BST 140.651 Final Exam
Notes:

- You may use your one 8.5 by 11 formula sheet.
- Please use only the basic mathematical functions on your calculator.
- Show your work on all questions. Simple "yes" or "no" answers will be graded as if blank.
- Please be neat and write legibly. Use the back of the pages if necessary.
- There are three pages containing 9 questions. You can omit one question.
- Good luck!

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signature and **printed name**

1. Suppose that the US intelligence quotients (IQs) are normally distributed with mean 100 and standard deviation 16. What's the probability that a randomly selected person from this population has an IQ above 132? (Explain your calculation.)

2. (Refer to the previous question.) Suppose that in a sample of 5 children 4 have IQs above 132. What is the probability of such an occurrence? What assumptions did you use to calculate this probability?

3. Let $X_1, \ldots, X_{10}$ be iid exponential random variables with mean 1 and $Y_1, \ldots, Y_{10}$ be iid exponential random variables with mean 2. A friend claims that $\bar{X}/\bar{Y}$ should be approximately normal with mean $1/2$ and variance $1/5$. Briefly describe how you could verify this claim using simulation.

The next three questions (4 and 5) involve the following setting: A random sample of 40 United States men contained 25% smokers. Let p be the true prevalence of smoking amongst males in the United States.

4. Calculate and interpret a 95% confidence interval for the prevalence of smoking amongst males in the United States.

5. Refer to Problem 4. Write out the likelihood for p (do not draw it, just write it out). Is $p = .35$ or $p = .15$ better supported given the data (why, and by how much)? What value of p is best supported (just give the number, do not derive)?

6. If X is what is called a Poisson random variable with population mean μ, then it is known that
$$\frac{X - \mu}{\sqrt{X}} = \frac{\text{Estimate} - \text{Estimand}}{\text{Std Error}} \sim \text{N}(0, 1)$$
is approximately normal. Derive a 95% confidence interval for μ.

The next three questions (7, 8 and 9) involve the following setting: Suppose that systolic blood pressures were taken on 16 oral contraceptive users and 16 controls at baseline and again then two years later. The average difference from follow-up SBP to the baseline (followup - baseline) was $11\ mmHg$ for oral contraceptive users and $4\ mmHg$ for controls. The corresponding standard deviations of the differences was $20\ mmHg$ for OC users and $28\ mmHg$ for controls.

7. Calculate and interpret a 95% confidence interval for the change in systolic blood pressure for oral contraceptive users; assume normality.

8. Does the change in SBP over the two year period appear to differ between oral contraceptive users and controls? Create the relevant 95% confidence interval and interpret. Assume normality and a common variance.

9. Suppose, instead, that in questions 7 and 8 we had calculated the intervals using the *log ratios* from followup to baseline (rather than the differences) and exponentiated result. What would each of the interval estimate?

EXTRA CREDIT (1 point). What brewery did William Gosset work for?