USC Viterbi School of Engineering

ISE 220: Probability Concepts in Engineering (Fall 2021)

Units: 3

Instructor: Mohammad Reza Rajati, PhD
PHE 412
rajati@usc.edu – Include ISE 220 in subject

Office Hours: By appointment, Online

Webpage: Personal Homepage at Intelligent Decision Analysis

TA(s): Javad Azizi
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Office Hours: TBD

Lecture: Monday, Wednesday, 4:00 - 5:20 pm in SGM 601 & Online

Webpages: Piazza Class Page for everything except grades
and USC Blackboard Class Page for grades

– All HWs, handouts, solutions will be posted in PDF format
– *Student has the responsibility to stay current with webpage material*

Prerequisites: MATH 126 Calculus II (MATH 226 recommended)

Recommended Preparation: Basic computer skills.

Tentative Grading: The maximum of the following methods:
Assignments 15%
Midterm 1 25%
Midterm 2 25%
Final Exam 35%
Participation in Class and on Piazza* 5%
or
Assignments 15%
Midterm 1 20%
Midterm 2 20%
Final Exam 45%
Participation in Class and on Piazza* 5%

Letter Grade Distribution:

≥ 93.00	A	73.00 - 76.99	C
90.00 - 92.99	A-	70.00 - 72.99	C-
87.00 - 89.99	B+	67.00 - 69.99	D+
83.00 - 86.99	B	63.00 - 66.99	D
80.00 - 82.99	B-	60.00 - 62.99	D-
77.00 - 79.99	C+	≤ 59.99	F

Disclaimer: Although the instructor does not expect this syllabus to drastically change, he reserves every right to change this syllabus any time in the semester.

Note on e-mail vs. Piazza: If you have a question about the material or logistics of the class and wish to ask it electronically, please post it on the piazza page (not e-mail). Often times, if one student has a question/comment, other also have a similar question/comment. Use private Piazza posts with the professor, TA, graders only for issues that are specific to your individually (e.g., a scheduling issue or grade issue). Try minimizing the use of email to the course staff.

Catalogue Description: Techniques for handling uncertainties in engineering design: discrete and continuous random variables; expectations, probability distributions and transformations of random variables; limit theorems; approximations and applications.

Course Objectives: Upon successful completion of this course a student will

- Understand probability as a model for uncertainty
- Be able to perform basic set probability relations including conditional probabilities, Total Probability, and Bayes' Rule
- Understand random variables as models for numerical measurements with uncertainty
- Use the 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.
- Be able to 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.
- Understand the Law of Large Numbers and Central Limit Theorem and their relation to statistical analysis.

Exam Dates:

- **Midterm Exam 1:** Monday, September 27, 4:00 - 5:20 PM
- **Midterm Exam 2:** Monday, October 25, 4:00 - 5:20 PM
- **Final Exam:** Wednesday, December 8, 4:30 - 6:30 PM as set by the university

Textbooks:

- **Required Textbooks:**

  1. *Probability and Stochastic Processes*, 3rd Edition
     Authors: Roy D. Yates and David J. Goodman; Wiley, 2014. **ISBN-13:** 978-1-118-32456-1
  2. *A First Course in Probability*, 10th Edition
     Author: Sheldon M. Ross, Pearson Education, 2018. **ISBN-13:** 978-0134753119

- **Recommended Textbooks:**

  1. *Probability & Statistics for Engineers & Scientists, MyLab Statistics Update*, 9th Edition
     Authors: Ronald E. Walpole and Raymond H. Myers, Pearson, 2016. **ISBN-13:** 978-0134115856
  2. *Probability and Statistics*, 4th Edition
     Authors: Morris H. DeGroot and Mark J. Schervish, Pearson, 2011. **ISBN-13:** 978-0321500465
  3. *Probability, Statistics, and Random Signals*, 1st Edition
     Author: Charles Boncelet; Oxford University Press, 2016. **ISBN-13:** 978-0-19-020051-0

Grading Policies:

- The letter grade distribution table guarantees the *minimum* grade each student will receive based on their final score. When appropriate, relative performance measures will be used to assign the final grade, at the discretion of the instructor.
  - Final grades are non-negotiable and are assigned at the discretion of the instructor. If you cannot accept this condition, you should not enroll in this course.
  - Three of your lowest homework grades will be dropped from the final grade.
  - *Participation in class and on Piazza has up to 5% extra credit, which is granted on a competetive basis *at the discretion of the instructor*.

- **Homework Policy**
  - Homework is assigned on an approximately weekly basis. A one-day grace period can be used for each homework with 10% penalty. *Absolutely no late homework will be accepted after the grace period. A late assignment results in a zero grade.*

  - In case of *documented illness* or *grave family* situations, exceptions can be made to the late submission policy.
  - Poor internet connection, failing to upload properly, or similar issues are **NOT** acceptable reasons for late submissions. If you want to make sure that you do not have such problems, submit homework *eight* hours earlier than the deadline. Please do not ask the instructor to make individual exceptions.
  - Homework solutions should be typed or *scanned* using scanners or mobile scanner applications like CamScan and uploaded on blackboard (photos taken by cell-phone cameras and in formats other than pdf will NOT be accepted). Programs and simulation results have to be uploaded on blackboard as well.
  - Students are encouraged to discuss homework problems with one another, but each student must do their own work and submit individual solutions written/ coded in their own hand. Copying the solutions or submitting identical homework sets is written evidence of cheating. The penalty ranges from F on the homework or exam, to an F in the course, to recommended expulsion.
  - Posting the homework assignments and their solutions to online forums or sharing them with other students is strictly prohibited and infringes the copyright of the instructor. Instances will be reported to USC officials as academic dishonesty for disciplinary action.

- **Exam Policy**
  - **Make-up Exams:** No make-up exams will be given. If you cannot make the above dates due to a class schedule conflict or personal matter, you must drop the class. In the case of a required business trip or a medical emergency, a signed letter from your manager or physician has to be submitted. This letter must include the contact of your physician or manager.
  - Midterms and final exams will be closed book and notes. Calculators will be allowed in the exams and probably needed, but computers and cell-phones or any devices that have internet capability are not allowed. Two letter size cheat sheets (back and front) is allowed for each midterm. Four letter size cheat sheets (back and front) are allowed for the final.
  - All exams are cumulative, with an emphasis on material presented since the last exam.

- **Attendance:**
  - Students are required to attend all the lectures and discussion sessions and actively participate in class discussions. Use of cellphones and laptops is prohibited in the classroom. If you need your electronic devices to take notes, you should discuss with the instructor at the beginning of the semester.

Important Notes:

- Textbooks are secondary to the lecture notes and homework assignments.
- Handouts and course material will be distributed.
- Please use your USC email to register on Piazza and to contact the instructor and TAs.

Tentative Course Outline

Monday	Wednesday
Aug 23rd **1** **Course Logistics** **Introduction** What is probability? History of Probability	25th **2** **Set Theory** Algebra of Sets Sample Space, Outcomes, and Events **Probability Basics** Kolmogorov's Axioms
30th **3** **Probability Basics** Properties of Probability	Sep 1st **4** **Conditional Probability and Independence** Definition of Conditional Probability and Its Properties Independent Events
6th Labor Day	8th **5** **The Law of Total Probability** Partitions Conditioning on Partitions and The Law of Total Probability
13th **6** **The Bayes Rule, Applications** Conditioning on Partitions and The Bayes' Rule Applications in AI	15th **7** **Sequential Experiments and Combinatorics** Tree Diagrams Counting Methods
20th **8** **Sequential Experiments and Combinatorics** Counting Methods Independent Trials Reliability Analysis	22nd **9** **Random Variables, Discrete Random Variables** The Concept of A Random Variable Discrete Random Variables
27th **10** **Midterm 1**	29th **11** **Discrete Random Variables** Probability Mass Functions (PMFs) Families of Discrete Random Variables Bernoulli Random Variables Geometric Random Variables Binomial Random Variables Pascal (Negative Binomial) Random Variables Discrete Uniform Random Variables

Monday	Wednesday
Oct 4th **12** **Discrete Random Variables** Families of Discrete Random Variables Poisson Random Variables Cumulative Distribution Functions (CDFs)	6th **13** **Discrete Random Variables** Averages and Expected Values Expected Values of Families of Random Variables Functions of Discrete Random Variables
11th **14** **Discrete Random Variables** Expected Value of a Function of A Random Variable	13th **15** **Discrete Random Variables** Variance and Standard Deviation Higher Order Moments
18th **16** **Continuous Random Variables** Continuous Sample Spaces Cumulative Distribution Functions (CDFs) Probability Density Functions (PDFs)	20th **17** **Continuous Random Variables** Expected Values and Variances Families of Continuous Random Variables Uniform Random Variable Exponential Random Variables
25th **18** **Midterm 2**	27th **19** **Continuous Random Variables** Erlang Random Variables Gamma Random Variables
Nov 1st **20** **Continuous Random Variables** Gaussian Random Variables	3rd **21** **Multiple Random Variables** Joint CDFs Joint PMFs Marginal PMFs
8th **22** **Multiple Random Variables** Joint PDFs Marginal PDFs Independence	10th **23** **Multiple Random Variables** Expected Value of A Function of Multiple Random Variables Covariance, Correlation, and Independence
15th **24** **Multiple Random Variables** Bivariate Gaussian Random Variables Multivariate Probability Models	17th **25** **Multiple Random Variables** Conditioning on an Event Conditional PDFs and PMFs Conditional Expectation
22nd **26** **Functions of Random Variables** Densities of Functions of Two Random Variables Sums of Random Variables	24th Thanksgiving Break

Monday	Wednesday
29th **27** **Limit Theorems** Expectation and Variance of Sums of Random Variables The Central Limit Theorem Binomial Approximation	Dec 1st **28** **Limit Theorems** The Sample Mean Laws of Large Numbers

Homework Due Dates

Thursday	
Aug 26th -	1
Sep 2nd **Homework 1 Due**	2
9th **Homework 2 Due**	3
16th **Homework 3 Due**	4
23rd **Homework 4 Due**	5
30th **Homework 5 Due** (Late penalty waived)	6
Oct 7th **Homework 6 Due**	7
14th **Homework 7 Due on Oct 13 (No late penalty if you submit on Friday)**	8
21st **Homework 8 Due**	9
28th **Homework 9 Due** (Late penalty waived)	10
Nov 4th **Homework 10 Due**	11
11th **Homework 11 Due**	12
18th **Homework 12 Due**	13
25th -	14
Dec 2nd **Homework 13 Due**	15

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 University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A. See: http://scampus.usc.edu.

Emergency Preparedness/Course Continuity in a Crisis In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies. See the university's site on Campus Safety and Emergency Preparedness: http://preparedness.usc.edu

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. Website: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html

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