

**Units:** 4

**Lectures:** TuTh 12-1:50 pm, WPH B28

**Discussion:** Mon 3-3:50 pm, KAP 146

**Instructor: Prof. Todd A. Brun**

**Office:** EEB 502

**Office Hours:** Mon 12-1:30 pm, Thu 3-4:30 pm, in person and on Zoom

**Link to Office hours Zoom meeting:**

<https://usc.zoom.us/j/93014427554?pwd=UE52cm5xZDlNaGFzeHFGano0UGxuUT09>

**Contact Info:** tbrun@usc.edu, (213) 740-3503 (O)

**Teaching Assistant: Muhammad Waqas**

**Office:** EEB 305

**Office Hours:** Wed 10 am–12 noon

**Contact Info:** [waqas@usc.edu](mailto:waqas@usc.edu)

**Teaching Assistant: Michael Neuman**

**Office:** EEB 516

**Office Hours:** Tue 2-4 pm

**Contact Info:** [mikeneum@usc.edu](mailto:mikeneum@usc.edu)

### **Catalogue Description**

Introduction to concepts of randomness and uncertainty: probability, random variables, statistics. Applications to digital communications, signal processing, automatic control, computer engineering and computer science.

### **Course Description**

This class will introduce the basic concepts and mathematical methods of probability, random variables, and statistics, and their applications to problems in engineering and computer science. The students will understand probability as a model for the treatment of uncertainty in engineering, and random variables as models for numerical measurements with uncertainty. They will be familiar with standard methods for deriving probabilities, including combinatorics and standard probability distributions. The conceptual basis of statistics in the Law of Large Numbers and Central Limit Theorem will be discussed, and used to derive basic statistical methods. This class will also provide a basis for more advanced subjects in probabilities and statistics, such as random processes and queueing theory.

### **Learning Objectives**

Upon successful completion of this course a student will be able to:

- Perform basic set probability relations including conditional probabilities and Bayes' Law.
- Derive probabilities for finite systems from combinatorics.
- Define discrete and continuous random variables, and use their complete statistical characterization of random variables (e.g., distribution and density functions) to compute probabilities.
- Develop novel probability distributions given a description of a random experiment.
- Interpret the incomplete statistical characterization of random variables, such as mean and variance, to draw qualitative and quantitative conclusions.

- Apply common distributions such as Gaussian, Poisson, Binomial, Exponential and Uniform to solve problems as appropriate.
- Utilize joint distributions and joint moments to compute probabilities and make estimates of random variables.
- Apply confidence interval formulas to characterize the accuracy of estimates from statistical data.
- Make decisions between a finite set of hypotheses from statistical data.
- Perform linear regression to estimate one variable from another using experimental data.

**Prerequisite(s):** MATH 225 or MATH 245

**Recommended Preparation:** General mathematical experience and comfort with numerical data.

### Course Notes

This course is Letter graded. Files and announcements will be distributed through the class Blackboard site, which will also be used to turn in homework. For the most part the work in this class will be analytical, i.e., pencil-and-paper work; but some use of software packages like Mathematica, Matlab and Excel will be permitted.

### Required Readings and Supplementary Materials

1. Textbook: "Introduction to Probability for Computing" by Mor Harchol-Balter, Cambridge University Press, 2024, ISBN: 978-1-009-30907-3. This book is available from the USC Bookstore. It is also available online in electronic form at this URL:  
<http://www.cs.cmu.edu/~harchol/Probability/book.html>.
2. Handouts and worked examples. These will be distributed via the Blackboard site.

### Optional Readings and Supplementary Materials

My lecture notes will also be posted on the Blackboard site as a resource for students.

### Description of Assessments

The course grade will be based on problem sets, two midterm exams, and the final exam. There will be approximately 10 homework assignments, assigned most weeks and due one week later. Late homework will not be accepted except for medical or other emergencies. Collaboration between students in understanding the homework is allowed and encouraged; copying is not. Homework assignments will be handed in via the Blackboard site. Exams will be closed book. Calculators and sheets of notes will be permitted. Midterm exams will take place during regular class periods.

### Grading Breakdown

Assessment Tool (assignments)	% of Grade
Problem Sets	20%
Midterm Exam 1	20%
Midterm Exam 2	20%
Final Exam	40%
<b>TOTAL</b>	<b>100%</b>

### Exam Dates

Midterm Exam 1: Tue 13 Feb 2024, in class

Midterm Exam 2: Tue 26 Mar 2024, in class

Final Exam: Wed 8 May 2024, 2-4 pm

## Course Evaluations

Learning experience evaluation occurs at the end of the semester through an online system. Be sure to watch out of the announcements and complete the evaluations, as these help us to improve the course and teaching.

## Course Schedule

Note that most weeks there will be handouts in addition to the assigned reading in the textbook. These handouts are also required reading.

	Topics/Daily Activities	Readings/ Preparation	Deliverables
<b>Week 1</b>	Introduction; probability as uncertainty; probability in science and engineering and elsewhere; experiments, events, sample spaces; set theory and combinatorics.	Chapter 1, Survivor's Guide	
<b>Week 2</b>	Combinations; set operations and probability; combining probabilities of multiple events; additive rules.	2.1-2 + handouts	HW 1 due
<b>Week 3</b>	Conditional probability; multiplicative and chain rules.	2.3-5 + handouts	HW 2 due
<b>Week 4</b>	The Bayes rule; random variables and probability distributions/density functions; cumulative distributions.	2.6, 3.1 + handouts	HW 3 due
<b>Week 5</b>	Joint probability distributions; marginal densities; conditional densities; statistical correlation and independence.	3.3 + handouts	HW 4 due
<b>Week 6</b>	<b>Midterm 1</b> ; Mean (expectation value) of random variables.	Chapter 4	
<b>Week 7</b>	Variance and covariance; mean and variance of linear combinations of random variables.	5.1-8	
<b>Week 8</b>	Useful inequalities; Bernoulli processes and binomial distributions; indicator random variables.	5.9-11, 18.1-3, 3.2 + handouts	HW 5 due
<b>Week 9</b>	Other discrete distributions; the Poisson distribution; continuous distributions; the uniform distribution.	Chapter 7, 12.1-4	HW 6 due
<b>Week 10</b>	The normal (Gaussian) distribution; Gaussian approximation to Binomials; the Gamma and exponential distributions.	Chapter 9	HW 7 due
<b>Week 11</b>	<b>Midterm Exam 2</b> ; other continuous distributions; functions of random variables.	Chapter 8	
<b>Week 12</b>	Functions of random variables continued; density function method; many-to-one transformations; sums of normals.	handouts	
<b>Week 13</b>	Introduction to statistics; law of large numbers; populations and samples; mean, median and mode; variance; sample range.	Chapter 15 + handouts	HW 8 due
<b>Week 14</b>	The Central Limit Theorem; confidence intervals.	Chapter 16 + handouts	HW 9 due
<b>Week 15</b>	Hypothesis testing; simple linear regression; least squares.	Chapter 19	HW 10 due
<b>FINAL</b>	Refer to the final exam schedule in the USC <i>Schedule of Classes</i> at <a href="http://classes.usc.edu">classes.usc.edu</a> .		

## 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](https://osas.usc.edu). You may contact OSAS at (213) 740-0776 or via email at [osasfrontdesk@usc.edu](mailto: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](mailto: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.