, 2005 : *The text for Stat 351 and Stat 353, chapters 1 – 11.*
2. *Introduction to Probability Models, 9th Ed.* by Sheldon Ross, Academic Press, 2007 : *The course text.*

The above books are on reserve for 3 hour loan.