ECE 314 Quiz 3

Name: NetID:

1. (-1 point if you don't answer this problem) Write your name initials on the paper to indicate your agreement to the following statement:
I know that:
• I may consult one page of notes. Otherwise it is closed book, no calculators, tablets, etc.
• The time limit of this quiz is 20 minutes writing + 5 minutes uploading to Gradescope.

2. (30 points) Consider a bloom filter of length n=10,000 based on k=3 hash functions. Suppose 500 items (for example, URLs) are entered in the filter.

(a) Can a bloom filter have a false positive? Explain why.
(b) Can a bloom filter have a false negative? Explain why.
(c) For the numbers above, what is the approximate fraction of 0's in the filter? (Give a simple expression and explain how you got it. A numerical value is not necessary.)

3. (30 points) A gambler plays a game for multiple rounds. Each round of the game has two possible outcomes: 1) the gambler wins \$10, which occurs with probability $\frac{3}{4}$
2) the gambler loses \$10, which occurs with probability $\frac{1}{4}$

Initially the gambler has \$0 but can borrow, meaning the amount of money she has can go negative.

(a) (10 points) What is the expected amount of money that the gambler gains in each round?
(b) (10 points) Draw a typical sample path of the amount of money the gambler has versus time, and on the same plot draw the expected amount of money the gambler has, for a time period of 10 rounds.
(c) (15 points) Repeat part (b) but now for a period of 1000 rounds? Label the axes of your plots carefully. (Hint: Keep the law of large numbers in mind. Your answers to (b) and (c) should look different.)

4. (40 points) The Zombies are attacking UI campus now! A group of ECE314 students survived and stay in the ECE building with 10 zombies already in the building at day 0. Each night, the zombies outside will attack ECEB and the students will resist using keyboards and cables. If more than 50 zombies are in the ECEB, the zombies win. If no zombie exists in ECEB, the zombies stop coming and the students will win. Suppose Z[t] represents the increase in the number of zombies in ECEB at day t, and X[t] represents the total number of zombies at day t, so X[0] = 10 and X[t+1]=X[t]+Z[t+1]. Suppose the change in number of zombies(Z) follows this distribution:

P{Z=4}=0.1	P{Z=2}=0.2	P{Z=-2}=0.3	P{Z=-4}=0.4

(a) What is the expected change in the number of zombies in the building each night? (5 Points)
(b) What is the minimum number of days it could take for the Zombies to win? (5 Points)
(c) What is the probability that Zombies win in the minimum number of days? (Assume numbers of zombies entering per night are independent. Give an expression. No need to calculate the exact number, 10 Points)
(d) As a well educated student, you want to use python to simulate the process of zombie attack and record the survival days in each simulation. As the number of simulations increase, the average (over all your simulations) number of days the battles last will approach to _____. This is due to _____.(10 Points)
(e) Suppose due to the state of morale of the students (i.e. confidence and enthusiasm), the probability of more zombies coming in per night increases (decreases) when the number of Zombies increase (decrease) the previous night. Is the battle expected to end sooner or later due to such effect? Explain why. (10 points)

Academic Integrity Statement: By submitting your solutions to the quiz, you declare you have completed the quiz entirely by yourself. Any violation of the academic integrity requirement may cause an academic integrity report to be filed that could go into your student record. See Students' Quick Reference Guide to Academic Integrity for more information.