EVERYTHING IN THIS BOX MUST APPEAR ON A FRONT, PAGE 1, OF YOUR SUBMITTED EXAM. YOU MAY WRITE EVERYTHING BY HAND ON PAGE 1 OF YOUR EXAM.

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 Section 102.01 or 102.02 of the UCLA Student Conduct Code and that I have and will not share this exam with anything or anyone.

YOUR SIGNATURE (in English):$----------------------$

INSTRUCTIONS

(points deducted for not following these instructions and those posted in the midterm folder)

(1) The exam must be submitted to Gradescope link for the exam **before 1 PM on 11/1/2020 Los Angeles Time.**

(2) **This is a two hour exam, but you are allowed three and a half hour from the moment you look at it for the first time (which will be logged in by CCLE) until the time it appears as submitted in gradescope (which will also be logged by CCLE).** So the three and a half hour includes the time it takes you to scan and submit the exam. You can choose any three and a half hours during a 48 hour window to do your exam, but you must submit before the deadline. No excuses will be accepted because you wait until the last minute to look at, download and (or) submit your exam. Start early to prevent problems.

(3) You must work on your own. No group work allowed, no consulting with anyone or anything allowed. No sharing of information allowed. You may use all the material in our CCLE course web site and the required textbook, including Cognella active learning materials that come with the textbook.

(4) You may only talk to Dr. Sanchez regarding the exam while doing the exam and during the 48 hours of the exam. Do not contact the TA or anybody else regarding class material or anything regarding the exam and the course during the time window allowed for the exam.

(5) There is a file called Q&A, where I 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 me (Dr. Sanchez). Read the instructions of the exam well to avoid wasting time asking questions that are answered in the instructions.

(6) The exam has two parts.

- Part I (20 points) is 20 multiple choice questions (pages 3-9). *Answer on the table given on page 3 or a table exactly like that written by hand. Required* . You must write the letter of the chosen answer or answers (A, B, C,...etc). Read MC instructions on page 3.

- Part II (20 points) problems where you must show work. Work is 80% or more of your grade. Make sure you read the instructions carefully.

(7) **Uploading to (Gradescope)**: You will scan and upload to the gradescope link in the midterm folder a pdf file called lastname-uclaID-midterm.pdf, containing, in this order, and telling gradescope the page where things are (scan your work using the adobe scan app downloaded to your phone,as in homework):

- (i)The front page (you may either print the one on page 1 of the exam or make your own on your notebook. The page must have everything that appears in the framed (boxed) part of the top of page of the exam (name, ID, statement

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saying what the paragraph says and full signature). This will be page 1 of your pdf file submission. There will be points deduction if this page is not submitted.

- (ii) the page with the table containing the multiple choice answer(s) and only the letter chosen. Work is not required. You must use the table on page 3, printed, or make one of your own exactly like that one, drawn by hand. This will be page 2 of your pdf submission. Warning: if your table is not like that one on page 3 (i.e., with 4 columns) points will be deducted from your exam.

- The remaining pages of your submitted exam will contain the work and answers for the questions that require work, in the order given. But you do not need to copy the question. You must indicate to gradescope the page number where the question appears. It is not necessary to have each question in a separate page but points will be deducted if you do not indicate the page number where the answer is when you submit to gradescope.

(8) 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 any other form of submission. No late exams will be allowed.

(9) Any indication that you did not follow these instructions or Sections 102.01 or 102.02 of the UCLA Student Code of Conduct

`https://www.deanofstudents.ucla.edu/portals/16/documents/uclacodeofconduct_rev030416.pdf`

or indication that you shared information or work with others will result in an F in the class and this exam, and a virtual visit to the Dean of Students office.

(10) Indication that this exam has been posted or shared with anyone will result in a visit to the Dean of Students Office. The exam can not be shared with anyone, during or after the exam is completed.

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.

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) 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 there is no 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. 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

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.* **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 there is no 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, on the same page where your table is. I will look at it when grading. This strategy will save you time.

Question 1. What is the probability that if I roll a 12-sided die, I will get the number 9.

(a) 1/12

(b) 9/12

(c) unknown

(d) 1/6

Question 2. If we roll two fair 4-sided die, and I have to bet on a sum of 4 or 5, which one should I choose?

(a) 4

(b) 5

(c) 4 and 5 are have equal chance of happening.

Question 3. Consider the toss of two fair coins. Which of the following is true?

(a) The sample space of this experiment contains 3 sets but 4 outcomes.

(b) The sample space of this experiment contains 4 sets but 3 outcomes

(c) The sample space of this experiment contains the same number of sets as the number of outcomes.

Question 4. A family has just moved to a new city and requires the services of both an obstetrician and a pediatrician. There are two easily accessible medical clinics, each having 4 obstetricians and 2 pediatricians. The family will obtain maximum health insurance benefits by joining a clinic and selecting both doctors from that clinic. In how many ways can this be done?

(a) 20

(b) 24

(c) 12

(d) 16

Question 5. Consider three events A, B, C contained in a sample space S. The events $(A \cap B \cap C^c), (A^c \cap B \cap C), (A \cap B^c \cap C)$ are

(a) mutually exclusive

(b) independent

(c) equal to $(A \cup B \cup C)$

(d) equal to $(A \cap B \cap C)^c$

Question 6. What do the three following experiments have in common?

- Tossing three coins where the probability of head is 2/3 to see how often we get head.

- Observing weekly for three randomly chosen weeks the status of a water meter to assess how often the meter is in good condition (working), where the probability that it works is 2/3

- Asking three randomly chosen persons in your home town whether they will leave town for the Summer vacation or not (assuming they all will have a Summer vacation) to do a project for your class where you will report the number of persons that will leave town per every 3 persons, where the probability that a person leaves town is 2/3.

(a) They have the same number of outcomes in the sample space S

(b) They are all Poisson experiments

(c) They have nothing in common

(d) They all have outcomes such that every outcome has probability 1/8 of happening.

Question 7. Daily sales records for a car dealership show that it will sell 0, 1, 2, or 3 cars, with probabilities as listed

x= Number of sales	0	1	2	3
P(X=x)	0.5	0.3	0.15	0.05

Assuming that sales in a given day are independent of sales in any other day, what is the probability that it takes more than 2 days to observe a daily sale of more than 1 car?

(a) 0.625

(b) 0.45

(c) 0.032

(d) 0.712

Question 8. Let R= event of referral to a specialist and let L = event of lab work.

The probability that a visit to a primary care physician's (PCP) office results in neither lab work nor referral to a specialist is 35% (that is, $P(L \cup R)^c = 0.35$). Of those coming to a PCP's office, 30% are referred to specialists and 40% require lab work. Determine the probability that a visit to a PCP's office results in both lab work and referral to a specialist.

(a) 0.95

(b) 0.35

(c) 0.05

(d) 0.62

Question 9. A robo-car or robotic car,(automated vehicles and fully automated vehicles in the European Union) is a vehicle that is capable of sensing its environment and moving safely with little or no human input. Suppose we have a car that needs no human input. The robot uses the rules of probability to make decisions. The car knows that 10% of alert signals while driving come from another car in front of it breaking suddenly (scenario I) ; 30% of alert signals come from small animals suddenly crossing in front of the vehicle (scenario II); 40% of alert signals come from driving over a huge pothole in the ground (scenario III). In the first scenario (another car crossing), the robot would make its car break. In the second scenario, the robot will make its car continue driving. In the last scenario (pothole case) the robot will make the car park safely and do an automatic check of tires condition. The robot also knows, based on statistics published by the local authorities, that the probability that a car breaks suddenly in front of another moving car is 60%, the probability that a small animal crosses a moving car is 30% and the probability that there is a pot hole on the road is 10%. While the car is driving in a randomly chosen day, an alert signal appears. What action will the robo-car take ?

(a) The robo-car will make its car break

(b) The robo-car will make its car continue driving

(c) The robo-car will make the car park safely and do automatic check of tires condition.

Question 10. Mr Rodriguez knows that there is a chance of 40% that the company he works with will open a branch office in Montevideo (Uruguay). If that happens, the probability that he will be appointed as the manager in that branch office is 80%. If not, the probability that Mr. Rodriguez will be promoted as a manager to another office is 10%. Find the probability that Mr. Rodriguez will be appointed as the manager of a branch office from his company.

(a) 0.38

(b) 0.84221

(c) 0.62

(d) 0.1118

Question 11. A company produces books. The number of typographical errors per page produced by this publisher is not constant. It is a random variable. If you know that this company has been in business for a very long time, and has a very good reputation, what would be your guess about the shape of the distribution of typographical errors per page.

(a) It will be bell-looking,symmetric.

(b) It must be uniform-looking

(c) It must be skewed left

(d) It must be skewed right

Question 12. A diagnostic test for the presence of a disease has two possible outcomes. Let X denote the disease state of a patient (1 for disease present and 0 for disease not present), and let Y denote the outcome of the diagnostic test (+ for test saying that disease is present and − for test saying that disease is not present. The joint probability mass function of X and Y is given by
  P(X=0,Y=−) =0.800; P(X=1,Y=−)=0.050; P(X=0, Y=+)=0.025; P(X=1, Y=+)=0.125
  Calculate the variance of the outcome of the diagnostic test for those with the disease.

(a) 0.204

(b) 0.13

(c) 1.5

(d) 0.67

Question 13. Consider the following joint probability mass function of random variables X and Y: P(X=0,Y=0)=1/8; P(X=0,Y=1) = 2/8, P(X=0, Y=2) = 1/8; P(X=1,Y=1)=1/8; P(X=1,Y=2)=2/8), P(X=1,Y=3)= 1/8.
  The Cov(X,Y) is equal to

(a) 0.75

(b) 0.577

(c) 0.214

(d) 0.25

Question 14. Suppose that random variable X follows a Poisson distribution with parameter $\lambda = 4$, what is the following expression equal to?

$$\sum_x [2P(X = x)] + \sum_x [3xP(X = x)] + \sum_x [4x^2 P(X = x)]$$

(a) 334

(b) 16

(c) 94

(d) 1124

Question 15. Proposition 134 is on the ballot for the next election. In a small town of 50 people, all eligible voters, 30 favor of the proposition and 20 do not. A committee of 4 people is selected from this town. What is the probability that there will be at least one person in favor?

(a) 0.02103778

(b) 0.9789622

(c) 0.148502

(d) 0.843129

Question 16. The joint probability mass function of two random variables X and Y is given by

$$P(X = x, Y = y) = k(2x + y), x = 1, 2; y = 1, 2, 3$$

What is the value of k?

(a) 1/30

(b) 0.111

(c) 1/16

(d) 18/30

Question 17. Zandree Rose is a car salesperson. On average, this person sells two brand new BMWs every week. There is a bonus if this person sells at least three brand new BMWs in any given week. Given three weeks, what is the probability that this person gets the bonus in two of the weeks?

(a) 0.2122155

(b) 0.1045423

(c) 0.5

(d) 0

Question 18. There are a large number of genetically based blood group systems that have been used for typing blood. Two of these are the Rh system (with blood types Rh+ and Rh-) and the Kell system (with blood types K+ and K-). It is found that any person's blood type in any one system is independent of his or her blood type in any other.

It is known that, for Europeans in New Zealand, about 81% are Rh+ and about 8% are K+. If a European New Zealander is chosen at random, what is the probability that he or she is either positive in both systems or negative in both systems?

(a) 0.1123

(b) Can't be computed with the information given.

(c) 0.2396

(d) 0.6714

Question 19. A town has 3 clinics where people go to donate blood. One third of the persons donating blood at each of these clinics have $O+$ blood. What is the probability that in a randomly chosen day, each and everyone of the clinics in this town find the first O^+ donor in the third donor of the day?

(a) 0.0987

(b) 0.03703

(c) 0.00325

(d) 0.1314

Question 20. 20% of the workers in a factory work in plant A and 80% work in plant B.

The number workers calling in sick per week follow a Poisson probability mass function with parameter $\lambda = 3$ for plant A, and $\lambda = 5$ for plant B.

What is the probability that next week there will be 2 workers calling in sick?

(a) 0.35671

(b) 0.9911

(c) 0.11218

(d) 0.006

    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. 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, 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.

Question 21. Consider the circuit shown below showing the components and the probability that each of the components work. The components work independently. Use the information we learned in class about parallel and series systems to answer the following questions.
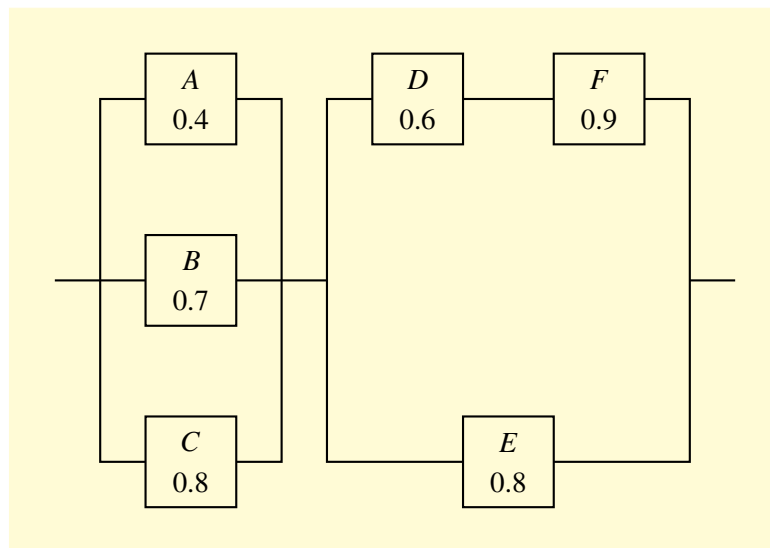
(a) Calculate the reliability of the circuit.

(b) Consider the random variable X denoting the number of components that work. Would the probability mass function of X be a binomial random variable? Why or why not?

Question 22. The price of the stock of a very large company on each day goes up with probability p or down with probability q=(1-p). There are no two consecutive days with the same price. The changes on different days are assumed to be independent. Consider an experiment where we observe the price of the stock for three days. Answer the following questions. (Note: do not assume any specific value for p for parts (a) to (e). Your answers for those parts will depend on p.)

(a) List the sample space of this experiment.

(b) Consider event A that the stock price goes up the first day. What is the probability of event A?

(c) Consider the random variable Y denoting the number of days that the stock goes up. Write a table indicating the probability mass function of Y and add a column to it where you will show how you calculated the probabilities.

(d) Calculate the expected value and standard deviation of Y, simplifying as much as possible.

(e) Does your probability mass function belong to any of the families of probability mass functions widely appearing in many experiments? Which? Give another example of a random variable W that would be a member of such a family, if any.

(f) Suppose now and only now that p=0.6. Provide the probability mass function of Y under this condition and also the cumulative probability mass function. Also draw the two distributions labeling the axes properly.

Question 23. A student of Probability proposed a discrete random variable Y which can take the possible values 1, 2, and 3. The student claims that the following function is a probability mass function for Y:

$$P(Y = y) = \frac{\theta^{2y}}{\theta^2 + \theta^4 + \theta^6}, \qquad y = 1, 2, 3; \theta > 0$$

Is P(Y) a probability mass function (i.e., does it satisfy Kolmogorov's axioms?)

Question 24. You want to create an email spam filter software package to sell to a company. You happen to have collected 1000 emails randomly chosen from all email messages received by workers in that company, including the CEO's emails, and look at the sentences included in all the emails. You will use information from this research to "train" your filter, where train means obtain the probability estimates you need to make your spam filter work and make the best possible decision in the face of uncertainty. You find out in your research that out of the 1000 email messages, 200 are spam (junk mail from the point of view of the company) and 800 are not spam. You also find out that among the spam emails, 150 contain the sentence "I have what your company needs," whereas among the not-spam mails 200 contain that sentence. Certainly a spam filter will take into account many other sentences, so you collect information on other sentences contained in spam mails and non-spam mails and also record their frequencies. You end up with a long list of sentences and their frequencies in each of the two types of email messages. Let's call each sentence in your list a "critical sentence." You have decided that your filter will work as follows (it is not the best way to work, but let's say you are just testing your filter sentence by sentence for now):

- The filter will calculate the probability that an email message that contains a "critical sentence" is spam, using the information that you provided to the filter based on your research. You do that separately for each "critical sentence."

- If that probability is larger or equal to 0.7 then the filter will reject the message as spam and the message will be discarded. Otherwise the message goes to the recipient's mailbox.

- The filter is trained on the rules of probability and uses them correctly. The filter will make the best decision possible given the information that it has been trained with.

Based on all the information given to the filter and the assumption that it is a probability-smart filter,

(a) What is the filter's estimated probability that an email message arriving to this company with the critical sentence "I have what your company needs," is a spam email message if only the information given above in this problem is known by the filter?

(b) If a message containing the critical sentence "I have what your company needs" arrives to the company, what will the filter do: reject as spam or accept and move to the recipient's mailbox?

(c) Suppose that you also learned that 70 of the spam emails contain both the sentence "I have what your company needs" and the email address "jupiterworks yourcompanyname.org" and 20 of the non-spam emails contain it. You tell your filter that information.

Suppose an email arrives with those two sentences in it. What will your filter decide regarding this email? Spam or not spam?