

ECE 6711: Matrix Analysis in Engineering and Science

Fall 2025

Time and Location:

Lectures:

- Monday & Wednesday, 9:30AM – 10:45AM.
- Thornton Hall D115.

Office Hours:

- Wednesday 11:00AM – 12:00PM; Thornton Hall E-317 (Instructor's office)
- Or by email appointment with Prof. Shen (Zoom or in person)

Instructor:

Cong Shen
Associate Professor
Electrical and Computer Engineering
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Web: <https://cshen317.github.io/>

Teaching Assistant:

Wei Shen
PhD Student
Electrical and Computer Engineering
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Time: Wednesday 4:00PM – 5:00PM
Location: Thornton Hall C-311 Conference Room

Course Objectives:

In a nutshell, this is to teach you how to reason under uncertainty. Learn the foundations of applied probability, random variables / vectors and random processes, including fundamental results such as laws of large numbers and the central limit theorem with proofs. Learn how to use analytical and computer simulation tools to come to grips with randomness and uncertainty in science and engineering.

Course Outcomes:

After taking this course, you will have a good understanding of the mathematical foundations of probability and random processes. Important concepts and tools will be introduced in the class.

After learning these, you will be able to choose an appropriate probabilistic model for a problem setup, make sound probability calculations and reason about the conclusions. You will also be prepared for advanced study. An important application domain of these concepts is modern machine learning and artificial intelligence.

An Important Note: It is generally felt that there are two approaches to the study of probability theory. One approach is heuristic and non-rigorous and attempts to develop in the student an intuitive feel for the subject that enables him or her to “think probabilistically.” The other approach attempts a rigorous development of probability by using the tools of measure theory. It is the first approach that is employed in this class. A big reason is that I cannot assume you have taken measure theory – which would be really important if you are serious about theoretical research in the future!

Textbooks:

We will not have a single textbook, but the following are a few books that I might use as references.

- Ross, Sheldon M. Introduction to Probability Models. Academic Press, 2014.
- John A. Gubner, Probability and Random Processes for Electrical and Computer Engineers, Cambridge University Press, 2006.
- Geoffrey Grimmett and David Stirzaker, Probability and Random Processes, Oxford University Press, 2020.

We will make up for the missing *engineering applications* by drawing from other books, Matlab demos, and homework assignments.

Prerequisites: Undergraduate Probability (e.g., APMA 3100, MATH 3100, or equivalent); Undergraduate Linear Algebra; Working knowledge of Matlab or Python.

Course Outline:

Part 1: Introduction to Probability

Part 2: Random Variables

Part 3: Conditional Probability, Conditional Expectations

Part 4: Introduction to Random Processes

Part 5: Markov Chains

Part 6: Exponential Distribution, Poisson Process

Part 7: Engineering Applications

Grading:

This course will be graded based on student's performance on homework assignment, mid-term exam, and final exam, with the following percentages.

6-7 Homeworks:	20%
Midterm exam:	35%
Final exam:	45%
Total:	100%

- **Letter grades** will be assigned as follows:

Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Score	100	95	90	87	83	80	77	73	70	67	63	60	Below 60

Homework:

- There are 6 or 7 homework assignments, which will start from week 2 on a (roughly) bi-weekly basis. Homework includes analytical problem-solving, some proofs, and some Matlab/Python programming. Homework will be posted on Canvas every Thursday afternoon, and the cutoff time for turning in your homework is 11:59pm of the next Thursday, i.e., you have roughly one week to submit your homework.
- **Group collaboration and homework grading policy:** It is allowed to discuss homework with fellow students, but the solutions that you turn in should reflect your own work. Verbatim copies, identical code segments, identical unusual mistakes will be investigated. More importantly, doing your homework will make a big difference in your ability to do well in the exams.
- **Late Assignments:** Assignments submitted after the deadline (11:59pm on a Thursday) but ≤ 24 hours will be subject to a 20% penalty; ≤ 48 hours will be subject to a 40% penalty; > 48 hours will be subject to a 100% penalty (i.e., 0 grade). Exceptions to this policy can be granted only by the instructor, and **only before the deadline**.

Exams:

- There will be one midterm exam, which is **closed-book**. The exam will be **in class**, during the regular lecture time (**9:30am to 10:45am**), on **October 15, 2025**. You will be allowed **three sheets of notes** of your choice. Please make sure you are available to physically be here and take the exam!
- Same format for final exam. Time: **9:30am to 10:45am, December 8, 2025**
- **Grading disputes:** Please contact the instructor and/or the TA regarding any grading dispute. Any grading dispute must be submitted **within 1 week of releasing the grades**.

Absences, make-up exams, incompletes:

I will make every attempt to provide reasonable accommodation if you miss an exam because of illness or other emergency, a job/internship interview, conference travel, or other career development event. If you are sick, please take care of yourself and protect others – and if that means not coming to class and/or not submitting an assignment on time, please let me know

before the assignment is due and I will provide reasonable accommodation. All incomplete work should be completed within reasonable time, at the instructor's discretion, and no later than 1 month after the final exam date. A student is not permitted to submit extra work in an attempt to raise his or her grade.

Software:

This is obviously a highly mathematical class. Many of the class activities and homework assignments will by default use *Matlab*, which students can obtain from UVA Information Technology Services. Visit <https://its.virginia.edu/> and search for MATLAB for more information. You are welcome to use Python or other programming language of your choice!

AI Use Policy:

You can use generative AI (e.g., ChatGPT/Claude) for background research and as an aid for the assignments that require programming, but you should be able to understand and explain any code that you used for a graded assignment. You may be asked to complete an oral walkthrough with the Instructor to verify authorship of your submission (failing so will be considered as violating this AI policy). You can also use generative AI to help you better present your ideas and solutions, find references, etc. However all references should be checked, and **all uses of AI must be disclosed in the submitted materials**. As of this writing (as we will see in this class) generative AI cannot correctly solve a lot of probability riddles that require probabilistic modeling. It may soon improve in this regard, but it will not help you gain the analytical insight that you need to master probability. Use at your own risk.

Students with disabilities or learning needs

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center (SDAC) to discuss a range of options to removing barriers in this course, including official accommodations. We are fortunate to have an SDAC advisor, Courtney MacMasters, physically located in Engineering. You may email her at cmacmasters@virginia.edu to schedule an appointment. For general questions please visit the [SDAC website: sdac.studenthealth.virginia.edu](http://sdac.studenthealth.virginia.edu). If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.

Religious accommodations

It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements.

Students who wish to request academic accommodation for a religious observance should submit their request to me by email as far in advance as possible. Students who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the [University's Office for Equal Opportunity and Civil Rights](#) (EOCR) at UVAEOCR@virginia.edu or 434-924-3200.

Harassment, Discrimination, and Interpersonal Violence

The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. If you or someone you know has been affected by power-based personal violence, more information can be found on the [UVA Sexual Violence website](http://www.virginia.edu/sexualviolence) that describes reporting options and resources available - www.virginia.edu/sexualviolence.

The same resources and options for individuals who experience sexual misconduct are available for discrimination, harassment, and retaliation. [UVA prohibits discrimination and harassment](#) based on age, color, disability, family medical or genetic information, gender identity or expression, marital status, military status, national or ethnic origin, political affiliation, pregnancy (including childbirth and related conditions), race, religion, sex, sexual orientation, or veteran status. [UVA policy](#) also prohibits retaliation for reporting such behavior.

If you witness or are aware of someone who has experienced prohibited conduct, you are encouraged to submit a report to [Just Report It](http://justreportit.virginia.edu) (justreportit.virginia.edu) or [contact EOCR](#), the office of Equal Opportunity and Civil Rights.

If you would prefer to disclose such conduct to a confidential resource where what you share is not reported to the University, you can turn to [Counseling & Psychological Services \("CAPS"\)](#) and [Women's Center Counseling Staff and Confidential Advocates](#) (for students of all genders).

As your professor and as a person, know that I care about you and your well-being and stand ready to provide support and resources as I can. As a faculty member, I am a responsible employee, which means that I am required by University policy and by federal law to report certain kinds of conduct that you report to me to the University's Title IX Coordinator. The Title IX Coordinator's job is to ensure that the

reporting student receives the resources and support that they need, while also determining whether further action is necessary to ensure survivor safety and the safety of the University community.

Support for your career development

Engaging in your career development is an important part of your student experience. For example, presenting at a research conference, attending an interview for a job or internship, or participating in an extern/shadowing experience are not only necessary steps on your path but are also invaluable lessons in and of themselves. I wish to encourage and support you in activities related to your career development. To that end, please notify me by email as far in advance as possible to arrange for appropriate accommodations.

Student support team

You have many resources available to you when you experience academic or personal stresses. In addition to your professor, the School of Engineering and Applied Science has staff members located in Thornton Hall who you can contact to help manage academic or personal challenges. Please do not wait until the end of the semester to ask for help!

Learning

[Lisa Lampe](#), Assistant Dean for Undergraduate Affairs

[Georgina Nembhard](#), Director of Student Success

[Courtney MacMasters](#), Accessibility Specialist

[Free tutoring](#) is available for most classes.

Health and Wellbeing

[Kelly Garrett](#), Assistant Dean of Students, Student Safety and Support

Elizabeth Ramirez-Weaver, CAPS counselor*

Katie Fowler, CAPS counselor*

*You may schedule time with the CAPS counselors through [Student Health](#) (<https://www.studenthealth.virginia.edu/getting-started-caps>). When scheduling, be sure to specify that you are an Engineering student. You are also urged to use [TimelyCare](#) for either scheduled or on-demand 24/7 mental health care.

Community and Identity

The Center for Connection (The Connect) is a dedicated student space within UVA Engineering that fosters academic success and personal growth. Through its programs and initiatives, The Connect helps students strengthen their engineering identity while providing resources to help them thrive during their

studies and beyond. Our work centers on three key areas: student belonging and development, academic support, and community programming grounded in intentional, data-driven strategies.

The Connect features an open study area, a flexible event space, and on-site staff who provide direct support and advising to students. It is part of the [Office of Community, Opportunity, and Engagement](#).

Honor

I trust every student in this course to fully comply with all of the provisions of the University's Honor Code. By enrolling in this course, you have agreed to abide by and uphold the Honor System of the University of Virginia, as well as the following policies specific to this course.

- All graded assignments must be pledged.
- All suspected violations will be forwarded to the Honor Committee, and you may, at my discretion, receive an immediate zero on that assignment regardless of any action taken by the Honor Committee.

Please let me know if you have any questions regarding the course Honor policy. If you believe you may have committed an Honor Offense, you may wish to file a Conscientious Retraction by calling the Honor Offices at (434) 924-7602. For your retraction to be considered valid, it must, among other things, be filed with the Honor Committee before you are aware that the act in question has come under suspicion by anyone. More information can be found at <http://honor.virginia.edu>. Your Honor representatives can be found at: <http://honor.virginia.edu/representatives>.