EE 512: Stochastic Processes
Spring 2018

Time: Tuesday and Thursday 12:30PM-1:50 PM
Location: OHE 100D
Instructor: Ashutosh Nayyar
Discussion: OHE 132, Friday 12:00-12:50 PM
TA: Shiva Navabi

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Prerequisites: EE 503

Course Overview:

This course provides a rigorous introduction to probability theory and stochastic processes and is geared towards first and second year graduate students in electrical engineering, but could also appeal to students in the financial engineering program, as well as computer science, industrial and systems engineering and other departments. The course shall do a quick overview of basic concepts of probability theory including probability spaces, random variables, expectation, and related convergence concepts. It will then introduce stochastic processes, and key limit theorems. Other topics to be covered include Poisson processes, renewal theory, discrete and continuous-time Markov chains, martingale theory, random walks, Brownian motion and Gaussian processes.

Intended Audience:

The course is intended for MS and PhD Students in Communications, Controls, Networks and Signal Processing Areas of Electrical Engineering, MS students in the Financial Engineering program, and should also be of interest to students in Industrial and Systems Engineering and Computer Science.

Suggested Texts:

Primary:
* *Stochastic Processes, second edition, by S. Ross, J. Wiley & Sons, 1996.*
* Essentials of Stochastic Processes, by Rick Durrett, 2011 (available online).

Supplementary:
(i)Stochastic Processes, Robert Gallagher, Cambridge, 2013
(ii) Probability and Random Processes for Electrical and Computer Engineers by J. Gubner, Cambridge University Press, 2006
(iii) Introduction to Probability Models by S. Ross, 10th edition.
(iv) Introduction to Stochastic Processes, by Hoel, Port and Stone.
(v) Stochastic Processes and Filtering Theory by Andrew H. Jazwinski

Grading:

1. *Home Works 15%*
2. *Mid-term: 40%*
3. *Final: 45%.*

TOPICS:

1. *Overview of Probability:* Probability spaces, random variables, distribution functions, moment generating functions, expectation, conditional probability and expectation, probability inequalities, examples

2. *Stochastic processes:* Examples, Notions of convergence, Definition of a stochastic process, Independence, Zero-one laws, Laws of large numbers, Central limit theorems.

3. *The Poisson Process:* Definition, Conditional distribution of the arrival times, non-homogeneous Poisson process, Compound Poisson random variables and processes

4. *Renewal Theory:* Limit theorems, Wald's identity, Key renewal theorem, Branching processes, Regenerative processes,
5. *Discrete-time Markov Chains:* Examples in Communication Systems, Chapman-Kolmogorov equations, Limit theorems, Time-reversible Markov chains, Semi-Markov processes

6. *Continuous-time Markov Chains:* Examples, Birth-death processes, Kolmogorov differential equations, Limiting probabilities, Time reversibility, Uniformization, Application to queueing theory
7. *Martingales:* Definition, Martingale differences, Level crossings, Stopping times, Azuma's maximal inequality, Sub-martingales, Supermartingales, and the Martingale convergence theorem

If time permits, we will look at additional topics:

8. *Random Walks:* Definition, Duality in random walks, Exchangeable random variables, Analysis using martingales, Ruin problems, Application in queueing systems

9. *Brownian motion and other Markov processes:* Definition, Continuity and non-differentiability of paths, Hitting times, maximum variable and arc sine laws

10. *Variations on Brownian motion:* Examples of diffusions, Backward and forward diffusion equations, Markov shot noise process, scale functions, speed measures, Calculation of functionals of measures

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct/.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu/ or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety whole USC community. Another member of the university community - such as a friend, classmate, advisor, or faculty member - can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. The *Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu/ will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.