Math 312 - Mathematical Statistics - Spring 2010
Instructor: Jeff Hamrick
Course Syllabus

ON STATISTICS. The seeds of statistics—which is often considered a mathematical science quite distinct from mathematics itself—were sown in the 17th century, with the development of probability theory by Blaise Pascal and Pierre de Fermat. Probability theory itself arose due to interest in games of chance. In contrast to probability theorists (who propose probability models and then study those models with somewhat less regard for the random realizations generated by those models), statisticians are interested in the random realizations themselves (called **data**), and what those random realizations suggest about the parameters that govern the (perhaps unknown) underlying probability models.

A critical development in the history of statistics was the method of least squares, which was probably first described by Carl Friedrich Gauss in 1794. Early applications of statistical thinking revolved around the needs of states to base public policy on demographic, economic, and public health data. The scope of the discipline of statistics broadened in the early 19th century to include the collection and analysis of data in general. Today, statistics is widely employed in government, business, and the natural and social sciences. Computers are transforming the field at a breathtaking pace.

Statistics is widely considered an exciting, dynamic, and intrinsically interdisciplinary science. The work of statisticians powers search engines like Google, has proven critical to the exploration of the human genome, and is used by hedge fund managers to detect arbitrage opportunities (risk-free trading strategies that yield profit with positive probability) that are profitable *only on average* (called **statistical arbitrage**). *The New York Times* recently declared that statisticians will enjoy one of the highest-paying, highly-coveted careers over the next decade. I hope you'll enjoy learning a little bit about statistics this semester with me!

ON COURSE GOALS. Any student who successfully completes this course should:

- Understand the importance, significance, and interpretation of a *sequence* of random variables;
- Understand the various senses in which a sequence of random variables can be said to *converge*;
- Model and simulate the occurrence of events using probability distributions that are particularly important to statisticians, including the beta, Student's t, chi-square, and F ratio distributions;
- Understand the conceptual underpinnings of point estimation and elementary tests of hypothesis;
- Be able to describe the various attributes that make an estimator attractive, including unbiasedness, sufficiency, consistency, completeness, uniqueness, and minimal sufficiency;
- Understand what it means for a statistical test to be a *uniformly most powerful* test; and
- Develop a sensitivity to, and a working knowledge of, the importance of nonparametric alternatives to the usual parametric hypothesis tests.

In general, this course will prepare successful students for undergraduate- and graduate-level research projects in the social and natural sciences, as well as for further study of statistics, probability theory, and stochastic analysis at the graduate level.

ABOUT ME. My name is Jeff Hamrick. I'm an assistant professor in the Department of Mathematics and Computer Science at Rhodes College. Please call me Jeff. My office is located in room 318 of Ohlendorf Hall. I will hold office hours from 11:00 a.m. - 12:00 noon on Mondays, 3:00 p.m. - 4:00 p.m. on Wednesdays, and 1:30 - 4:30 p.m. on Thursdays during the spring semester. My office number is 901/843-3253 and my e.mail address is `hamrickj@rhodes.edu`. Please stop by my office anytime. If you're unable to make my office hours, let me know and we may be able to schedule an appointment at an alternate time.

ABOUT YOU. You should be hard-working and enthusiastic about learning! This course features a fairly traditional treatment of mathematical statistics (with at least one special topic at the end of the course), so you should already have taken Math 311 or the equivalent course at some other institution.

ABOUT US. We will meet to talk about mathematical statistics on Mondays, Wednesdays, and Fridays from 2:00 p.m. - 2:50 p.m. during the spring semester. We will meet in Buckman Hall 110. We will use *Introduction to Mathematical Statistics*, by Robert Hogg, Allen Craig, and Joseph McKean (ISBN: 978-0130085078). We will more or less cover everything after (and including) chapter 5, though we will not necessarily cover every section in every chapter.

A warning to you: The first several chapters of this textbook *should* be familiar material at this point. If you need to review this material, please do so rapidly and intensively at the *beginning* of the semester before you fall hopelessly behind!

ON PREREQUISITES. On the first day of class, I will give out a take-home examination covering topics from calculus-based probability theory. You may work on this examination with one another so that you have an opportunity to recall some pretty important probability concepts, to practice using the language of probability theory, and to get to know one another better. This examination will count towards your final grade in this course and **will be due in my office on January 20, 2010 at 5:00 p.m.** If you find yourself utterly lost or totally unaware of some of the critical probability concepts considered on this examination, you may want to consider re-taking (or auditing or reviewing) Math 311 or the equivalent before attempting to master the material in this course. **In short, you are expected to recall basic results from probability theory.**

Yet another warning: this course is, in a sense, similar to a basic calculus course, a computer science course, and a point-set topology course. We will execute calculus-like computations by hand, write computer software to explore estimators and think about inference, and construct proofs of theorems. Statisticians must do a little bit of everything and they must do all of it well!

ON ATTENDANCE. Attendance is expected in this course but is neither required nor rewarded. You may only miss a midterm examination under the most dire of circumstances, and even then only with advance consent from me.

ON HOMEWORK. Problems from the textbook will be assigned during each class period. They will be noted on the chalkboard or a worksheet. I expect you to work on these homework problems very frequently but for short periods of time. In general, I encourage you to work with your colleagues on any of the assigned problems, subject to the caveat in the next paragraph.

Approximately every 10-12 calendar days, I will ask you to write up a handful of the previously assigned homework problems. **Once I make a formal assignment, you are no longer permitted to work with your colleagues on the assigned problems, consult with other parties, or use resources other than the course textbook.** I typically will give you very short notice (approximately 48 hours) to write up a formal homework assignment. It should not take long to write up your results since you should have been working on the problems anyway.

A special opportunity: LaTeX is the most prominent document preparation package used by mathematicians, economists, and other scientists. For each formal homework assignment for which you **nicely** type up your results in LaTeX (I prefer to use WinEdt with MiKTeX), I will increase your final grade in the course by two-thirds of one percent (2/3%). The web is filled with information on how to download, install, and use LaTeX, and I am happy to answer your questions about LaTeX too. (This extra credit opportunity does not apply to class projects.)

Each day, I will allot a few minutes of class time for homework-related questions. We won't have enough time to discuss many questions, so please come to my office hours. **I will not accept late homework assignments under any circumstances.** Instead, at the end of the semester, I will drop your lowest homework grade.

ON CLASS PROJECTS. In this course, we will complete four projects involving both simulation and/or real-world data. For projects that are relatively intensively focused on simulation, I will ask you to use Mathematica. For projects that are more oriented towards real-world data, I will most likely let you use Mathematica, Stata, SPSS, SAS, or some other comparable statistical package. **Please note: you will most likely have to take the initiative and learn to use a package like SPSS, SAS, or Stata on your own or with the aid of your (very generous) colleagues!**

ON MIDTERM EXAMINATIONS. Three times during the semester, we will pause and take a brief, 90-minute midterm examination. Each examination will focus on material that we have recently (but not too recently) discussed in class. Each examination will also feature a take-home component with a single question possessing multiple but related parts. You must work on the take-home component by yourself without any reference to any materials except the textbook and your class notes.

ON THE FINAL EXAMINATION. A final, written, comprehensive 2.5-hour examination will be held on December 7, 2010 at 8:30 a.m. in Buckman 110.

ON GRADING. I've noticed that students are too focused on grades, to the great detriment of their own learning. If students put as much effort into actually learning material as they did worrying about their grades, their performance would be much better. Nevertheless, part of my job is to assign grades fairly and in a manner that reflects the high academic standards at Rhodes College. In this class, we will use the standard ten-point scale. "Plus" or "minus" grades will be assigned to students with grades close to the extremes of each ten-point bracket (plus or minus three points from the boundary of each bracket). **In general, I do not inflate grades. Specifically, I do not curve final grades in this course. The "curve" is the make-up examination policy. See the section below.**

Your grade in this course will be computed according to the following weights:

Component	**Weight**
Initial Take-Home Examination	6%
Homework	20%
Midterm Examinations	24%
Final Examination	20%
Class Projects	30%

ON RETAKING EXAMINATIONS. Grades will not be curved at the end of the semester. I subscribe to the somewhat radical and non-modern notion that students should receive grades

that indicate how much they have actually learned. However, I also believe in making learning objectives clear and attainable for a reasonably bright, reasonably hard-working student.

More importantly, I believe that when students do poorly on an examination, they should have the opportunity to review their errors, learn from those errors, and then demonstrate that they have acquired an improved mastery of the material. Hence, there will be an opportunity to obtain "grade forgiveness" in this course.

The opportunity for "grade forgiveness" will be during the final examination. You may attempt to replace any or all of your earlier midterm examination grades by retaking those examinations. By retaking an earlier examination, you are irrevocably committing to replacing the grade you earned on the earlier attempt. It is possible to do worse on make-ups than on the original examinations and end up in a worse position! You will have to tell me if you want to re-attempt an examination several days prior to the final examination.

You may not re-take the initial review examination that covers topics from probability theory. Because of time constraints, you will not have an opportunity to re-take the final examination.

You should plan on allocating 90 minutes of your time for each make-up examination. So, for example, if you plan on re-taking the first midterm examination on the day of the final examination, you will have to stay 90 minutes after class to do so. You may need to stay up to nearly five hours (!) after class if you want to do all of the possible make-ups. (We may have to find a special location for the make-up examinations; details are forthcoming.)

ON MISSING EXAMINATIONS. I do not, under any circumstances, offer make-up examinations due to absence or sickness. You must plan on taking each examination. If you miss an examination, you may simply opt to do the corresponding make-up examination at the end of the semester.

ON CHEATING. In this class, we will adhere to the provisions of the Rhodes College Honor Code. In general, I encourage you to do the homework problems with colleagues **until, and only until, the official write-up period begins.** Obviously, you may not work with other students on examinations and you may not use crib notes, a calculator, or your textbook during an examination. In general, if the Rhodes College Honor Council concludes that a student in this course has violated the honor code, I will adhere to the recommendations of the honor council. However, I reserve the right to lower a student's grade in this course if I sincerely believe that an infraction has occurred.