

AME 540

Probability and Statistics in Engineering Science

Units: 4 (Tuesday and Thursday, 4:00-5:50pm)

Location: OHE 100B

Instructor: Assad A Oberai

Office: OHE 412 E

Office Hours: TBD

Contact Info: TBD

Teaching Assistant: TBD

Office: TBD

Office Hours: TBD

Contact Info: TBD

IT Help: DEN Services

Catalogue Description

Probability; random variables and vectors; joint, marginal, and conditional distributions; Bayes theorem; introduction to stochastic processes; statistical inference; regression and generative models.

Course Description

The class is an introduction to probability and statistics appropriate for all engineering disciplines. The focus of the class is on learning elementary concepts of probability and statistics that find application in interpreting engineering/scientific data and in probabilistic machine learning techniques. The first part of the course will focus on foundational concepts of probability spaces, random variables and vectors, cumulative and probability density functions, joint, marginal, and conditional probabilities, Bayes theorem, Central Limit Theorem, and an introduction to stochastic processes. In the second part of the course these ideas will be applied to statistical tasks that include parameter estimation, hypothesis testing, regression, and generative models of machine learning.

Learning Objectives

Students who successfully complete the course will

- Solve problems that employ fundamental concepts in probability such as probability spaces, random variables, and cumulative and probability density functions.
- Apply the understanding of random vectors, and joint, marginal, and conditional probability density functions to solve problems in science and engineering.
- Identify the appropriate use of commonly occurring random variables like Bernoulli, Poisson, uniform, normal and exponential.
- Apply concepts in probability and statistics in analyzing and drawing inferences from data generated in science and engineering.
- Generate appropriate models for regression including least squares, weighted least squares, and polynomial and logistic regression.
- Demonstrate the use of variational inference in simplifying inference problems.
- Describe the important steps involved in developing generative models in machine learning.

Prerequisite(s): None

Co-Requisite(s): None

Concurrent Enrollment: None

Recommended Preparation: Multivariable calculus at the level of MATH 229.

Course Notes

Letter grade

The course will be run through the Distance Education Network (DEN) at Viterbi School of Engineering. Students can enroll either in the DEN section or the non-DEN section

Technological Proficiency and Hardware/Software Required

None

Required Readings and Supplementary Materials

Required book: Introduction to Probability and Statistics for Engineers and Scientists 5th Edition by Sheldon M. Ross (Author)

<https://www.amazon.com/Introduction-Probability-Statistics-Engineers-Scientists/dp/0123948118>

Optional Readings and Supplementary Materials

MITOPENCOURSEWARE: Probability and Statistics (<https://ocw.mit.edu/courses/1-151-probability-and-statistics-in-engineering-spring-2005/pages/lecture-notes/>)

Description of Assignments and How They Will Be Assessed

Students are referred to the schedule section where the release and due dates for the Assignments are specified. Assignments will closely follow the material presented in the textbook.

Grading Breakdown

Assessment Tool (assignments)	% of Grade
Homework assignments	25%
Midterm exam	35%
Final Exam	40%
TOTAL	100%

Grading Scale

The class will be graded on a curve based on total points earned according to the above weighting scale. Letter grades will not be assigned to individual assignments, but class averages and statistical breakdown will be announced for the midterm and final exams.

Assignment Submission Policy

All students will turn in homework via the Viterbi D2L portal. No late assignments will be accepted. Special arrangements may be made in case of documented illness or emergency.

Use of Generative AI Policy

Generative AI is not permitted: Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups as described on each assignment. Students may not have another person or entity complete any portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Course-Specific Policies

All exams are in class and must be taken at the same time. Special arrangements may be made in case of documented illness or emergency.

Academic Integrity

Unless otherwise noted, this course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). The general USC guidelines on Academic Integrity and Course Content Distribution are provided in the subsequent “Statement on Academic Conduct and Support Systems” section.

For this class, students are allowed to work in groups for the homework assignments, but each student must turn in their own homework not copying anyone else in their group.

Course Evaluations

Course evaluation occurs at the end of the semester university-wide.

Course Schedule

	Topics/Daily Activities	Readings/Preparation	Deliverables
Week 1	Elements of probability; sample space and events; algebra of events; axioms of probability;	Chapter 3	
Week 2	Conditional probability; Bayes formula; independent events; random variable	Chapter 3 HW 1 assigned	
Week 3	Types of random variables; random vectors; expectation and covariance; marginal and conditional distributions	Chapter 4	HW 1 due
Week 4	Special random variables: Bernoulli, Poisson, Uniform; Normal; Exponential; Gamma	Chapter 5 HW 2 assigned	Graded HW 1 returned
Week 5	Distribution of sampling statistics: mean and variance and the central limit theorem.	Chapter 6	HW 2 due
Week 6	Description of spatial fields and time series: Introduction to stochastic processes.	Chapter 7 HW 3 assigned	Graded HW 2 returned
Week 7	Parameter estimates; maximum likelihood estimate;	Chapter 7	HW 3 due
Week 8	Midterm Review and Midterm exam		Graded HW 3 returned
Week 9	Interval estimates; point estimator; Bayes estimator	Chapter 9 HW 4 assigned	Midterm returned
Week 10	Regression; least squares estimator; statistical inference of estimators; analysis of residuals	Chapter 9	HW 4 due
Week 11	Weighted least squares; polynomial regression; logistic regression	Lecture Notes HW 5 assigned	Graded HW 4 returned
Week 12	Divergences between distributions: KL, JS, and Wasserstein.	Lecture Notes	HW 5 due
Week 13	Variational inference and its applications.	Lecture Notes HW 6 assigned	Graded HW 5 returned
Week 14	Generative models 1: variational autoencoders.	Lecture Notes	HW 6 due
Week 15	Generative models 2: adversarial training.	Lecture Notes	Graded HW 6 returned
FINAL	Final exam		Refer to the final exam schedule in the USC <i>Schedule of Classes</i> at classes.usc.edu .

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies:

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services](#) (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each

course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.