
STAT 300 Midterm Exam

(Time: **50 minutes**, Friday, October 30, 2015, 12:00 - 12:50pm, II)

Name _____ Student ID _____
Lab (day/time) _____

Closed notes/books. One "cheat sheet" (8.5' × 11', two sided) is allowed.

Problem 1 (40 pts, 4 pts each). Circle the answer that is the most appropriate (*choose one answer only*).

1. In a hypothesis testing problem, if you decide to set the significance level of the test to 0.01 instead of 0.05, then what would you generally expect?
 - A. The power of the test will usually increase.
 - B. The power of the test will usually decrease.
 - C. The power of the test will usually remain the same.
 - D. insufficient information to tell.
2. A sign test only uses the signs of the data rather than the data values themselves. This will lead to some loss of information even if it is used to test the medians. The foregoing statement is
 - A. true
 - B. false
 - C. insufficient information to tell
3. When using the χ^2 test to test the normality of the data, if the data are divided into 5 intervals (bins), the degrees of freedom for the χ^2 distribution is
 - A. 1
 - B. 2
 - C. 3
 - D. 4
 - E. 5
4. In an ANOVA with fixed sample sizes and levels, even if the null hypothesis H_0 is true, the difference of the within and between sample mean-square errors (variations) can still be very large. The foregoing statement is
 - A. true
 - B. false
 - C. insufficient information to tell

5. In an ANOVA test, the effects of differences in the population means should appear in
- A. all sums of squares.
 - B. the test at the 0.05 level only.
 - C. the sum of squares between groups.
 - D. the sum of squares within groups.
 - E. none of the above.
6. Although statistical software (e.g., R, SAS, SPSS) is available, you are still asked to do calculation by hand in class because
- A. some calculation can easily be done by hand
 - B. software may not be reliable
 - C. we will understand the methods better so we are less likely to mis-use the methods in the future
 - D. it is fun to do by hand
7. The association between two binary variables can be tested using
- A. a t-test
 - B. an ANOVA test
 - C. the chi-square test
 - D. the sign test
8. Which of the following methods will *not* be affected by outliers (i.e., unusually large or small values)
- A. an ANOVA test
 - B. the t-test
 - C. the permutation test
 - D. the Wilcoxon rank sum test
9. In a simulation study to evaluate the power of a paired t-test for testing equality of two population means, where samples are generated from $N(\mu_A, \sigma)$ and $N(\mu_B, \sigma)$, which of the following would NOT lead to an increase in power
- A. Increase the sample size
 - B. Change $\mu_A = 10, \mu_B = 12$ to $\mu_A = 10, \mu_B = 15$
 - C. Change $\mu_A = 10, \mu_B = 12$ to $\mu_A = 13, \mu_B = 15$
 - D. Increase σ
10. In a hypothesis testing problem, the p -value tells us
- A. if the null hypothesis is true.
 - B. if the alternative hypothesis is true.
 - C. the evidence against the null hypothesis.
 - D. the evidence against the alternative hypothesis.

Problem 2 (27 pts). A drug company tested two new pain relief drugs for headache sufferers. They randomly selected 18 patients who suffered from headaches and randomly assigned them into three groups of 6 each, with 12 patients taking one of the two drugs and 6 patients taking a placebo (one that does not have medicinal ingredients). After the experiment, each subject was asked to report his/her pain on a scale of 1 to 10, with 10 being most pain.

(a) (7 pts) Suggest **three** methods to compare the effectiveness of the two drugs (write the names of the methods below).

Method I: _____. Method II: _____.

Method III: _____. For these three methods, method _____ may be most reliable/appropriate for this dataset. Method _____ may be most powerful if all required assumptions hold, because (one sentence) _____.

(b) (2 pts) To compare the two new drugs, if the ranks of the pain scores in one group are

1, 3, 4, 6, 8, 10

in the combined sample of the two drug groups, the test _____ (name) may be used, and the value of the test statistic is given by _____.

(c) (10 pts) To compare all three groups, the company performed a one-way ANOVA and obtained the following table:

Source	df	SS	MS	Test Statistic	P-value
Between group (drug)	2	28.22	—	11.91	<0.0001
Within group (residual)	24	28.44	1.19		

(i) The value of the between group MS (mean square) is _____. Under the null hypothesis, the test statistic follows a/an _____ distribution (clearly specify the parameter values or degrees of freedom as appropriate), because (one sentence) _____.

(ii) Assuming equal variance, the value of the common variance is estimated to be _____.

(iii) To perform pair-wise comparisons at 5% level, the significance level for each two-sample comparison should be _____, because (one sentence) _____.

(d) (4 pts) Suppose that each patient in the third group (placebo group) took both drugs at different times (instead of taking a placebo). To compare effectiveness of the two drugs for this group, suggest two methods: Method I _____, Method II _____. Reason (one sentence): _____.

(e) (4 pts) If the effectiveness of a drug depends on the gender of the patients, we say that there is an _____. Does it affect the significance of the drug? (Yes/No) _____. In this case, what should we do in data analysis (one sentence)? _____.

Problem 3 (21 pts). In an air pollution study, a random sample of 20 households were selected from each of two communities A and B. A respondent in each household was asked whether or not anyone in the household was bothered by air pollution. Here are the collected data:

		Community (Y)		
		A	B	Total
Bothered by air pollution (X)?	Yes	4	8	12
	No	16	12	28
Total		20	20	40

A researcher wishes to know if people in the two communities are equally bothered by air pollution.

(a) (2 pts) Write the hypotheses in words

H_0 :

H_1 :

(b) (5 pts) Suggest **two** methods to perform the test for H_0 versus H_1 :

Method I: _____ Method II: _____

For these two methods, method _____ may be more reliable for this dataset, because (one sentence) _____

(c) (3 pts) If X and Y are independent, the expected cell count for the first cell (i.e., the cell with count 4) is _____, and the difference between the expected cell count and the observed cell count for the first cell is _____.

(d) (5 pts) If the sum of the differences between all the observed cell counts and the corresponding expected cell counts is large, it suggests that the _____ hypothesis is more likely to hold. To determine if the sum of the differences is large or not, we can compare the test statistic (write a formula) _____ to the 95% percentile of the _____ distribution approximately (specify parameter values or degrees of freedom as appropriate, an approximation is acceptable), and we reject H_0 if _____.

(e) (2 pts) If there are *three* communities (instead of two), assuming a large sample, the null distribution is _____ (specify parameter values or degrees of freedom as appropriate).

(f) (4pts) Suppose that we also wish to test if there are equal number of individuals who are bothered by and not bothered by air pollution, ignoring which community they are from. We decide to reject the null hypothesis of equal number if 25 or more individuals (out of the total 40) are not bothered by air pollution. The power of the test when in fact 60% individuals are not bothered by air pollution is given by (Show the key steps. No need to compute the final answer):

Problem 4 (12 points). Referring to Problem 3. Suppose that we also wish to test if there are equal numbers of individuals who are bothered by and not bothered by air pollution, ignoring which communities they are from. We decide to reject the null hypothesis of equal number if 25 or more individuals (out of the total 40) are not bothered by air pollution.

(a) (6 pts) Under the null hypothesis, the test statistics follows a _____ distribution (clearly specify the parameter values or degrees of freedom as appropriate). Is a large sample required for the null distribution of the test statistic to be reasonably accurate? Answer: _____ (Yes or No). We can also approximate the null distribution of the test statistic by a _____ distribution with parameter(s) given by _____.

(b) (6 pts) If we wish a power of at least 80% if in fact 60% individuals are not bothered by air pollution, (i) use an exact method to compute required the sample size, and (ii) use an approximate method to compute the required sample size. (For both methods, you just need to write down the key steps. No need to compute the numerical answers.)

This table is for instructor use only

Problem 1	Problem 2	Problem 3	Problem 4	Total Mark