

MATHEMATICS 154, SPRING 2009
MATHEMATICAL PROBABILITY

Instructor: Lauren Williams

Office: Science Center 432.

Email: lauren@math.harvard.edu

Office Hours: My official office hour is Tuesday 2:30-4:00 in Science Center 432. If you want to meet at another time, email me to arrange it.

Course Assistants:

- Charles Chen chen33@fas.harvard.edu
- Yi Sun yisun@fas.harvard.edu

Course Website: <http://www.math.harvard.edu/~lauren/154.html>

Goals and Prerequisites: This is a moderately rigorous course in probability theory and its applications. A nice feature of probability is that it presents subtle issues involving the infinite in contexts that appear realistic in the sense that you could imagine betting on the outcome of the questions that was posed. So while the course will require only infinite series (Math 1b), multivariable calculus (Math 21a or Math 23b, perhaps concurrently) and a bit of linear algebra (Math 21b or 23a), it will lead naturally into areas such as set theory and elementary measure theory. Freshmen who did well last term in Math 21, 23, 25, or 55 are welcome to take the course.

Texts:

Probability and Random Processes, Grimmett and Stirzaker, third edition, Oxford University Press, 2002, ISBN# 0-19-857222-0 (at the Coop)

One Thousand Exercises in Probability, Grimmett and Stirzaker, Oxford University Press, 2002, ISBN# 0-19-857221-2 (at the Coop)

The course will follow the order of topics in the textbook (PRP) fairly closely, although we will cover only the first half of the book. In particular, Chapters 1-5 of Grimmett and Stirzaker will be covered quite thoroughly. Coverage of chapters 6 and 7 will be limited to a couple of interesting topics.

Course Meetings: The course meets Tuesdays and Thursdays from 1-2:30 PM in Science Center 110. *Lecture outlines* (about 200 pages in all) will be posted on the Web site. You must bring printed copies to class, since lectures will be largely devoted to filling in the blank spaces in the outlines.

There will be additional small weekly problem sessions (8-10 students in each) led by the course staff. These will not be optional “help sessions.” Instead, members of the class will be assigned problems to present at the blackboard, drawn from the collection of 1000 solved problems that accompanies the textbook. Participation in these sessions will count for one-third of your homework grade, and graded written problem sets will be shorter than usual.

Permission to post your section assignment: If you want to learn your section assignment from a list on the Web site, you must give your signed permission on the sectioning form that will be filled in on Thursday, Feb. 5.

If you do not sign a permission form, then it is your responsibility to send me an email before Sunday, Feb. 8, to learn what section you are in.

Homework: Homework (five or six problems) will be assigned weekly and will be due at the start of Thursday’s class. The CA will return your corrected homework to you at the following class.

Six problems will be assigned for each weekly section. You will be responsible for preparing three of these to present at the blackboard, and exams will assume that you become familiar with all six. The solutions are all in One Thousand Exercises in Probability, but they take a while to understand!

Homework that is handed in after the Thursday when it is due will not be graded. If it looks fairly complete, you will get a grade of 50% for it. No late homework will be accepted after May 14, the last day of Reading Period.

The last day to drop and add courses is March 2. By then you will have gotten back several problem sets.

Before homework scores are totaled, your worst score will be converted to your best score.

You are encouraged to discuss the course with other students, your CA and the instructors, *but you should always write your homework solutions out yourself in your own words. Additionally, if you work with other students, you must write their names at the top of your homework.*

Casino Night: This special event will be held in the Quincy House SCR from 9-11 PM, probably on Thursday, April 16. Craps, roulette, poker, and blackjack will be available. If you and your guest both don formal attire, you can have \$1000 in play money to work with. The six biggest winners get a little extra credit.

Programming Projects: There are two optional programming projects, one

on discrete random variables and one on random walks. On the Programming Projects page of the Web site are detailed instructions for implementing these in the object-oriented scripting language PHP. If you happen to know PHP, or if you would like to learn how to write simple client-server software, you are welcome to do these projects. Prior experience with PHP or HTML is not necessary, but the ability to write and debug simple programs in a language such as C, C++, or Java is essential.

You can get up to 5 points of extra credit for doing one of these assignments (you won't get more for doing both), with the exact number dependent on what features you choose to implement. You are basically on your own for this assignment, and need to be skilled in object-oriented programming to do it.

Exams: There will be two quizzes and one final exam.

The first quiz will be in-class on Tuesday, March 3. The second quiz will be on *Monday, April 6, from 7-9 PM*. You will need about an hour to do the quiz, but you may use more time if you like.

Please make sure you are available for the quizzes. Makeup quizzes can be arranged if you have a valid excuse and get permission in advance.

A practice version of each quiz will be available on the course Web site.

Students who will need accommodations for the quizzes should bring me their letters from the AEO as soon as possible, since I will need to find extra rooms and proctors.

The final exam will be comprehensive, with fairly uniform coverage. It is a standard, proctored 3-hour final, not a take-home exam.

Grades: Your course grade will be determined as follows:

- problem sets, 40 points.
- problem session presentations, 20 points.
- two quizzes, 20 points each.
- final exam, 100 points.
- extra credit for being a big winner at Casino Night, 1-5 points.
- extra credit for optional programming projects, 1-5 points.

The total points available, exclusive of extra credit, are thus 200. The grading scheme is as follows:

Points	Minimum Grade
93%	A
87%	A-
81%	B+
75%	B
69%	B-
63%	C+
57%	C

List of Topics:

<u>Date</u>	<u>Topics</u>
January	29 Countability and Uncountability
February	3 Sets and Probability
	5 Infinite Unions and Infinite Series
	10 Combinatorics, Bridge, and Poker
	12 Conditional Probability and Independence
	17 Simpson's Paradox explained by Conditional Probability
	19 Random Variables, Law of Averages
	24 Discrete Random Variables, Expectation
	26 Variance
March	3 QUIZ 1
	5 Matching Problems, Poisson Distribution
	10 Negative Binomial Distribution, Conditional Expectation
	12 Simple Random Walk and Gambler's Ruin
	17 Ballot theorem and Reflection Principle
	19 Arc Sine Laws for Random Walks
	31 Continuous Distributions and Random Variables
April	2 Functions of Random Variables
	6 QUIZ 2
	7 Bivariate Normal Distribution
	9 Two Random Variables
	14 Change of variable; convolution
	16 Geometric Probability (Bertrand's Paradox, Crofton's method)
	16 CASINO NIGHT
	21 Generating Functions, random walks via generating functions
	23 Famous Inequalities, Weak Law of Large Numbers
	28 Central Limit Theorem, Strong Law of Large Numbers
	30 Markov Processes
May	19 FINAL EXAM