Course Information

1 Who's Who in ESE 530 . . .

Instructor: Santosh S. Venkatesh
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Office Hours: After class Mondays and Wednesdays, Tuesdays: 4:00 pm to 5:00 pm

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2 . . . and What's What in ESE 530

This rapidly moving course provides a rigourous development of fundamental ideas in probability theory and random processes. This course is a prerequisite for subsequent courses in communication theory and telecommunications such as ESE 576 and Tcom 501. The course is also suitable for students seeking a rigourous graduate-level exposure to probabilistic ideas and principles with applications in diverse settings. We will focus on discrete and continuous probability spaces. The topics covered are drawn from: abstract probability spaces; combinatorial probabilities; conditional probability; Bayes's rule and the theorem of total probability; independence; connections with the theory of numbers, Borel's normal law; rare events, Poisson laws, and the Lovász local lemma; arithmetic and lattice distributions arising from the Bernoulli scheme; limit laws and characterisations of the binomial and Poisson distributions; continuous distributions in one and more dimensions; the uniform, exponential, normal, and related distributions and their characterisations and applications; random variables, distribution functions; random number generation and statistical tests of randomness; measures of central tendency—mean, median, mode; mathematical expectation and the Lebesgue theory; expectations of functions, key properties, moments, convolutions; operator methods and distributional convergence, the central limit theorem, selection principles; conditional expectation; tail inequalities, concentration; convergence in probability and almost surely, the law of large numbers, the law of the iterated logarithm; Poisson approximation, Janson's inequality, the Stein-Chen method; moment generating functions, renewal theory; characteristic functions.

3 Lectures

Lectures will be held in Towne 303 on Mondays and Wednesdays from 12 noon to 1:30 pm.

4 Prerequisites

A solid foundation in undergraduate probability at the level of Stat 430 or ESE 301 at Penn. Students are expected to have a sound calculus background as covered in the first two years of a typical undergraduate engineering curriculum. Undergraduates are warned that the course is *very* mathematical in nature with an emphasis on rigour; upperclassmen who wish to take the course will need to see the instructor for permission to register.

5 References

There is no required textbook for the class. While instructor-provided notes will be made available at intervals, taking good class notes will be essential. There are a plethora of probability references and to get the most of the course students should read over and beyond what is covered in class. The following selected subset of references have been placed on reserve in the engineering library.

> G. Grimmett and D. Stirzaker, *Probability and Random Processes*, Third Edition. Oxford University Press, 2002.

This book provides a reasonable balance between theory and application. There are a wealth of other books providing different perspectives and approaches. Of these, Feller's volumes are immortal and should be on the shelf of any serious student of probability.

> W. Feller, *An Introduction to Probability Theory and Its Applications, volumes 1 and 2*. John Wiley and Sons.

A standard reference with a more engineering flavour is

> A. Papoulis and S. U. Pillai, *Probability, Random Variables, and Stochastic Processes*. McGraw-Hill.

The book that put the theory on a rigourous footing is the classic

> A. N. Kolmogorov, *Foundations of Probability*. New York: Chelsea, 1956.

6 Grading

The cumulative grade will be decided based upon performance in assigned homework, a midterm examination, and a final examination. The distribution of credit is as follows:

- Homework problem sets: 30%
- Midterm examination: 30%
- Final examination: 40%

7 Homework

Problem sets will be assigned on a weekly basis. The homework is essential to a proper understanding of the course material and success in the examinations is problematic in the absence of sustained effort at solving the homework problems throughout the semester; in particular, *a belated effort to go through the problem solutions on the eve of an examination is unlikely to yield success*.

There will be approximately ten assigned problem sets, the actual number depending on how rapidly we are progressing through the material. For grading purposes, your worst problem set will be discarded with the remaining problem sets receiving equal weightage.

7.1 Collaboration and Reference Policy

Collaboration on homework in study groups is encouraged. While such collaboration in the sense of discussions is allowed, *students must write up the final solutions of the homework problems alone and not simply copy the material from another source*. All collaborators *must* be clearly and explicitly acknowledged in the first page of the submitted homework. Acknowledged collaboration will have no effect on the received grade but is demanded by intellectual probity. Unacknowledged collaboration is theft.

No outside reference material is permitted; in particular, handouts, solutions, and course notes from previous incarnations of this course are expressly forbidden. Anti-intellectual behaviour such as plagiarism will be regarded most severely. This has no place in a community of scholars and students are expected, nay constrained, by the honour system to comport themselves with the utmost integrity.

7.2 Turn-in and Return

Problem sets are due *one week from assignment in class*. Our course TA will collect the homework 15 minutes after class begins. Please ensure that your homework is turned in on time as ***late submissions will not be accepted***. If you're going to be late or are going to miss a class it is your responsibility to make prior arrangements to deliver the homework to the TAs.

Graded homework can be picked up from Ms. Spanner's office in the anteroom outside Moore 368 on the next class day after submission.

8 Examinations

The midterm examination will be a restricted take-home examination. The final examination will be in-class, closed-book, of 120 minutes duration.

Missed examinations or quizzes will not be allowed to be retaken except when University of Pennsylvania guidelines are met for cases of illness or emergency. Under such officially sanctioned circumstances, a missed examination or quiz may, at the instructor's discretion, be replaced by an oral examination.

8.1 Examination Schedule

- Midterm examination: Assigned in class, Wednesday, October 31, 2007. Due at the start of class, 12 noon, Monday, November 5.
- Final examination: As announced by the registrar's office.