LAST NAME (Please Print): _____

FIRST NAME (Please Print): _____

HONOR PLEDGE (Please Sign): _____

Statistics 111

Midterm 4

- This is a closed book exam.
- You may use your calculator and a single page of notes.
- The room is crowded. Please be careful to look only at your own exam. Try to sit one seat apart; the proctors may ask you to randomize your seating a bit.
- Report all numerical answers to at least two correct decimal places or (when appropriate) write them as a fraction.
- All question parts count for 1 point.

I have really enjoyed this semester, and I hope you have too. It is a lot of work, but I think and hope it has sometimes been fun and always worthwhile.

David Banks

1. Consider the following design and data.

run	A	B	C	D	E	obs
1	-	-	-	+	+	3
2	+	-	-	-	-	7
3	-	+	-	-	+	-2
4	+	+	-	+	-	4
5	-	-	+	+	-	6
6	+	-	+	-	+	-10
7	-	+	+	-	-	1
8	+	+	+	+	+	13

What is equal to I? (That is, what are the defining relations?)

What effects are confounded with E?

_____ What is your numerical estimate of the effect due to E?

Explain what the estimate of the E effect describes (2 points)

How would you decide whether this estimate is significant?

_____ Give the symbolic name for this design (include the resolution).

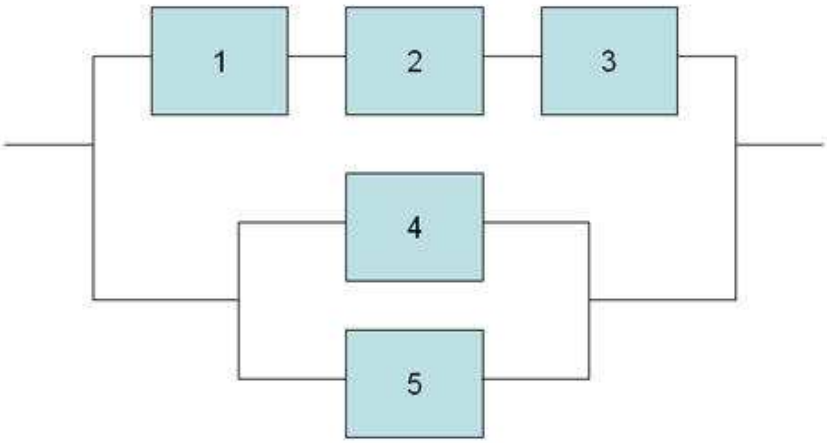
2. Suppose that the lifespan of a laptop has cumulative distribution function $x^3/27$ for $0 \leq x \leq 3$.

   What is the survival function of a laptop? _____

   What is the hazard function of a laptop? _____

   _____ What kind of failure rate does a laptop have? (We discussed four kinds in class.)

3. Consider a system of the following form:



   _____ Assume that all components in the upper subsystem have have exponential lifespans with $\lambda = 1/2$ and all components in the lower subsystem have exponential lifespans with $\lambda = 1/3$. What is the probability that the system fails in less than one time unit?

4. Suppose that the lifespan of a vacuum cleaner follows the Rayleigh distribution, so $F(t) = 1 - \exp(-\theta_0 t - \theta_1 t^2/2)$. You observe three vacuum cleaners: one lasts one year, one lasts two years, and one lasts three years. In the special case when $\theta_0 = \theta_1 (= \theta)$, find the numerical value for the maximum likelihood estimate of θ.

   _____ $= \hat{\theta}$

5. Suppose you have done a one-way ANOVA that looks at sentence lengths (in days) for bar brawlers in Durham County, Alamance County, and Chatham county. Use $\alpha = 0.05$. You have 4 observations from Durham, 6 from Alamance, and 4 from Chatham. Complete the following partial ANOVA table.

Source	df	SS	MS	F
County	_____	_____	_____	_____
Error	_____	_____	10	
Total	_____	180		

_____ What is the critical value for Fisher's LSD in this situation?

_____ Suppose the average sentence in Durham is 5 days in jail, and the average sentence in Chatham is 8 days in jail. What is your test statistic if you were to use Fisher's LSD?

Is it appropriate to use Fisher's LSD in this case? Why or why not?

_____

6. Assume that flood insurance for your home costs \$100/month, fire insurance costs \$200/month, and a policy that covers both costs \$250/month.

   In your area, the annual probabilty of a flood is 1/100 and the annual probability of a fire is 1/40. You plan to live in your home for 30 years, and your home costs \$100,000.

   _____ What is the expected loss from purchasing flood insurance alone?

   What is your best choice? _____

7. Which model is better for the lifespan of your goldfish: competing risks or the Cox proportional hazards model?

   _____

8. List all, and only, the true statements. _____

   A. A fractional factorial with resolution III is better than one with resolution IV.

   B. The exponential distribution has decreasing failure rate.

   C. People tend to overestimate risks that are common.

   D. People evaluate risks in terms of their ability to control them, and whether the risk has high or low dread.

   E. People have a linear perception of the value of money.

   F. Significance probability is the chance of observing data that support the alternative hypothesis as more strongly than the data that were collected, when the null hypothesis is true.

9. You want to know whether there are differences among freshmen, sophomores, juniors and seniors in their performance in a statistics class. And you think there may also be a dormitory effect, so you arbitrarily compare students from Brown, Jarvis and Wilson. This is a balanced two-way ANOVA with two observations on each combination of factor levels.

   Complete the following partial ANOVA table:

Source	df	SS	MS	F
Year	_____	_____	_____	_____
Residence	_____	14	_____	_____
Interaction	_____	36	_____	_____
Error	_____	_____	2	
Total	_____	80		

   _____ Is this a fixed-effects, random-effects, or mixed-effects design?

   _____ What is the critical value for a test of whether Year is significant? ($\alpha = 0.05$.)

   _____ What is the value of the test statistic for deciding whether Year is significant?

   _____ Do you conclude that Year is significant at the 0.05 level?