MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.262 - Discrete Stochastic Processes
Spring 2009

Lectures: Mondays & Wednesdays, 2:30 – 4:00, 36-112

Recitations: Mondays 11:00 – 12:00 & 5:00 – 6:00, 34-301

Instructors: Prof. Robert Gallager
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Office Hours: Thursday 11:00 – 12:00 & 2:00 – 4:00

Prof. John Wyatt
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blitvic@mit.edu
Office Hours: Tuesday 1:00 – 2:20, 36-713

Grader: Joongwoo Brian Park

Course website: http://web.mit.edu/6.262/www

Secretary: Susan Davco, Room 36-872, x3-0455
davco@mit.edu

Required Text: Class notes (for 2nd ed. of *Discrete Stochastic Processes*)

Reference Books: *Discrete Stochastic Processes*, R.G. Gallager, Kluwer Academic Publishers, 1996. (In stock at Quantum Books.)
Introduction to Probability, 2nd ed., Bertsekas and Tsitsiklis, Athena Scientific, 2008.
Ross, S., *Stochastic Processes*, 2nd ed., Wiley & Sons, 1996.
Grimmett and Stirzaker, *Probability and Random Processes*, 3rd ed., Oxford University Press, 2001.

Prerequisite: Curiosity about random processes, patience with subtlety, attention to detail. Also, thorough understanding of 6.431 or 6.041, (i.e., the basics of Bertsekas and Tsitsiklis, *Introduction to Probability*, 2nd ed, or equivalent.)

Mechanics: Weekly assignments. A random subset of the problems will be carefully graded each week.
Mid-term quiz evening of April 7, 6:00 – 10:00 pm.
Three hour final exam during finals week.

Requirements:

- Weekly assignments 20%: A random subset of the problems will be carefully graded each week. The lowest problem set grade will be dropped.
- Midterm 35%: Tuesday evening, April 7, 6:00 – 10:00 pm.
- Final 35%: Scheduled by Registrar's Office, during finals week.
- Participation 10%: Evidence of interest, effort, diligence, enthusiasm from student participation in class, recitation and/or office hours. This can raise your grade but not lower it.

Midterm

The midterm will be closed book, with 2 pages of your notes allowed, both sides (4 sides in total). We will design it to be finished in roughly a 2-hour period, if done at the breathtaking pace of most MIT exams, but we will allow you four hours. Prof. Wyatt will take soft drink and candy orders at no charge.

Homework

- Thinking through the homework is an important aspect of the subject. This is a graduate subject, and as such you should be learning to pose your own questions and find your own ways of organizing the material and thinking about how and where it is useful. The homeword has been designed to help you in doing this and also to help you discover whether your grasp of the material is sufficient to avoid getting lost as new material is presented.

- Homework is due in class each Wednesday. Solution sets will be handed out or put on the web at that time, and therefore late homeworks will be noted but not graded.

- You are welcome to collaborate on the problem sets, but you ***must*** write up your own solutions independently. If you don't know many others in the class and are looking for a homework group to join, please let one of us know, and we'll help you find a group.

- You may seek help from any source you want in doing the homeworks, e.g., Natasa or Prof. Gallager or Prof. Wyatt, friends, other texts, old homeworks or solution sets from previous years (if you can find some that overlap), astrologers, necromancers, soothsayers – any source. But you ***must*** acknowledge briefly in writing any source or collaborators you use other than the TA, the professor, the text or class handouts.

- Fundamentally, learning how to approach a problem is more important than carrying out the details, so to the extent that you fail to fully engage in finding a good approach, you will fail to fully understand the material.

Professor Gallager is writing a second edition of *Discrete Stochastic Processes*, which has been the text for this course for many years. These draft chapters are not in final shape, but are a substantial improvement over the first edition. They will be passed out in class, but usually not in time for reading ahead; thus the existing text will be useful for those who want to read ahead. Comments on things that are confusing (or perhaps wrong) will be greatly appreciated.

Further Recommended Reading

Beyond the required text by Gallager and the recommended texts Grimmett and Stirzaker and by Ross, this classical text on probability is a wonderful read and should be on the bookshelf of every person with a serious interest in probability:

Feller, W., *An Introduction to Probability Theory and Its Applications*, vols. I and II, 3rd ed., Wiley, 1968.

Alternate Courses

This course assumes a strong background in probability, equivalent to having recently earned an A in 6.041/6.431. It concentrates on analysis of many the most common classes of probability models and does not develop applications in much depth. If your background in probability is not up to snuff, you might be better advised to take 6.431 instead. If you need or would enjoy more applications, you might prefer 1.203J, which applies many of the tools we study to the analysis of transportation and urban systems. It does not require 6.262 as a prerequisite. You might also enjoy taking 1.203J after 6.262 as an opportunity to use the tools in an urban studies/transportation setting.

This course does not deal with measure theory or the deeper mathematical foundations of probability. That material is addressed in 6.436J or in 18.103 and 18.175 in the math department.

Approximate Outline and Schedule of Topics (subject to modification)

2/4	**Lect. 1**	Introduction and probability review	Chap. 1 / Handout
2/9	**Lect. 2**	Further probability review, weak law, CLT, strong law	Chap. 1 / Handout
2/11	**Lect. 3**.	Strong law, convergence of r.v.'s,	Chap. 1 / Handout

2/16	**Holiday**	Monday classes held on Tuesday	
2/17	**Lect. 4**	Poisson process	Chap. 2 / Handout
2/18	**Lect. 5**	Poisson Process, symmetry and order statistics	Chap. 2 / Handout
2/23	**Lect. 6**	Poisson Process, introduction to queues	Chap. 2 / Handout
2/25	**Lect. 7**	Renewal processes – strong law, expected number of renewals	Chap. 3
3/2	**Lect. 8**	Renewal processes – Wald's equality, stopping rules, Blackwell's theorem	Chap. 3
3/4	**Lect. 9**	Renewal processes – asymptotic behavior in time	Chap. 3
3/6	**Add date**		
3/9	**Lect. 10**	Renewal processes & renewal-reward processes	Chap. 3
3/11	**Lect. 11**	Renewal-reward processes	Chap. 3
3/16	**Lect. 12**	Renewal-reward processes	Chap. 3
3/18	**Lect. 13**	Little's theorem, PK formula	Chap. 3
3/23	**Spring break week**		
3/30	**Lect. 14**	Finite Markov chains	Chap. 4
4/1	**Lect. 15**	Countable Markov chains	Chap. 5
4/6	**Lect. 16**	Countable Markov chains	
4/7	**Midterm quiz :** 6:00 pm – 10:00 pm, covers Lectures 1- 13, Chapters 1- 3		
4/8	**Lect. 17**	Reversibility of Markov chains	Chap. 5
4/13	**Lect. 18**	Semi-Markov processes	Chap. 5
4/15	**Lect. 19**	Continuous-time Markov processes	Chap. 6
4/20	**Holiday**		
4/22	**Lect. 20**	Random walks	Chap. 7
4/23	**Drop date.**		

4/27	**Lect. 21**	Random walks: queues, sequential hypothesis testing	Chap. 7
4/29	**Lect. 22**	Random walks: large deviations, Chernoff bound, Wald's identity	Chap. 7
5/4	**Lect. 23**	Random walks and martingales	Chap. 7
5/6	**Lect. 24**	Sub- and super-martingales, Jensen's inequality, stopping rules	Chap. 7
5/11	**Lect. 25**	Kolmogorov submartingale and martingale inequalities	Chap. 7
5/13	**Lect. 26**	Strong law revisited & martingale convergence theorem	Chap. 7