

**CE 311S: Exam 2**  
Thursday, April 8  
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		25
3		25
4		30
<b>TOTAL</b>		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). As you and your friends become fully vaccinated against COVID, you slowly begin engaging in activities you've avoided doing over the last year. You are a huge transportation nerd, and decide to celebrate the two-week anniversary of your last vaccine by riding the 801 bus from start to end several times over with your friends.<sup>1</sup>

You notice that the time between stops on the 801 roughly follows an exponential distribution, with a mean of 2 minutes.

- (a) (5) What is the median time between stops?
- (b) (5) What is the standard deviation of the time between stops?
- (c) (5) After the bus starts at Tech Ridge, the 801 has 28 stops before reaching the end of the route at Southpark Meadows. What is the mean time to drive the entire route?
- (d) (5) What is the standard deviation of the time taken to drive the entire route?

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<sup>1</sup>Not going to lie, I am very much looking forward to coming to campus via the 7 again.

**Problem 2.** (25 points). You next begin to start attending concerts in person. Since you demanded riding the 801 bus as the first activity after being fully vaccinated, your friends insist that they choose the concerts. Unfortunately your friends have highly questionable taste in music, and you are treated to a succession of shows by Ylvis, Pitbull, Robin Thicke, Silentó, and others.

So instead of listening to the music, you pay note to the size of the crowd and put your knowledge of probability and statistics to work. The crowd size is always between 0 and 1000 people. Let  $X$  denote the crowd size *measured in thousands of people* (so if 500 people show up,  $X = 0.5$ ). You notice that the PDF of  $X$  is described by  $6x(1 - x)$  if  $0 \leq x \leq 1$ , and 0 otherwise.

- (a) (15) What is the mean and variance of  $X$ ?
- (b) (5) If tickets sell for \$20 each, what is the mean and variance of the ticket sales for a concert?
- (c) (5) By the end of the year you have been subjected to 36 of these concerts. What is the probability that the mean attendance from these concerts is more than 530?

**Problem 3.** (25 points). During the winter storm, you and your friends really wanted to re-enact the famous scene from *A Christmas Story* where Flick is triple-dog-dared to lick the school flagpole, only to have his tongue freeze to the pole. Of course, it is unsafe to do this during a pandemic, so you waited until you were fully vaccinated.

Let  $X$  denote the temperature on any given day (in Celsius), and  $Y$  the amount of hospital bills associated with licking the flagpole on a given day (in thousands of dollars), whether due to freezing, catching an infection, or anything else. The joint PDF of  $X$  and  $Y$  is  $\frac{1}{200} - \frac{x(y-5)}{10^4}$  if  $x \in [-10, 10]$  and  $y \in [0, 10]$ , and 0 otherwise.

- (a) (6) What is the marginal PMF for  $X$ ?
- (b) (6) What is the marginal PMF for  $Y$ ?
- (c) (6) Are  $X$  and  $Y$  independent? (Explain your answer, do not just say yes or no.)
- (d) (7) What is the probability that the day you lick the flagpole happens to be below freezing ( $X < 0$ ) and your hospital bills end up below \$500?

**Problem 4.** (30 points). To cap off your post-vaccine fun, now that you are immune you and your best friend engage in a test-tube-eating contest at a Covid testing lab.<sup>2</sup> Let  $X$  denote the number of test tubes you eat, and  $Y$  the number of test tubes your friend eats. The following table shows the joint PMF for  $X$  and  $Y$ , except for one missing value.

		$X$		
		1	2	3
$Y$	1	$q$	$1/8$	0
	2	$1/16$	$1/4$	0
	3	0	$1/4$	$1/16$
	4	0	$1/8$	$1/16$

- (a) (5) What is the missing value  $q$ ?
- (b) (5) What is the probability that you eat more test tubes than your friend?
- (c) (5) What is the expected number of test tubes you eat?
- (d) (15) What is  $\rho_{X,Y}$ ?

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<sup>2</sup>Hat tip to Randall Munroe.