CHAPTER 13 FORM C

Name______________________________ Course Number:__________ Section Number:__________

Directions: Answer the questions and solve the problems in the spaces provided, or attach paper. Circle the correct choice for each response set. Where appropriate, use computer assistance.

Provide an appropriate response.

1) Describe the Wilcoxon signed–ranks test. What types of hypotheses is it used to test? What assumptions are made for this test?

2) Describe the Kruskal–Wallis test. What types of hypotheses is it used to test? What assumptions are made for this test?

3) Describe the rank correlation test. What types of hypotheses is it used to test? How does the rank correlation coefficient r_s differ from the Pearson correlation coefficient r?

4) Which of the following methods could lead to stronger evidence for the outcome of a nonparametric test?

A) ensure that the distributions are normal

B) increase sample size substantially

C) take multistage random samples

D) ensure that the populations have equal variances

5) Which of the following distribution–free tests has no parametric counterpart?

A) runs test

B) sign test

C) rank correlation test

D) Kruskal–Wallis test

Use the sign test to test the indicated claim.

6) Fourteen people rated two brands of soda on a scale of 1 to 5.

Brand A	2	3	2	4	3	1	2
Brand B	1	4	5	5	1	2	3

Brand A	5	4	2	1	1	4	3
Brand B	4	5	5	2	4	5	4

At the 5 percent level, test the null hypothesis that the two brands of soda are equally popular.

7) The waiting times (in minutes) of 28 randomly selected customers in a bank are given below. Use a significance level of 0.05 to test the claim that the population median is equal to 5.3 minutes.

8.2	8.0	10.5	3.8	6.4	5.3	7.8
2.9	6.0	7.7	6.1	5.9	1.2	10.4
7.3	6.9	5.8	5.1	6.2	3.1	5.8
11.7	4.5	6.5	9.8	7.4	2.3	7.8

Use the Wilcoxon signed–ranks test to test the claim that the matched pairs have differences that come from a population with a median equal to zero.

8) In a study of the effectiveness of physical exercise in weight reduction, 12 subjects followed a program of physical exercise for two months. Their weights (in pounds) before and after this program are shown in the table. Use Wilcoxon's signed–ranks test and a significance level of 0.05 to test the claim that the exercise program has no effect on weight.

Before	162	190	188	152	148	127	195	164	175	156	180	136
After	157	194	179	149	135	130	183	168	168	148	170	138

Use the Wilcoxon rank–sum test to test the claim that the two independent samples come from populations with equal medians.

9) A teacher uses two different CAI programs to remediate a randomly selected group of students. Results
for each group on a standardized test are listed in a table below. At the 0.05 level of significance, test the hypothesis that the sample results are from populations with the same median.

Program I	Program II
60 75 61 63	66 89 68 77
86 69 64 70	84 80 81 87
72 82 59	78 73 91 93
	94 95

Solve the problem.

10) The Mann–Whitney U test is equivalent to the Wilcoxon rank–sum test for independent samples in the sense that they both apply to the same situations and always lead to the same conclusions. In the Mann–Whitney U test we calculate

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}}, \text{ where } U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R.$$

For the sample data below, use the Mann–Whitney U test to test the null hypothesis that the two independent samples come from populations with the same median. At the 5% level of significance, state the hypotheses, the value of the test statistic, the critical values, and your conclusion.

Test scores (men): 70, 96, 77, 90, 81, 45, 55, 68, 74, 99, 88

Test scores (women): 89, 92, 60, 78, 84, 96, 51, 67, 85, 94

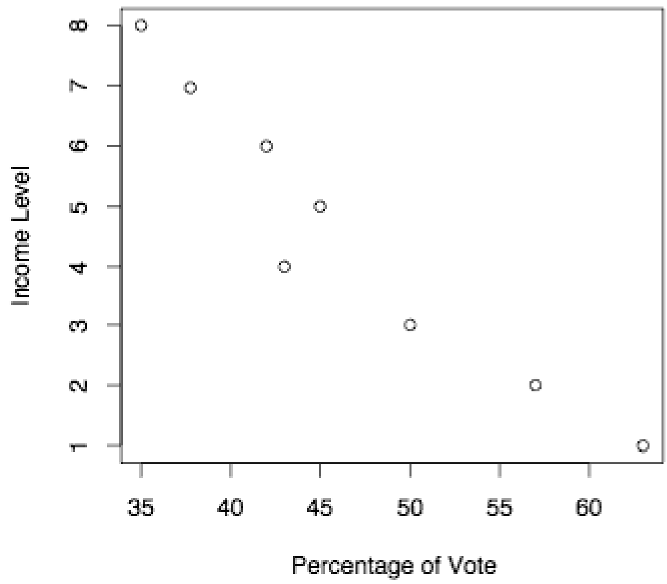
Use a Kruskal–Wallis test to test the claim that the samples come from populations with equal medians.

11) Listed below are grade averages for randomly selected students with three different categories of high–school background. At the 0.05 level of significance, test the claim that the three groups have the same median grade average.

HIGH SCHOOL RECORD

Good	Fair	Poor
3.21	2.87	2.01
3.65	3.05	2.31
1.00	2.00	2.98
3.12	0.00	0.50
2.75	1.98	2.36

The following scatterplot shows the percentage of the vote a candidate received in the 2004 senatorial elections according to the voter's income level based on an exit poll of voters conducted by CNN. The income levels 1–8 correspond to the following income classes: 1=Under $15,000; 2=$15–30,000; 3=$30–50,000; 4=$50–75,000; 5=$75–100,000; 6=$100–150,000; 7=$150–200,000; 8=$200,000 or more.



12) Use the election scatterplot to determine whether there is a correlation between percentage of vote and income level at the 0.01 significance level with a null hypothesis of $\rho_s = 0$.

A) The test statistic is between the critical values, so we reject the null hypothesis . There is sufficient evidence to support a claim of correlation between percentage of vote and income level.

B) The test statistic is not between the critical values, so we reject the null hypothesis . There is sufficient evidence to support a claim of correlation between percentage of vote and income level.

C) The test statistic is not between the critical values, so we fail to reject the null hypothesis . There is no evidence to support a claim of correlation between percentage of vote and income level.

D) The test statistic is between the critical values, so we fail to reject the null hypothesis . There is no evidence to support a claim of correlation between percentage of vote and income level.

Find the critical value. Assume that the test is two–tailed and that n denotes the number of pairs of data.

13) n =60, $\alpha = 0.05$

A) 0.255 B) ±0.253 C) −0.255 D) ±0.255

Use the rank correlation coefficient to test for a correlation between the two variables.

14) Given that the rank correlation coefficient, r_S, for 20 pairs of data is 0.528, test the claim of correlation between the two variables. Use a significance level of 0.05.

15) Use the sample data below to find the rank correlation coefficient and test the claim of correlation between math and verbal scores. Use a significance level of 0.05.

Mathematics	347	440	327	456	427	349	377	398	425
Verbal	285	378	243	371	340	271	294	322	385

16) A college administrator collected information on first-semester night-school students. A random sample taken of 12 students yielded the following data on age and GPA during the first semester.

Age x	GPA y
18	1.2
26	3.8
27	2.0
37	3.3
33	2.5
47	1.6
20	1.4
48	3.6
50	3.7
38	3.4
34	2.7
22	2.8

Do the data provide sufficient evidence to conclude that the variables age, x, and GPA, y, are correlated? Apply a rank-correlation test. Use $\alpha = 0.05$.

Use the runs test to determine whether the given sequence is random. Use a significance level of 0.05.

17) A sample of 15 clock radios is selected in sequence from an assembly line. Each radio is examined and judged to be acceptable (A) or defective (D). The results are shown below. Test for randomness.

D	D	A	A	A
A	A	A	A	A
A	A	D	D	D

18) Answers to a questionnaire were in the following sequence. Test for randomness.

Y	Y	N	Y	N	N	N	N	Y	Y
N	N	N	N	Y	Y	Y	N	N	N

19) Test the sequence of digits below for randomness above and below the value of 4.5.

0	4	7	3	6	0	9	7	4	8
7	2	8	5	7	3	9	6	4	6
4	7	9	1	6	1	9	5	8	3
7	8	5	7	3	5	2	9	3	8

Solve the problem.

20) When performing a rank correlation test, one alternative to using the *Critical Values of Spearman's Rank Correlation Coefficient* table to find critical values is to compute them using this approximation:

$$r_s = \pm\sqrt{\frac{t^2}{t^2 + n - 2}}$$

where t is the t–score from the *t Distribution* table corresponding to n – 2 degrees of freedom. Use this approximation to find critical values of r_s for the case where n = 11 and $\alpha = 0.01$.

A) ±0.726 B) ±0.411 C) ±0.685 D) ±0.735

1) The Wilcoxon signed–ranks test is similar to the sign test, but it looks at the magnitude as well as the signs of the differences, and thus has a higher efficiency level than the signs test. The test is used to test claims that matched pairs have differences that come from a population whose median is 0. The Wilcoxon signed–ranks test assumes that the population of the differences (found from the pairs of data) has a distribution that is approximately symmetric.
2) The Kruskal–Wallis test is used to test claims about the differences in means among several independent samples, as opposed to the Wilcoxon rank–sum test which looks at claims for two independent samples. The assumptions include: there are at least three random samples; we want to test the null hypothesis that the samples come from the same or identical populations; and each sample has at least five observations. The Kruskal–Wallis test also sums ranks for the sample data ranked as a whole.
3) The rank correlation test uses ranks to measure the strength of the relation between two variables. The rank correlation test is used to test the null hypothesis that there is no correlation between the two variables. The Pearson correlation coefficient r detects linear relationships between two variables. The rank correlation r_s, also known as Spearman's rank correlation coefficient, detects relationships which are non–linear as well as linear.
4) B
5) A
6) H_0: The two brands of soda are equally popular.
   H_1: The two brands of soda are not equally popular.
   Test statistic: $x = 3$. Critical value: $x = 2$.
   Fail to reject the null hypothesis. There is not sufficient evidence to warrant rejection of the claim that the two brands are equally popular.
7) H_0: median is equal to 5.3 minutes.
   H_1: median is not equal to 5.3 minutes.
   Convert $x = 7$ to the test statistic $z = -2.31$. Critical values: $z = \pm 1.96$.
   Reject the null hypothesis. There is sufficient evidence to warrant rejection of the claim that the population median is equal to 5.3 minutes.
8) H_0: The exercise program has no effect on weight. H_1: The exercise program has an effect on weight. Test statistic $T = 12.5$. Critical value: $T = 14$.
   Reject the null hypothesis that the population of differences has a median of zero. It appears that physical exercise had an effect on weight .
9) H_0: Test results are from populations with the same median. H_1: Test results are from populations with different medians. $\mu_R = 143$, $\sigma_R = 18.2665$, $R_1 = 90$, $R_2 = 235$, $z = -2.90$.
   Test statistic: $z = -2.90$. Critical values $z = \pm 1.96$.
   Reject the null hypothesis that the populations have the same median. There is sufficient evidence to support the hypothesis that the two programs produce different results.
10) H_0: The two samples come from populations with the same median.
   H_1: The two samples come from populations with different medians.
   Critical values $z = \pm 1.96$, $R = 115.5$, Test statistic: $z = 0.39$
   Do not reject the null hypothesis. There is not sufficient evidence to reject the claim that the two samples of test scores come from populations with the same distribution.

11) H_0: The three groups come from populations which have the same median grade average.
H_1: The three groups come from populations which don't have the same median grade average.
Test statistic: H = 2.9600. Critical value: $\chi^2 = 5.9915$.
Fail to reject the null hypothesis of equal medians. The available data do not provide sufficient evidence to suggest that the median grade average is different for the three categories of high-school background.
12) B
13) D
14) $r_s = 0.528$. Critical values: $r_s = \pm 0.447$.
Reject the null hypothesis $\rho_s = 0$. There appears to be a correlation between the two variables.
15) $r_s = 0.867$. Critical values: $r_s = \pm 0.700$.
Reject the null hypothesis $\rho_s = 0$. There appears to be a correlation between the two variables.
16) $r_s = 0.532$. Critical values: $r_s = \pm 0.587$.
Fail to reject the null hypothesis $\rho_s = 0$. The data do not provide sufficient evidence to indicate that age and GPA are correlated.
17) $n_1 = 5$, $n_2 = 10$, G = 3, 5% cutoff values: 3, 12.
Reject the null hypothesis of randomness.
18) $n_1 = 8$, $n_2 = 12$, G = 8, 5% cutoff values: 6, 16.
Fail to reject the null hypothesis of randomness.
19) $n_1 = 15$, $n_2 = 25$, G = 28, $\mu_G = 19.75$, $\sigma_G = 2.9212$.
Test statistic: z = 2.82. Critical values: $z = \pm 1.96$.
Reject the null hypothesis of randomness.
20) D