EVERYTHING (EXCEPT THE RED LETTERS) IN THIS BOX MUST (WORD BY WORD, WITH NAME AND ID ADDED) APPEAR ON A FRONT PAGE 1 OF YOUR SUBMITTED EXAM. YOU MAY WRITE EVERYTHING BY HAND ON PAGE 1 OF YOUR EXAM. DO NOT WRITE ANYTHING ELSE ON THAT PAGE.

LAST NAME: $---------- **FIRST NAME:** $---------- **ID:** $----------

Write a statement like this below and add your full signature (in English) below it.

I, $$(your name here)$$sign to confirm that this exam reflects my work and only my work, that I have not consulted with anyone or anything except the class material posted in CCLE, the textbook, and Cognella active learning and that I have taken the time specified in the instructions or very close to that time to complete the exam from the moment that I first looked at it until it was in Gradescope. I also confirm that I have adhered to the UCLA Student Conduct Code `https://deanofstudents.ucla.edu/student-conduct-code` and that I have and will not share this exam with anything or anyone. (Note: do not omit the url, you must also write it)

YOUR (handwritten-on paper or tablet) SIGNATURE (in English):$----------

INSTRUCTIONS

In addition to the instructions given to you days before the midterm, please adhere to the following to avoid losing precious points in your exam.

(a) MIDTERM TIME WINDOW: Friday, 10/29/2021 8:00 AM to Monday 11/1/2021 7 AM. (Note: there is no lecture or office hours on 10/29/2021).

(b) MIDTERM EXAM MAX TIME ALLOWED: 3 HOURS from the moment you click on gradescope or the pdf file or the Q&A file until it is submitted. This time includes the time it takes to upload the file to gradescope. The exam itself is a two hour exam, but you are allowed three hours to do it.

(c) All clock times mentioned below refer to Los Angeles time. You must take the exam within the exam time window period which is between Friday, 10/29/2021 8:00 AM to Monday, 11/1/2021 7 AM. Los Angeles Time. All exams must have been uploaded to Gradescope by 7:00 AM on 11/1/2021. Students that wait until the last minute to do the exam and have internet problems of any kind will not receive excuse for turning it late. You are given a wide time window in order to prevent these problems.

(d) You must work on your own. No group work allowed, no consulting with anyone or anything allowed. You only may use all the material in our CCLE course web site and the textbook and active learning materials that come with it. Do not use the discussion forum or any other discussion sites that you have been using during the quarter.

(e) You may not talk to anybody in the class about the exam during the time window of the exam, even if you have submitted your exam. The TA will not be available during the time window. Contact only Dr. Sanchez.

(f) If you have a question, read the instructions carefully and check the Q&A file, where Dr. Sanchez will be posting anything worthwhile that may benefit the whole class, such as a typo found. You will look at that file before you email Dr. Sanchez. If you do not receive an answer it is because you should not have asked that question or because the answer is in the Q&A. But read carefully instructions for each section of the exam.

(g) The exam has two parts

- Part I (20 points) is 20 multiple choice questions and does not require showing work, but you will have to do your scratch work to find answers. Do not submit your scratch work. The multiple choice questions will be answered in the table on page 3 of this exam.
- Part II (20 points) consists of 1or 2 longer problems or several short problems where you must show work (each problem has several parts). Work is 80% or more of your grade. Make sure you read the instructions carefully. Complete work means you must define your notation, must state what you are computing and must show detailed and justified work and final answers. You must use class notation and material covered in class.

(h) You may write your answers, and everything required, on your own paper, or print the exam and write on it, or use your ipad. In all cases, you must follow the requirements listed in the following instructions.

(i) You will scan and upload, indicating to Gradescope the page number where each item in the outline is, to gradescope a pdf file called lastname-uclaID-midterm.pdf, containing, in this order, and with page numbers (scan your work using the adobe scan up downloaded to your phone, or similar):

- (i)A front page handmade with your paper or the one in the exam, with your lastname, first name, UCLA ID, full signature (handwritten signature, typed not allowed) and a statement that you must write exactly as given in the exam indicating that you worked on your own and only consulted the course web site and our textbook and did not talk to anyone about the exam during the time window of the exam. Without this page, your exam will not be graded. This will be page 1 of your pdf submission. Nothing else can be on it. Email after submission saying you forgot to include it will not be accepted.
- (ii) the page with the table containing the multiple choice answer(s) will be page 2. You may use the one on page 2 of the exam, printed, or make one of your own identical to the one in the exam on your own paper. This will be page 2 of your pdf submission. The table must have format exactly equal to the one given in the exam. Nothing else allowed on that page.
- (iii) The remaining pages will contain the work problem answers, in the same order as written on the exam. You do not need to copy the question. Those writing on their notebook or a tablet without the exam pdf file do not need to write the question but they must indicate the questions number. All questions must be answered in the order given.

(j) UCLA student code of conduct is enforced. Any indication of not following it or not following the instructions given above and on the instructions given to you before the exam, will be reported to the Dean of Students office and will result in an F in the exam and the class. `https://deanofstudents.ucla.edu/individual-student-code`

(k) Only gradescope is allowed as a form of submission. Allow yourself enough time to be able to upload on time. I will not accept emails with files or anything else.

(l) No late exams will be allowed. No makeups.

Part I. MULTIPLE CHOICE ANSWERS. WRITE YOUR ANSWER FOR QUESTIONS 1-20 ON A TABLE EXACTLY LIKE THE ONE GIVEN BELOW. YOU MAY WRITE A TABLE LIKE THIS BY HAND ON YOUR PAPER OR TABLET OR PRINT AND USE THIS ONE

The work you do to solve the MC will not be graded. Only this table or a table exactly like this written by hand (if you use your own paper or tablet) or this page with the letter corresponding to what you think is the answer will be graded for this part.

Since this is not a scantron exam (meaning it will be graded manually), if by any chance you think that the options given do not contain the answer, look at the Q&A file. If nothing is there, select the closest answer to what you think is correct and then write a small comment indicating your concern below the table, indicating question number and concern, as well as the complete work for only that question. Your work must show why you have the concern. I will look at it when grading. This strategy will save you time.

THERE IS A BOX FOR EACH QUESTION. WRITE YOUR ANSWER FOR EACH QUESTION INSIDE THE BOX WHERE THE QUESTION NUMBER IS. THE FORMAT OF THE BOX YOU WRITE (IF YOU WRITE IT BY HAND ON YOUR NOTEBOOK PAGES) MUST BE EXACTLY LIKE THIS (4 columns).

Question(Q) Answer	Q Answer	Q Answer	Q Answer
Q 1	Q 6	Q 11	Q 16
Q 2	Q 7	Q 12	Q 17
Q 3	Q 8	Q 13	Q 18
Q 4	Q 9	Q 14	Q 19
Q 5	Q 10	Q 15	Q 20

PART I. Multiple choice questions. *Showing work is not required. Write all your answers to the multiple choice questions in the table on page 3 or a hand-written version of the table that you have created on your own paper, a table identical to the one on page 3.* **There is only one answer to each question**

NOTE: Since this is not a scantron exam (meaning it will be graded manually), if by any chance you think that none of the choices given is the answer, look at the Q&A file. If nothing is there, select the closest answer to what you think is correct and then write a comment and your complete work for only that question below the table, on the same page where your table is. I will look at it when grading. This strategy will save you time.

You may use the space near the question for scratch work, but scratch work will not be read. You do not need to submit the questions. Only the table on page 3 will be read.

Question 1. We figured out in class the distribution of the random variable X=max(a,b) where a is the roll of a fair six sided die and b is the roll of another fair six sided die. A distribution like that is

(a) skewed right

(b) skewed left and has probability of X larger than 4 equal to 0.5555

(c) symmetric with probability that X is larger than 4 equal to 0.8333

(d) uniform discrete, with probability 1/36 for each value of the max

Question 2. An electronic circuit contains 3 components, each of which has a probability of 0.2 of failing during a period of 4 years. The circuit fails if all the components fail. Assuming that the components fail independently, what is the probability that the circuit will work during the whole 4-year period?

(a) 0.79991

(b) 0.03940

(c) 0.88234

(d) 0.992

(e) 0.3439

Question 3. 10 percent of students at a certain school wear both a ring and a necklace. Twenty five percent were a ring and 30 percent were a necklace. If two students are chosen randomly, what is the probability that both of them are wearing neither a ring, not a necklace?

(a) 0.3025

(b) 0.35

(c) 0.0025

(d) 0.55

Question 4. Waiting time (W) to vote at the local voting station (which has only one booth to cast votes) in election days is exponentially distributed, with expected value 15 minutes. A person arrives before you to the voting station. Calculate the probability that you will have to wait more than 5 minutes to vote.

(a) 0.6149

(b) $(1 - 6000t)^{-1}$

(c) 0.7165313

(d) 0.2834687

Question 5. Each day a frog either jumps right one inch with probability 2/5 or jumps left one inch with probability 3/5 independently of the previous movements. The distance jumped to the left will be denoted by a distance with negative sign (for example, -1). We are interested in the movement of the frog during three jumps. The Expected distance jumped at the end of the third jump is

(a) -1 cent

(b) 1 cent

(c) -0.6 cents

(d) 0.3 cents

(e) 0.84 cents

Question 6. Consider an automobile accident on a city street in which car I stops suddenly and is hit from behind by car II. Suppose the three persons, whom we call A,B,and C, witness the accident. Suppose the probability that each witness has correctly observed that car I stopped suddenly is estimated by having the witnesses observe a number of contrived incidents about which each is then questioned. Assume that it is found that A has probability 0.9 of stating that car I stopped suddenly, B has probability 0.8 of stating that car I stopped suddenly, and C has probability 0.7 of stating that car I stopped suddenly. Let A, B, and C denote, respectively, the events that persons A, B,and C will state that car I stopped suddenly. Assuming that A, B, and C are independent events, what is the probability that at least two of them will state that car I stopped suddenly?

(a) 0.398

(b) 0.010

(c) 0.902

(d) 0.

Question 7. Suppose that the height, in inches, of a randomly chosen 25-year-old person is a normal random variable with parameters $\mu = 71$ and $\sigma^2 = 6.25$. What percentage of persons in the 6-footer club are over 6 feet, 5 inches?

(a) 0.02379

(b) 0.36827

(c) 0.02239

(d) 0.00819

Question 8. The cumulative distribution function F(x) of a discrete random variable X is given by F(0)=0.2, F(1) = 0.6, F(2)=0.8, and F(3) = 0.9, F(4)=1. Then the value of the probability mass function P(X=2) is

(a) 0.8

(b) 0.3

(c) 0.4

(d) 0.2

Question 9. The cumulative distribution function F(x) of a discrete random variable X is given by F(10)=0.2, F(15) = 0.6, F(20)=0.8, and F(31) = 0.9, F(61)=1. The 80th percentile equals

(a) 0.8

(b) A number between 20 and 31

(c) 20

(d) 15

Question 10. The following table was given to us to illustrate information available about blood type cataloguing (H-labeled type means that blood type is measured with system K and and T-labeled type means that blood type is measured with system L).

Blood types in a population according to two systems

		Blood type with system L	
		T	T^c
Blood type with K	H		
	H^c		

The probability that a randomly chosen person in the population is catalogued as type H by system K is 0.3, and the probability that system L catalogues a blood type as T is 0.4. The cataloguing of blood types by these two systems are independent events. The probability that a randomly chosen person is labeled H type by system K and is labeled T with system L is not given. Calculate that probability.

(a) 0.6818

(b) 0.42

(c) 0.3109

(d) 0.12

Question 11. According to the information given in Question 10, what is $P(T \mid H)$

(a) 0.12

(b) 0.4

(c) 0.54

(d) 0.98

Question 12. Consider the system of components connected as in the accompanying picture in Figure 1. Let A_i denote the event that component i works, $(i = 1, 2, 3, 4)$. If components work independently of one another and the reliability of A_i, $(i = 1, 2, 3, 4)$ is 0.8, calculate the reliability of the system.

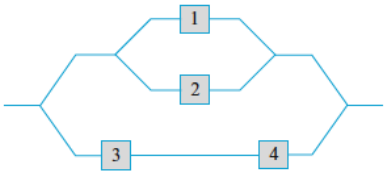

Figure 1: A system with 4 components

(a) 0.4311

(b) 0.8910

(c) 0.9856

(d) 0.9981

Question 13. Consider the type of clothes dryer (gas or electric) purchased by each of five different customers at a certain story. If the probability that at most one of these customers purchases an electric dryer is 0.67, what is the probability that at least two purchase an electric dryer?

(a) 0.572

(b) 0.33

(c) 0.781

(d) 0.99

(e) 0.04

Question 14. Imagine that you conducted a survey of randomly chosen foreign exchange students to get data to answer the question: "are you from a European country or not"? You collected recently a random sample of 3000 foreign exchange students from among the very large population of all foreign exchange students in the United States. The goal was to estimate the parameter "p" (the probability that a randomly chosen foreign exchange student in the United States is from Europe).

Your estimate of p, based on that random sample was 0.3. If this 0.3 was indeed the true proportion of foreign exchange students in the United States that are from Europe, what is the probability that a randomly chosen sample of 10 foreign exchange students taken today from the population of foreign exchange students in the United States without replacement contains some from Europe?

(a) 0.9717525

(b) approximately 0

(c) 0.02824752

(d) 0.1210608

$$\begin{aligned} P(X \leq x) &= P(X=1) + P(X=2) \cdots P(X=x) \\ &= p + qp + q^2p \cdots + q^{x-1}p \\ &= p[1-q^x]/(1-q) \\ &= 1 - q^x \end{aligned}$$

Figure 2: Theoretical result about the geometric random variable

Question 15. If X is a geometric random variable with parameter p and q=1-p, and the results in Figure 2 is correct, what is the following probability equal to?

$P(X > 10 \mid X > 6)$

(a) q^4

(b) $P(X > 4)$

(c) q^6

(d) $1 - q^6$

Question 16. Students applying to graduate schools usually try the GRE exams several times until they get a score that they are satisfied with. That costs money, say $200. The random variable X measures the number of attempts until satisfied with the score. Assuming that money is not a limitation for how many attempts a student can make, and that p represents the probability that a student is satisfied by an attempt, what is the variance of the cost?

(a) $\frac{400-400p}{p^2}$

(b) $200(np(1-p))$

(c) $400p(1-p)$

(d) $200p(1-p)$

Question 17. Consider three events E, F, G in the sample space S.

$$P(E^c \cap F \cap G) + P(E \cap F \cap G)$$

equals

(a) $P(E \cap G)$

(b) $P(E \cap F)$

(c) $P(F \cup G)$

(d) $P(F \cap G)$

(e) $P(E \cup F \cap G)$

Question 18. A psychologist has some mice that come from lab A and some that come from lab B. The psychologist ran 50 mice through a maze experiment and reported the following: 25 mice were from lab A, 25 were previously trained, 20 turned left (at the first choice point), 10 were previously trained lab A mice, 4 lab A miced turned left, 15 previously trained mice turned left, and 3 previously trained lab A mice turned left. Let L denote the event "turned left"; T the event "trained" and A denote "lab A". Consider choosing a rat at random, i.e., each rat is equally likely to be chosen. What is the probability of the following event?

$$A \cap (L \cup T)^c$$

(a) 0.72

(b) 0.99

(c) 0.36

(d) 0.08

(e) 0.28

Question 19. In a city, 20% of the taxi cabs are yellow, 70 percent are blue and 10 percent are orange. We know that 30% of yellow taxicabs overcharge customers, 10% of the blue overcharge customers and 80% of the orange overcharge customers. A customer complained that in a late night ride, the taxicab overcharged, but the color of the taxicab was forgotten due to being kind of sleepy at that time of the night. Which cab color is more likely to have produced the overcharge?

(a) a blue cab

(b) a yellow cab

(c) an orange cab

(d) can not be determined

(e) they are all equally likely to have overcharged.

Question 20. In the song found at `https://youtu.be/ZINXFoQMZVs` "Summary Song 2 Discrete random variables Stats Parody", which of the probability mass functions covered in our course web site and textbook did the author not mention ?

(a) the Negative binomial pmf

(b) the Poisson pmf

(c) the Binomial pmf

(d) the Bernoulli pmf

GO TO NEXT PAGE FOR WORK QUESTIONS IN PART II

PART II. SHOW WORK FOR THE FOLLOWING QUESTIONS.

For this part of the exam, you must show work to obtain full credit even if the question does not ask for it. The grading rubric will be as in the homework, 80 or 90% of the grade comes from work, including proper definition of your random variable(s), events, notation, thorough work, assumptions and final answer. When the results are numeric, please, do not leave your final result as a fraction. Calculate the value of the fraction, providing at least three decimals.

In the work, do not assume that we know what you are thinking and that we know the material. Explain as if the person reading it did not know the answer. Make sure you provide the WHY and show work.

Note: Some students print the exam and scan the printed version with their answers. For those students, I leave space. You do not need to print the exam, just copy what you are asked to put in your exam. You may write your answers on your notebook and scan that, as indicated in the instructions on the front pages of this exam.

Question 21. A Z generation student has 3000 songs in their playlist. 15% of these songs are classic rock. The student selects their songs at random. What is the probability that in the next 100 songs chosen, the number of classic rock songs is larger than 70?

Question 22. The random variable "Netflix subscriber status" can take two possible values: 1 if the person is a Netflix subscriber and 0 otherwise. Let's denote that random variable X. We are interested in $E\left(X^2\right)$. Find it.

Question 23. During several randomly chosen days, a data scientist enters an amusement park as soon as it opens and stands near the shown Hammer game in the amusement park. Each day, the data scientist observes individuals that try the game to see whether they hit the 100 strength (see Figure 3. The data scientist leaves the park as soon as a person hits the 100 strength mark. On average, the number of people observed is 10. The data scientist then publishes in the park's annual bulletin the estimated probability that a random player of this game hits the 100 mark strength in this game. Which value should the data scientist publish for that probability, based on the evidence?

Figure 3: A random park visitor playing Hammer strength game

Question 24. Show the work that you did to answer Question 5 in the Multiple Choice Section. Your work must show the elements of the Sample Space S, and the probability mass function that you put together using the outcomes in S well explained, before you calculate the expected value. Add to that the calculation of the Expected value of the squared distance.

Question 25. Show the work that you did to answer question 4.