Department of Electrical Engineering
University of Southern California

EE 562 – RANDOM PROCESSES IN ENGINEERING Spring 2025

Instructor: Urbashi Mitra, Professor
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Teaching Assistant: TBD

Course Web Page: DEN Brightspace D2L `courses.uscden.net`
Contains homework, solutions, and relevant handouts. Course announcements, homework hints and modifications will be posted on this page – please check it regularly.

Lectures: MW 10:00 am - 11:50am, OHE 100D
No lecture (federal/USC holidays): Monday, January 20, Monday, February 17 and March 17-21, 2025 (Spring Break).

Course Objectives: To provide a fundamental understanding of concepts and techniques of ran- dom processes. The emphasis will be on developing the analysis and design tools needed to apply random process theory to graduate electrical engineering courses and research. This is a first course in random processes for engineers, and is a prerequisite for many courses in communications, controls and signal processing. The course will include a review of probability theory. Topics include random vectors and processes, and their convergence and key limit theorems. The course will also cover Gaussian random vectors, minimum mean square estimation and conditional expectation. Other topics to be covered include stationary and wide sense stationary processes, correlation and covariance functions, power spectral density, Poisson processes, discrete and continuous-time Markov chains, martingales, basic calculus of random processes, random processes in linear systems and Wiener filtering. The course will provide examples of applications in queueing networks, communications and autonomous systems.

Prerequisites: 1. Linear Algebra, matrix theory, linear spaces, bases, eigenvectors, eigenvalues, etc. (EE 510). 2. Probability theory and random variables, moments, transformations of random variables, characteristic functions, etc. (EE 503).

Other Requirements: Basic Basic computer skills (i.e. programming, plotting, random variable generation, familiarity with Matlab is helpful although not necessary.). Fourier, Laplace, and z transforms, complex variables, contour integrals, and residue theory (EE 401 or equivalent).

Text: Random Processes for Engineers, by Bruce Hajek, Cambridge University Press, 2015.

Grading: (tentative) 15% Homework
30% Midterm
45% Final
Final grades will be assigned by a combination of student score distribution (curve) and the discretion of the instructor.

Exams: **Midterm** Wednesday, March 5 or March 12, 2025 10:00am-12:00pm
Final Monday, May 12, 08:00-10:00am

Office Hours: TBD
Use of email to set up appointments outside of office hours is encouraged: ubli@usc.edu. Attending office hours in person is encouraged.

Late Policy: No late homework will be accepted. A late assignment results in a zero grade.; however, the lowest homework grade will be dropped before computing the overall homework score at the end of the semester.

Make-up Material: Homework assignment dates are non-negotiable. Your lowest homework score will be thrown out before computing final grades. If you are missing a key exam due to presenting a paper at a conference, please contact me and we will work out a solution with your Ph.D. supervisor.

Grade Adjustment: If you dispute any scoring of a problem on an exam or homework set, you have **one week** from the date that the graded paper is **returned** to request a change in the grade. After this time, no further alterations will be considered. All requests for a change in grade must be submitted in writing to me.

Attendance: Lecture attendance is encouraged; many examples and applications not in the text will be covered in the lectures. The student is responsible for all assignments, changes of assignments, announcements, lecture notes *etc.* All such changes should be posted on the course web-site. There is strong correlation between good performance in the course and lecture attendance.

References:

1. Random Processes for Engineers, by Robert A. Scholtz (will be posted on DEN website)
2. Intuitive Probability and Random Processes using MATLAB, Steven Kay, Springer 2006 (ISBN-13: 978-0387241579)
3. Probability, Statistics, and Random Processes for Engineers , Henry Stark and John Woods, 4th ed., Prentice Hall 2011 (ISBN-13: 978-0132311236)
4. Probability and Random Processes, Yannis Viniotis, McGraw-Hill 1997 (ISBN-13: 978-0070674912)
5. Stochastic Processes, 2nd ed. by Sheldon Ross, Wiley 1995 (ISBN-13: 978-0471120629)
6. Probability in EE and CS: An Applications-driven course Jean Walrand, Quoi? Publishers 2014 (ISBN-13: 978-0615899367)
7. Probability and Random Processes for Electrical & Computer Engineers, by John Gubner, Cambridge University Press 2006 (ISBN-13: 978-0521864701)

Outline:

1. Review of probability theory (Hajek Ch 1.1-1.11).
2. Convergence of random sequences; limit theorems (Hajek Ch 2).
3. Random vectors and minimum mean-squared error estimation (Hajek Ch 3).
4. Random processes: definition, characterization, special processes (Hajek Ch 4.1-4.8).
5. Countable Markov chains (Hajek Ch 6.1-6.9).
6. Continuous Time Markov chains (supplemental reading in Ross Ch 5).
7. Martingales (Hajek Ch 10).
8. Mean-square calculus, representations of random processes (Hajek Ch 7.1-7.7).
9. Random processes in linear systems and spectral analysis (Hajek Ch 8).
10. Optimal filtering of random processes (Hajek Ch 9).
11. (time permitting) Inference for Markov Models, EM Algorithm, Hidden Markov models (Hajek Ch 5).

Suggestions:

1. Remember the big picture.
2. Read the book and supplementary sources.
3. Prepare your own summaries from texts and notes.
4. Work as many problems as you can.

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 . Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, . Note that the posting of homework and exam solutions in a public forum also constitutes academic 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 (see below) or to the Department of Public Safety (see below). Anyone in 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 provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Disabilities: The Office of Disability Services and Programs
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.

Support Systems: *Student Counseling Services (SCS)* - (213) 740-7711 – 24/7 on call Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.
https://engemannshc.usc.edu/counseling/

National Suicide Prevention Lifeline - 1-800-273-8255 Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. http://www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call Free and confidential therapy services, workshops, and training for situations related to gender-based harm. https://engemannshc.usc.edu/rsvp/

Sexual Assault Resource Center For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: http://sarc.usc.edu/

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086 Works with faculty, staff, visitors, applicants, and students around issues of protected class. https://equity.usc.edu/

Bias Assessment Response and Support Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. https://studentaffairs.usc.edu/bias-assessment-response-support/

Student Support and Advocacy – (213) 821-4710 Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. https://studentaffairs.usc.edu/ssa/

Diversity at USC Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. https://diversity.usc.edu//

American Language Institute http://dornsife.usc.edu/ali, sponsors courses and workshops specifically for international graduate students for whom English is not their primary language.

USC Emergency Information Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, http://emergency.usc.edu

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime. Provides overall safety to USC community. http://dps.usc.edu