ORI 390R.1 - Applied Probability

- **Time & Place:** Tues & Thurs 11:00am-12:30pm, ETC 5.132
- **Professor:** John J. Hasenbein
  - **Office:** ETC 5.128B
  - **Phone:** 471-3079
  - **Email:** *jhas@mail.utexas.edu* (This is the best way to contact me.)
  - **Office Hours:** Mondays 10:30am–12noon. You can also email me for an appointment.
- **Class Web Page:** All class materials will be posted on *Canvas*.
- **Required Text:** *A First Course in Probability, 9th Edition* by Sheldon Ross (Prentice Hall).
- **Additional Reference:** *An Intermediate Course in Probability* by Allan Gut (Springer-Verlag).
- **Grading:** Problem sets will be assigned about once a week. There will be one mid-term exam and one comprehensive final exam. The mid-term exam will be worth 35% of your grade. The final exam will be worth 40% of your grade. Your homework average will comprise the other 25% of your grade.

  For the problem sets, you may discuss problems with your classmates and in fact are encouraged to do so. However, you should understand and write-up your own solutions. A good rule of thumb is that you should be able to explain to me the solutions you have submitted.
- **Exams:** You are required to take all exams to pass the course. Make-up exams will not be given without a valid medical excuse.

  The first exam will be given on Thursday, October 16th, during class.

  The final exam will be given at the university scheduled time, which should be Saturday, December 13th, 9am-12pm. No early final exams will be given. You must take the final at the university scheduled time to pass the class.
- **Grading Appeals:** If you believe a mistake has been made in grading a homework or exam, you must appeal within one week of receiving the graded homework or exam. After one week, no grading changes will be made.
- **Email Communication**: For this class, email will be used as an official form of communication for notifying you of new homework assignments and other class updates. The University of Texas email policy can be found at

http://www.utexas.edu/its/policies/emailnotify.html.

Here is a portion of that policy, which is in force for this class: "Students are expected to check e-mail on a frequent and regular basis in order to stay current with University-related communications, recognizing that certain communications may be time-critical. It is recommended that e-mail be checked daily, but at a minimum, twice per week. Regular e-mail management will also minimize the risk that the inbox will be full, causing the e-mail to be returned to the sender with an error. Undeliverable messages returned because of either a full inbox or use of a "spam" filter will be considered delivered without further action required of the University."

- **Prerequisites:** Graduate standing is required. Other prerequisites are multivariable calculus and an undergraduate course(s) in probability and statistics.
- **Students with disabilities:** The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TTY.
- **Course Evaluation:** Near the end of the course you will have an opportunity to anonymously evaluate the course and instructor using the standard College of Engineering evaluation form.
- **Class Web Site and Privacy:** For this class, web-based, password-protected class sites will be available via the *Canvas* system. The syllabus, handouts, assignments and other resources are types of information that may be available within this site. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, a class e-mail roster will be a component of the site. Students who do not want their names included in this electronic class roster must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information see: http://registrar.utexas.edu/students/records/restrictmyinfo.

Course Outline

The topics below are those we tentatively plan to cover during the semester. Some topics will be covered in more depth than the Ross text provides.

I. Axioms of Probability

- Basic set theory, countable and uncountable sets
- Sample space, events
- Axioms and basic properties of probability
- Boole's inequality, continuity of the probability measure

II. Combinatorial Probability

- Sample spaces with equally likely outcomes
- Multiplication rule
- Combinations, permutations, multinomials

III. Conditional Probability and Independence

- Conditional probability
- Independent events, law of total probability, mutual vs. pairwise independence
- Bayes' Theorem, multiplication rule for dependent events

IV. Discrete Random variables

- Definition of discrete r.v.'s
- Examples: binomial, negative binomial, geometric
- Poisson r.v.'s and the Law of Small Numbers
- Hypergeometric r.v.'s
- Expected value of discrete r.v.'s
- Expected value of a function, variance
- Properties of variance, Chebyshev's inequality
- Cumulative distribution functions

V. Continuous Random Variables

- Definition of continuous r.v.'s, density and distribution functions
- Properties of c.d.f.'s,
- Expectation and Variance
- Examples: uniform, Pareto, exponential, Cauchy, normal
- Approximating binomial distribution with a normal
- Functions of r.v.'s, calculating transformed density functions

VI. Jointly Distributed Random Variables

- Definition of multivariate r.v.'s, density and distribution functions
- Marginal distributions, independent r.v.'s (pairwise and general cases)
- Functions of several random variables, calculating transformed density functions
- Sums of independent r.v.'s
- Conditional distributions

VII. Properties of Expectation

- Law of the Unconscious Statistician, expectation of sums
- Covariance and properties, correlation coefficients
- Conditional expectation and variance

VIII. Limit Theorems and Convergence

- Four modes of convergence
- Markov's inequality
- Chebyshev's Inequality and the Weak Law of Large Numbers
- Strong Law of Large Numbers
- Introduction to the Central Limit Theorem
- An aside on moment generating functions, random sums, convergence
- Proof of the CLT
- Chernoff bounds, introduction to large deviations