



School of Engineering

EE562: Random Processes in Engineering

Units: 4
Spring 2023

Lecture: Mon. Wed., 10:00-11:50 AM, OHE 136

Discussion: Tue., 3:30-4:20, OHE 136

Instructor: Ashutosh Nayyar

Office Hours (tentative): Mondays 12:30pm-1:30pm in EEB 318 and Wednesdays 4:00pm-6:00pm on Zoom:

<https://usc.zoom.us/my/anayyar>

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Office Hours: TBD

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Course Webpage: USC DEN
(<https://courses.uscden.net>)

Exam Dates:

- **Midterm:** March 8 (tentatively), in class
- **Final Exam:** May 8, 8am-10am, as set by the university

Course Description

This course provides a rigorous introduction to probability and stochastic process theory and is geared towards first and second year graduate students in electrical engineering, computer science, industrial and systems engineering and other departments. The course will include a review of basic concepts of probability theory including probability spaces, random variables, expectation, and related convergence concepts. It will also cover Gaussian random vectors, minimum mean square estimation and conditional expectation. It will then introduce stochastic processes and key limit theorems. 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.

Learning Objectives

1. Introduction to basic concepts, definitions and limit theorems about stochastic processes.
2. Exploring key properties and applications of various kinds of stochastic processes in engineering including communications, networks and autonomous systems.

Pre-requisite(s): EE 503 (Probability)

Website: Syllabus, home-works and other class information will be posted on USC DEN course website.

Required textbook: 1. Random Processes for Engineers by B. Hajek, 2015 (pdf available online).

Additional recommended text:

1. Stochastic Processes, 2nd ed. by Sheldon Ross, 1996.
2. Essentials of Stochastic Processes, by Rick Durrett, 2011 (pdf available online).
3. Markov Chains, by J.R. Norris, 1997.

Grading Type: Letter grade

Grading Breakdown: Final 45%, Midterm 35%, Homework 20%.

Assignment Submission Policy

Late home-works will not be accepted unless prior approval for late submission has been obtained.

List of Topics to be covered:

1. Probability Review: Random variables, expected value, moment generating functions, conditional distribution, conditional expectation.
2. Sequences of Random variables, modes of convergence and limit theorems.
3. Random vectors, orthogonality principle, minimum mean square estimation.

4. Random processes: Definitions and basic properties.
5. Counting processes, Poisson process, renewal processes.
6. Discrete and continuous time Markov chains.
7. Martingales: Definitions, properties and inequalities.
8. Basic Calculus of random processes, continuity, mean square differentiation, integration.
9. Random processes in linear systems, spectral analysis, Fourier transforms, power spectral density.
10. (*If time permits*) Wiener Filtering, causal functions and spectral factorization, causal Wiener filtering problem.

. **Statement for Students with Disabilities** Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.– 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

. **Statement on Academic Integrity** USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus*, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: <http://www.usc.edu/dept/publications/SCAMPUS/gov/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.

. **Academic Conduct and Support Systems**

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](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.