CE 311S: Exam 1
Thursday, March 4
8:00 – 9:15 AM

Name _____

Instructions:

- **SHOW ALL WORK** unless instructed otherwise. No shown work means no partial credit!

- If you require additional space, you may use the back of each sheet and/or staple additional pages to the end of the exam.

- If you need to make any additional assumptions, state them clearly.

- You may use a calculator and one regular-sized sheet of notes. No additional resources are permitted.

- The number of points associated with each part of each problem is indicated.

Problem	Points	Possible
1		20
2		20
3		20
4		20
5		20
TOTAL		100

Please copy the following statement (based on UT's honor code and the ASCE code of ethics) in your own handwriting, and sign it. For the purposes of this statement, academic dishonesty includes (but is not limited to) sharing with or receiving information from others about the exam, by any mode of communication.

"As a student of The University of Texas at Austin and as a civil engineer, I certify that I have not and will not participate in any acts of academic dishonesty related to this exam. If I witness any acts of academic dishonesty, I will report them to the instructor."

Your handwritten copy of the statement:

Signature _____

Problem 1. (20 points). You are anxious to receive a Covid vaccine, so you can meet up again with your friends. Unfortunately, current wait times are long. You ask a number of your friends who are studying public health to provide their best estimate of how many days it would take until you receive the vaccine, obtaining the following data:

$$48 \quad 94 \quad 84 \quad 48 \quad 46 \quad 94$$

(a) (5) What is the mean amount from the sample?

(b) (5) What is the median?

(c) (5) What is the mode?

(d) (5) What is the standard deviation?

Problem 2. (20 points). You decide that those wait times are too long, so you reach out to your shady brother-in-law, a biochem dropout from A&M who is working on his own underground vaccine. He offers to give you a sample of the vaccine if you help him with his "clinical trials," which you readily agree to. The first task is to gather a sample of 5 students who are willing to participate. You set up a table on Speedway, and ask students who walk by (assume they walk by one at a time, an average of 120 students per hour). Each student you ask agrees to participate with probability 0.2.

(a) (6) What is the expected value and standard deviation of the number of students who walk by your table in the next ten minutes?

(b) (7) What is the probability that exactly 5 students will refuse to participate in the study, before you find the 5 who are willing to participate? What is the expected value and standard deviation of the number of students who refuse to participate?

(c) (7) You give his "vaccine" to the 5 participants. Assuming there is a 20% chance it is effective at conferring immunity in any given participant, what is the probability that at least one person in the sample receives immunity? What is the probability that exactly three people become immune?

Problem 3. (20 points). The next step is to look for side effects in the participants. After conducting more trials, you see that 45% of participants develop minor side effects, 60% develop major side effects, and 10% develop no side effects at all. (These do not add up to 100%, since someone may develop *both* major and minor side effects.)

(a) (5) Are developing major side effects and developing minor side effects independent events? Explain your answer, do not just say yes or no.

(b) (10) Assuming that someone develops major side effects, what is the probability they also develop minor side effects?

(c) (5) Assuming someone develops minor side effects, what is the probability they also develop major side effects?

Problem 4. (20 points). Unsurprisingly, lawsuits begin to come in due to the side effects participants are encountering. Your brother-in-law decides to pay people off to prevent them from taking their cases to court: $100 to each person who develops only minor side effects, $1000 to each person who develops only major side effects, and $1500 to each person who develops both. (Use the same probabilities as in the previous problem.) Payment is made either in dollars, or converted to a shady cryptocurrency (bUTcoin) at a conversion rate of 20 bUTcoin per dollar.

(a) (8) Let the random variable X represent the amount paid to a participant in the trial, in dollars. What are the mean and variance of X?

(b) (4) Let Y represent the amount paid to a participant in the trial, in bUTcoins. What are the mean and variance of Y?

(c) (8) In spite of this naked attempt at bribery, some participants will sue your brother-in-law anyway; in fact, the amount they sue for is the *square* of the amount he tried to pay them off. (For example, if he tried to pay them $100, they would sue for $100 \times 100 = 10,000$ dollars.) Let Z be the amount in such a lawsuit. What are the mean and variance of Z?

Problem 5. (20 points). After all this, you and five of your friends finally succeed at obtaining a legitimate vaccine — including Jordan, whom you are madly in love with and hoping to woo. The six of you go to the movies, and sit in a single row completely at random. You desperately hope to sit next to Jordan but are too afraid to say anything, and leave it up to chance instead. What is the probability that you and Jordan sit next to each other?