Rules. You will be allowed a "cheat sheet" for the exam. This should be only one side of an 8.5×11 or regular notebook paper. You may include formulas and one or two word labels, but no examples, worked problems, or notes in sentences or paragraphs will be allowed. You will be able to use a calculator on the exam, but you will be expected to show your calculations as much as possible. You cannot use your phone in place of a calculator.

1. Review the basics of probability: sample space, events, intersections and unions of sets and probability, probability mass/density functions, conditional probability and Bayes' Theorem, law of total probability, counting and probability. Some example questions:

   (a) For some value of c, $f(x) = ce^{-\theta x}$, $x > 0$, $\theta > 0$ is a probability density function. Find c.

   (b) In a certain assembly plant, three machines, B_1, B_2, and B_3 make 30%, 45%, and 25% of the products, respectively. It is known from past experience that 2%, 3%, and 2% of the products made by each machine, respectively, are defective. If a finished product is randomly selected for inspection, what is the probability that it is defective? If another product is randomly selected and found to be defective, what is the probability is was manufactured by machine B_1?

   (c) A standard 52−card deck has 4 suits: diamonds, spades, clubs, and hearts. Each suit has 13 cards labeled $2 - 10$ and J, Q, K, A. If you are randomly dealt five cards for a poker hand, what is the probability that you hold 2 Aces and 3 Jacks?

2. Know how to compute sample mean and variance for a data set. Here is an example problem: Consider the data

   $$-1.79 \quad 0.53 \quad -0.40 \quad -0.90 \quad -0.28 \quad -1.44 \quad -0.49 \quad -0.43 \quad -2.45 \quad -0.87$$

   Compute the sample mean and sample variance. If I told you this data came from a normal distribution with $\mu = -1$ and $\sigma^2 = 1$, would you believe me? Why or why not?

3. Know each of the named distributions we have covered, both discrete and continuous. For each you should be able to come up with an example of an experiment in which that distribution would be appropriate to use. Also, know the formulas for probability mass/density functions, means, and expectations.

   For example: The binomial distribution could be used in the following experiment. A campaign worker canvasses the area by calling residents and asking them if they will vote Democrat or Republican in the coming election. Suppose the area is evenly split so that 50% of people will vote either way and that voters vote independently of each other. Then, the number of people who plan to vote Republican out of the next 100 people the campaign worker calls follows a binomial distribution with parameters $n = 100$ and success probability $q = 0.5$. The binomial distribution is reasonable because we are interested in the sum of independent dichotomous trials with common success probability.

4. Review the Poisson and normal approximations to computing binomial

probabilities. Each approximation has guidelines for its use. You should be able to explain, for a given situation, why each of these approximations could be expected to be accurate or not very accurate. For example, if $X \sim$Binomial$(n = 10, q = 0.1)$ which approximation do you think will do better? Hint: you can answer this with minimal calculation. Roughly compare the shape of the binomial probability mass function with $n = 10, q = 0.1$ to that of a normal probability density function with the same mean and variance. Recall that the normal pdf is bell-shaped, symmetric about its mean, and has about 95% of its area within 2 standard deviations of its mean. What goes wrong with the normal distribution here? Does the Poisson approximation with $\lambda = nq$ have this problem?