Exam 2

STA 3024 Spring 2023

Class #: 16898 (Zheng)

Name: ______________________________

UFID: ______________________________

Instructions:

1. This examination contains 8 pages, including this page.
2. You have **50 minutes** to complete the exam.
3. The total score is 105. The extra 5 points serve as a buffer, so the highest score you can get is 100.
4. Write your answers clearly and legibly on the exam. Answers without sufficient work shown will not receive full credit.
5. You may use a scientific calculator. Do not share a calculator with anyone.
6. This is a closed-book exam. You may not use any resources including lecture notes, books, or other students.
7. Please sign the below Honor Code statement.

In recognition of the UF Student Honor Code, I certify that I will neither give nor receive unauthorized aid on this examination.

Signature: ______________________________

1. (5 points) Which of the following tests can be a nonparametric alternative to a matched pairs t-test? Circle your choice and write the letter in the blank below.

   A. Pearson χ^2 test

   B. Wilcoxon rank-sum test (Mann-Whitney test)

   C. Wilcoxon signed rank test

   D. Kruskal-Wallis H-test

   E. ANOVA test

1. ______________

2. (30 points) Are the following statements true or false? You do not need to give reasons.

   (a) ___ In Pearson χ^2 tests, a very small p-value indicates a very strong association.

   (b) ___ In Pearson χ^2 tests, the test statistic follows χ^2 distribution provided that the null hypothesis is true. This is one of the reasons why the null hypothesis is no association as opposed to having an association.

   (c) ___ A contingency table with 6 rows and 5 columns has degrees of freedom 29.

   (d) ___ For a 2×2 contingency table, the Pearson χ^2 test of independence gives the same conclusion as the significance test for comparing two independent proportions.

   (e) ___ In Pearson χ^2 tests, we are usually able to find the p-value from a χ^2 table.

   (f) ___ Generally speaking, parametric methods are statistically more powerful than nonparametric methods but need stronger assumptions.

   (g) ___ In order to use the rank-based nonparametric methods in this class, the response variable must be categorical.

   (h) ___ If the response variable is subjective ratings for movies, parametric methods are better than nonparametric methods.

   (i) ___ A two-sided confidence interval must agree with its corresponding two-sided significance test, but it does not necessarily agree with the one-sided significance test.

   (j) ___ Under the null hypothesis, the Kruskal-Wallis test statistic follows χ^2 distribution with degrees of freedom $g - 1$ where g is the number of groups.

3. Riverside High School recently conducted a survey on students to investigate whether there is an association between gender (male or female) and whether they like playing video games (Yes or no). The data appears in the table below.

	Male	Female	Total
Yes	95	35	130
No	63	138	201
Total	158	173	331

(a) (9 points) Compute the following quantities from the table.
- The probability that a student who is male likes playing video games.
- The probability that a student is male and likes playing video games (at the same time).
- The probability that a student likes playing video games.

(b) (6 points) Compute the relative risk of liking video gaming for males compared to females and interpret it.

(c) (4 points) State both the null and alternative hypotheses for Pearson χ^2 test.

(d) (5 points) What are the expected counts AND the contribution to the test statistic for the Female/No category?

(e) (4 points) The Pearson χ^2 test statistic is 55.14. Which one of the following is the p-value for the χ^2 test? Circle your choice and write the letter in the blank below.

A. $P(Y \geq 55.14)$ where Y follows χ^2 distribution with degree of freedom 1

B. $P(Y \geq 55.14)$ where Y follows χ^2 distribution with degrees of freedom 4

C. $P(Y \leq 55.14)$ where Y follows χ^2 distribution with degree of freedom 1

D. $P(Y \leq 55.14)$ where Y follows χ^2 distribution with degrees of freedom 4

E. None of the above

(e) ____________

4. Amy and Bob are two students at Riverside High School. We randomly select several grades of the two students to test if Amy has better grades than Bob. Below is the data.

Amy	Bob
80	74
76	76
81	56
80	73

(a) (5 points) We will use a nonparametric method we learned in class to do the test. Briefly discuss why it is NOT appropriate to conduct a normal-based parametric test here. (Hint: consider what assumptions are not met)

(b) (5 points) State the null and alternative hypotheses. (If you are using any notation, please clarify the meaning)

(c) (5+2 points) Compute the test statistic. Does the test statistic follow a χ^2 distribution with degrees of freedom 3?

(d) (5 points) Suppose the p-value is 0.02. Based on this p-value, what conclusions can we make?

(e) (5 points) Suppose Amy is a girl and does not like to play video games, and Bob is a boy and likes to play video games. Can we conclude from the test that girls who do not like video gaming have higher grades than boys who like video gaming? Why or why not?

5. (15 points) The use of thalidomide was studied in patients with HIV-1 infection (Klausner, et al., 1996). All patients were HIV-1+, and half of the patients also had tuberculosis infection (TB+). There were $N = 32$ patients at the end of the study, 16 received thalidomide and 16 received placebo. Half of the patients in each drug group were TB+ (the other half TB-), so we can think of this study as having 4 treatments: TB+/thalidomide, TB+/placebo, TB-/thalidomide, and TB-/placebo. One primary measure was weight gain after 21 days. We would like to test whether or not the weight gains differ among the 4 populations. The weight gains (negative values are losses) and their corresponding ranks are given below, as well as the average rank $\bar{R}_i$ for each group. We can test whether or not the weight loss distributions differ among the four groups using the Kruskal-Wallis H-test.

TB+/Thal	TB-/Thal	TB+/Plac	TB-/Plac
9.0 (32)	2.5 (23)	0.0 (9)	-0.5 (7)
6.0 (31)	3.5 (26.5)	1.0 (15.5)	0.0 (9)
4.5 (30)	4.0 (28.5)	-1.0 (6)	2.5 (23)
2.0 (20.5)	1.0 (15.5)	-2.0 (4)	0.5 (12)
2.5 (23)	0.5 (12)	-3.0 (1.5)	-1.5 (5)
3.0 (25)	4.0 (28.5)	-3.0 (1.5)	0.0 (9)
1.0 (15.5)	1.5 (18.5)	0.5 (12)	1.0 (15.5)
1.5 (18.5)	2.0 (20.5)	-2.5 (3)	3.5 (26.5)
$\bar{R}_1 = 24.4$	$\bar{R}_2 = 21.6$	$\bar{R}_3 = 6.6$	$\bar{R}_4 = 13.4$

The formulae for computing the K-W test statistic are

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{g} n_i(\bar{R}_i - \bar{R})^2 \quad \text{(Round to the nearest hundredth for } H\text{)}$$

$$D = 1 - \frac{\sum(t^3 - t)}{(N-1)N(N+1)} \quad \text{(Round to the nearest thousandth for } D\text{)}$$

For convenience, the ordered ranks are listed below:

$$1.5, 1.5, 3, 4, 5, 6, 7, 9, 9, 9, 12, 12, 12, 15.5, 15.5, 15.5, 15.5,$$

$$18.5, 18.5, 20.5, 20.5, 23, 23, 23, 25, 26.5, 26.5, 28.5, 28.5.$$

Please find the Kruskal-Wallis test statistic H_{adj} (Round to the nearest hundredth). (If you do not have enough space to write down your answer below, feel free to use the next page)

(Problem 5 Continued)