

# Stochastic Processes

## Stat219/Math136

### Fall 2008

**Place:** Building 260 (Pigott Hall, Language Corner) Room 113

**Time:** Monday, Wednesday, Friday, 11:00am – 11:50am

**Instructor:** Kevin Ross, kjross@stanford.edu, Sequoia Hall room 113

Office hours: Monday 2:45 – 3:45pm, Friday 3:30 – 4:30pm

Instructor's office hours will usually be held in Sequoia Hall room 105 (library)

#### Teaching Assistants & Office hours

Li Ma	ma2@stanford.edu	Sequoia 208	TBA
Camilo Rivera	camilor@stanford.edu	Sequoia 227	TBA
Bo Shen	bshen@stanford.edu	Sequoia 229	TBA

**Course website:** <http://coursework.stanford.edu>

Please check the website regularly for announcements and other course materials (e.g. lecture slides, homework solutions, practice exams). If you are enrolled in the course, you should have access to the website; send an email to HelpSU if you have problems. If you are auditing the course send an email to the Instructor to get access to the website.

#### Course Goals

This course prepares students for a rigorous study of Stochastic Differential Equations, as done in Math236/Stat316. Towards this goal, we cover — *at a very fast pace* — elements from the material of the (Ph.D. level) Stat310/Math230 sequence, emphasizing the applications to stochastic processes, instead of detailing proofs of theorems. A critical component of Stat219/Math136 is the use of measure theory.

The Stat217-218 sequence covers many of the same ideas and concepts as Stat219 but from a different perspective. The Stat217-218 sequence can be seen as an extension of undergraduate probability (e.g. Stat116) in both level of mathematical sophistication (i.e. no measure theory) and in emphasis on “real world” applications (modeling, computation, etc). Thus, it is possible, and in fact recommended, to take both Stat217-218 and Stat219 for credit. However, be aware that Stat217-218 alone is NOT adequate preparation for Math236.

Main topics of Stat219/Math136 include: introduction to measurable,  $L^p$  and Hilbert spaces, random variables, expectation, conditional expectation, uniform integrability, modes of convergence, stationarity and sample path continuity of stochastic processes, examples such as Markov chains, branching, Gaussian and Poisson processes, martingales and basic properties of Brownian motion.

#### Prerequisites

Students should be comfortable with probability at the level of Stat116/ Math105/ Math151 and with real analysis (a.k.a. advanced calculus) at the level of Math115. See the course

website for a summary of prerequisite topics. For a good review of undergraduate probability see the optional Grimmett & Stirzaker text. Appendix A of the optional Rosenthal text includes a brief review of prerequisite material from real analysis.

### Required Text

Amir Dembo's Stat219/Math136 lecture notes (September 25, 2008 version). Download the .PDF file from the course webpage.

Read each section of the notes **prior to the corresponding lecture** (see schedule below). When doing so, you may skip items marked as "omit at first reading".

### Optional Texts (on sale at the bookstore & on reserve in the Math & CS Library)

All course material and homework assignments are contained in the required text. While neither of the following texts is required, but both are good supplements to the lecture notes and are excellent references for future study.

- Rosenthal, *A First Look at Rigorous Probability Theory*, 2nd edition. Focuses on measure-theoretic probability and discrete time stochastic processes, rigorously proving all main results while avoiding excessive technicalities.
- Grimmett & Stirzaker, *Probability and Random Processes*, 3rd edition. No measure theory, but contains a comprehensive introduction to probability and stochastic processes with lots of applications, examples, and exercises.

### Other References

There are many excellent texts covering probability and/or stochastic processes. We list here just a few, which are on reserve in the Math & CS Library. (See also the list of references in Appendix B of the Rosenthal text.)

- Ross, *Stochastic Processes* (for treatment of stochastic processes without measure theory, as in Stat218, and more problems/examples).
- Karlin and Taylor, *A First Course in Stochastic Processes*, Ch. 6, 7, 8 (many examples and applications of martingales, Brownian motion and branching processes).
- Lawler, *Stochastic Processes* (more modern examples and applications than in Karlin and Taylor).
- Lefebvre, *Applied Stochastic Processes*. (no measure theory, but lots of examples, applications, and exercises).
- Shreve, *Stochastic Calculus for Finance II: Continuous time models*, Ch. 1, 2, 3, A, B (covering same material as the course, but more closely oriented towards stochastic calculus).

## Grading & Exam Schedule

Homework	25%	Due each Wednesday in class
Midterm	25%	Friday, October 24, 11:00am – 12:30pm (note: 90 minute exam)
Final	50%	Monday, December 8, 8:30am – 11:30am

Exams will be open book; a list of allowed materials will be provided before the exam.

NO MAKE-UP EXAMS will be given except for serious illness, religious holidays, or family emergencies. Students who miss the final will receive an automatic failure in the course. In any case, if you anticipate difficulty in taking the examination at the scheduled time, you should contact the course instructor as soon as possible.

## Homework

Homework problems will be posted on the course webpage. A tentative homework schedule is included on page 127 of the class notes; however, be sure to check the website for the final assignment.

Homework is due IN CLASS on the due date. NO LATE HOMEWORK WILL BE ACCEPTED. The lowest homework grade will be dropped to accommodate for emergencies and late enrollment.

Collaboration is allowed in solving the problems, but each student should hand in his or her own independently written solutions. You are strongly encouraged to see the instructor or TA's during office hours if you have questions about the homework assignments (or about the course material in general.)

Assignments will be graded by the following Wednesday and returned in class. Homework solutions will be posted within 24 hours of the due date.

**Schedule** (Read corresponding sections of lecture notes before class)

<b>Week beginning</b>	<b>Monday</b>	<b>Wednesday</b>	<b>Friday</b>
9/22	1.1	1.1-1.2.2	1.2.2, 1.2.3
9/29	1.3.1, 1.4.1	1.3.2, 1.4.1	1.4.2, 1.4.3
10/6	2.1, 2.2	2.3	2.4
10/13	3.1	3.2	3.3
10/20	5.1	Review	Midterm
10/27	4.1.1, 4.1.2	4.1.3	4.2
11/3	4.3.1	4.3.1, 4.3.2	4.3.2, 5.2
11/10	4.4.2, 4.5	4.4.1, 5.3	4.6
11/17	6.1	6.1	6.2
11/24	—	—	—
12/3	6.2	6.3	Review