UNIVERSITY OF CALIFORNIA, LOS ANGELES
Civil and Environmental Engineering Department

CEE 110 Introduction to Probability and Statistics for Engineers

Midterm Exam
(4:00-5:50 pm Thursday April 29, 2021 PT)

- Students are allowed to bring one page (one side, approximately 8.5·11 inches) of summary notes with them for the exam (reference sheet). No other materials such as textbooks, class notes, or homework and any other online sources are permitted.
- Useful tables are included at the end of the exam.
- Students may use any calculator during the exam, but the entire answer process must be clear on the written answer sheet. All problems must be worked as if only a basic calculator was available.
- The exam has ***five*** problems with multiple parts. The credit for each part is indicated.
- Full credit will be given for answers that are worked out correctly. You may leave your answer in terms of a correct symbolic equation if you like (partial credits). To obtain credit, be sure to show as much work as possible! You should draw a box around your final answer to each problem.
- You cannot leave the room until the end of the exam. Please use your restroom before the exam.
- You are not allowed to speak during the exam. Use chat window if you have any questions.
- Before submitting your solution, make sure all pages of your solution are legible.
- You must turn in your answers and reference sheet with your name on it through Gradescope.

- Honor Code: Section 102.01 of UCLA's UCLA Student Conduct Code prohibits all forms of academic misconduct or research misconduct, including, but not limited to, cheating, fabrication or falsification, plagiarism, multiple submissions, facilitating academic dishonesty, coercion regarding grading or evaluation of coursework, or unauthorized collaboration. By submitting your assignment and exam for grading you acknowledge these terms / you declare that your work is solely your own and that you have not communicated with anyone other than the instructor and proctors in any way during the exam."
- **You should write this in the beginning of your solution: "On my honor, I have neither received nor given any unauthorized assistance on this examination. Agreed by *Your Name and Signature*"**

Good Luck!

1. Wastewater should be treated before it is discharged to water bodies. The following data shows chemical oxygen demand (COD, mg/L) measured in effluents from Hyperion Wastewater Treatment in Los Angeles in the past month.

   119 83 5 74 33 58 22 40 37 30 5

   a. What is the sample mean and median? Why is the mean different from the median? (5 pt)

   b. If the water quality standard for COD is 100 mg/L, how would you assess the quality of effluent on average? Is it a valid assessment? (5 pt)

   c. Calculate the lower and upper quartiles and fourth spread. (5 pt)

   d. Construct a box plot and show all the processes. How many outliers in this data set? (5 pt)

2. In a water treatment plant, the probability that the plant has an operation problem because of flow variation is 0.03, the probability that the plant has an operation problem because of variation in turbidity is 0.04, and the probability that a plant has an operational problem because of both variations in flow and turbidity is 0.01.

   a. What is the probability that a plant has an operational problem? Draw the Venn Diagram with probabilities and cross hatch the area representing this event. (5 pt)

   b. What is the probability that it has no operational problem? Draw the Venn Diagram with probabilities and cross hatch the area representing this event (5 pt).

   c. What is the probability that a plant will have an operational problem because of the flow variation given that it has a variation in turbidity? (10 pt)

3. At the UCLA computer store, 20% of the students buy personal computers (C), 45% buy notebook computers (N), and 35% buy tablets (T). Of those students buying PCs, only 55% buy Apple products (A). Of those students buying notebooks, 30% buy Apple products, whereas of those buying tablets, 80% buy Apple products.

    a. What is the probability that the next student buys an Apple product? Draw a tree diagram and show the probability of each branch and the final case (*i.e.* intersection of first and second branch) (10 pt)

    b. If the next student buys an Apple product, what is the probability that a PC is requested? If the next student buys an Apple product, what is the probability that a notebook is requested? If the next student buys an Apple product, what is the probability that a tablet is requested? The answer should be rounded to two decimal places. (5 pt)

    c. What is the probability that the next student buys a PC if the student does not buy an Apple product? The answer should be rounded to two decimal places. (5 pt)

4. In Westwood, the Bruin bus must pass through four traffic lights on the way to UCLA campus. For each light, the probability that it is green when the bus arrives is 0.7. The lights are independent.

    a. What is the probability that all four lights are green? The answer should be rounded to three decimal places. (5 pt)

    b. The Bruin bus goes to the campus five times a day. Let X be the number of times out of five times in a given day that all four lights are green. Assume each time is independent of one another. What is the distribution of X? Provide the parameters of the distribution. (5 pt)

    c. What is the probability that X is 4? The answer should be rounded to three decimal places. (10 pt)

5. Seventeen students are scheduled to take a TOEFL speaking test at UCLA on a certain day, eleven of whom will be taking the test for the first time. Suppose that four out of the seventeen students are randomly assigned to test set A, and let X be the number among the four who are taking the test for the first time.

    a. What kind of a distribution does X have? Provide the parameters. (5 pt)

    b. Compute $P(X=2)$. The answer should be rounded to two decimal places. (5 pt)

    c. Compute $P(X<2)$. The answer should be rounded to two decimal places. (5 pt)

    d. Compute $P(X\geq 2)$. The answer should be rounded to two decimal places. (5 pt)

Table: Cumulative Binomial probabilities

$$P[X \le c] = \sum_{x=0}^{c} \binom{n}{x} p^x (1-p)^{n-x}$$

		p										
	c	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
n = 1	0	0.950	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.050
	1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n = 2	0	0.903	0.810	0.640	0.490	0.360	0.250	0.160	0.090	0.040	0.010	0.003
	1	0.998	0.990	0.960	0.910	0.840	0.750	0.640	0.510	0.360	0.190	0.098
	2	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n = 3	0	0.857	0.729	0.512	0.343	0.216	0.125	0.064	0.027	0.008	0.001	0.000
	1	0.993	0.972	0.896	0.784	0.648	0.500	0.352	0.216	0.104	0.028	0.007
	2	1.000	0.999	0.992	0.973	0.936	0.875	0.784	0.657	0.488	0.271	0.143
	3	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n = 4	0	0.815	0.656	0.410	0.240	0.130	0.063	0.026	0.008	0.002	0.000	0.000
	1	0.986	0.948	0.819	0.652	0.475	0.313	0.179	0.084	0.027	0.004	0.000
	2	1.000	0.996	0.973	0.916	0.821	0.688	0.525	0.348	0.181	0.052	0.014
	3	1.000	1.000	0.998	0.992	0.974	0.938	0.870	0.760	0.590	0.344	0.185
	4	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n = 5	0	0.774	0.590	0.328	0.168	0.078	0.031	0.010	0.002	0.000	0.000	0.000
	1	0.977	0.919	0.737	0.528	0.337	0.188	0.087	0.031	0.007	0.000	0.000
	2	0.999	0.991	0.942	0.837	0.683	0.500	0.317	0.163	0.058	0.009	0.001
	3	1.000	1.000	0.993	0.969	0.913	0.813	0.663	0.472	0.263	0.081	0.023
	4	1.000	1.000	1.000	0.998	0.990	0.969	0.922	0.832	0.672	0.410	0.226
	5	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n = 6	0	0.735	0.531	0.262	0.118	0.047	0.016	0.004	0.001	0.000	0.000	0.000
	1	0.967	0.886	0.655	0.420	0.233	0.109	0.041	0.011	0.002	0.000	0.000
	2	0.998	0.984	0.901	0.744	0.544	0.344	0.179	0.070	0.017	0.001	0.000
	3	1.000	0.999	0.983	0.930	0.821	0.656	0.456	0.256	0.099	0.016	0.002
	4	1.000	1.000	0.998	0.989	0.959	0.891	0.767	0.580	0.345	0.114	0.033
	5	1.000	1.000	1.000	0.999	0.996	0.984	0.953	0.882	0.738	0.469	0.265
	6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n = 7	0	0.698	0.478	0.210	0.082	0.028	0.008	0.002	0.000	0.000	0.000	0.000
	1	0.956	0.850	0.577	0.329	0.159	0.063	0.019	0.004	0.000	0.000	0.000
	2	0.996	0.974	0.852	0.647	0.420	0.227	0.096	0.029	0.005	0.000	0.000
	3	1.000	0.997	0.967	0.874	0.710	0.500	0.290	0.126	0.033	0.003	0.000
	4	1.000	1.000	0.995	0.971	0.904	0.773	0.580	0.353	0.148	0.026	0.004
	5	1.000	1.000	1.000	0.996	0.981	0.938	0.841	0.671	0.423	0.150	0.044
	6	1.000	1.000	1.000	1.000	0.998	0.992	0.972	0.918	0.790	0.522	0.302
	7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000