Final Study Guide
3160 Probability, Fall 2009

This is a preliminary study guide for chapters 4–8; for now, please consult the study guide for midterm 1 for the earlier chapters.

You will be allowed to bring one page (front and back side) of your own, hand-written notes. There will be one to three problems where you will have to deduce a formula from first principles (e.g. "compute the expectation and variance of the exponential random variable with parameter λ"). For all other problems, you will be allowed to use formulas given in the book.

About one third of the final will cover the new material (chapters 7 and 8).

Most importantly, you should review the quizzes and midterms (but a topic mentioned below or in the study guides for the midterms that didn't appear as a problem in the test may still appear in the final).

You should be familiar with all the standard random variables that appeared over and over in the course (from the lists in chapter 7, we only skipped the hyper-geometric random variable). Below is a short list of what you should be able to do, as related to every chapter. *Some topics are in italics, as I especially recommend to review these—you should try to do several problems related to each such topic as practice.*

Chapter 1 - Counting There are just two basic princples in this chapter (but of course many problems): counting of permutations and combinations (binomial coefficients, multinomial coefficients), and the multiplication rule ("basic principle of counting"). Repractice them if you don't feel familiar with the related problems in the quizzes and midterm.

Skip: 1.6, problems marked with an asterisque.

Chapter 2 - Basics of Probability No problems will specifically related to 2.2 or 2.3. Use inclusion/exclusion principle in simple examples (p. 56 no. 9) or more complicated examples (p. 60 no. 54) (2.4). *Compute probabilities by counting (2.5).*

Skip: 2.6.

Chapter 3 - Conditional Probability Use the definition of conditional probability; use the multiplication rule (3.2). Use the partition formula (equation 3.1); *use Bayes' formula* (3.3). *Test independence of events; use independence of events* (3.4). Use probabilities that are updated according to new information (3.5 example 5a)

Skip: Gambler's ruin in 3.4. Anything besides example 5a in 3.5.

Chapter 4 - Discrete Random Variables Compute simple examples of random variables (4.1). Compute expectation values in examples (4.3). Use the formula $E[(g(X)] = \sum g(x_i)p(x_i)$ (4.4). Compute variance in examples (4.5). Use binomial random variable in examples (4.6). Use Poisson random variable in examples (4.7). Use the geometric random variable (4.8.1).

Skip: 4.6.2, 4.8.2, 4.8.3, 4.8.4, 4.9.

Chapter 5 - Continuous Random Variables Use probability density functions (5.1). Compute expectation and variance in examples; compute $E[g(X)]$ (5.2). Use uniform/normal/exponential random variable in examples (5.3/5.4/5.5). Use approximation of binomial by normal (5.4.1). If $Y = g(X)$, compute $f_Y(y)$ when given $f_X(x)$, either using the method in examples 7a-7c or using Theorem 7.1 (5.7).

Skip: 5.5.1, 5.6

Chapter 6 - Joint distributions of random variables Use joint probability mass function and joint probability density functions–in practice this often needs (6.1). *Use independence of random variables.* This is the most important topic of chapter 6, it would be good to go through our chapter 6 homework problems as a review (6.2). Compute distribution of $X + Y$ for independent random variables (equation 3.2); sum of independent normal random variables (proposition 3.2) (6.3). Compute conditional probability distributions (6.4, 6.5).

Skip: 6.6, 6.7.

Chapter 7 Compute an expectation value as a sum of expectation values (7.2). Compute and use covariance and correlation (7.4). Use moment generating functions; identify random variables from their moment generating function; use $M_{X+Y}(t) = M_X(t)M_Y(t)$ (7.7).

Skip: Anything else (including 7.3 and 7.7.1).

Chapter 8 Use Markov's inequality, use Chebyshev's inequality (8.2). Use the central limit theorem (8.3).