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KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATION, 2023/2024 ACADEMIC YEAR
FOURTH YEAR, FIRST SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE
MATHEMATICS
KMA 408- NON- PARAMETRIC METHODS

Date: 18TH APRIL 2023
Time: 8:30 AM-10:30AM

INSTRUCTIONS TO CANDIDATES
ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS
QUESTION ONE (30 MARKS)

a) Outline the advantages of non-parametric over parametric methods of hypothesis testing. (5 Marks)

b) A driver buys fuel either at the total (T) or mobile stations (M). The following arrangement shows the order of the stations from which he bought fuel of a certain period of time;
TTTMTMTMMTTMTMTMTMTMMTMT
Test for randomness at the 5% level of significance. (5 Marks)

c) The following random sample data are weights in grams of 14 packages of certain kind of cigarettes. 100.8, 100.0, 102.6, 100.3, 98.2, 101.0, 100.5, 102.5, 100.0, 97.1, 103.6, 100.9, 99.8 and 101.0 Use the sign test based on binomial probability and 0.01 level of significance to test the null hypothesis $H_0: \mu = 100$ against the alternative, $H_1: \mu < 100$.
(5 Marks)

d) Consider a randomized controlled trial evaluating a new anti-retroviral therapy for HIV. A pilot trial randomly assigned participants to either the treated (those who received the new antiretroviral therapy) or untreated (those who did not) groups. After a treatment period, an assessment on viral load (quantity of virus per millilitre of blood) in the treated versus the untreated groups was conducted. The data are as shown below.

Treated	540	670	1000	960	1200	4650	4200
Untreated	5000	4200	1300	900	7400	4500	7500

Use Man-Whitney U- test at $\alpha = 0.05$ to test whether the viral loading is not the same for the two groups. (5 Marks)

e) An insurance company has estimated that the number of claims received daily have a Poisson distribution with parameter three. In the last 100 days the following claims were received.

No of claims	0	1	2 or more
Number of Days	20	40	40

Test whether the estimated distribution actually fits the data or not at 5% level of significance.
(5 Marks)

f) A two-way table is given below;

Gender	Smoking		Total
	Yes	No	
Male	20	40	60
Female	10	30	40
Total	30	70	100

Test whether there is an association between gender and smoking at 5% level of significance.

(5 Marks)

QUESTION TWO (20 MARKS)

a) Given the following paired observations;

X: 20 32 27 39 31 29 25

Y: 21 33 28 38 32 27 27

i) Between Ordinary sign test and Wilcoxon signed-rank test, which of the two tests is more powerful and why? (3 Marks)

ii) Use Wilcoxon signed-rank test to test at 5% level of significance the hypothesis that the two samples have come from identical populations. (7 Marks)

b) The following is a sequence of weights of boxes sampled from a production line in a company manufacturing asbestos.

45	58	56	47	38	50	63	60	49	54	52	55	44	58	64	60	49	68	67	50	60
51	53	45	44	49	51	50	57	50	54	56	55	60	49	68	47	52	66	47	56	54

Use one sample median test to check whether the line require adjustment to eliminate sequential under packaging. Use 1% level of significance. (10 Marks)

QUESTION THREE (20 MARKS)

a) Let (x_i, y_i), i =1,2, . . . n be a random sample of *n* pairs drawn from a bivariate population. The correlation coefficient is given by.

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

Suppose these pairs of observations are ranked and that one works with the rank instead of the actual values of X and Y. Let U_i *and* V_i be the ranks of X and Y respectively and $d_i = U_i - V_i$. If there are no repeated, show that the above correlation coefficient reduces to;

$$r = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

(12 Marks)

b) A study was conducted to find whether there is any relationship between the weight and blood pressure of an individual. The following set of data was arrived at from a clinical study.

Weight	78	86	72	82	80	85	84	89	68	71
Blood Pressure	140	160	134	144	180	176	174	178	128	132

Test the null hypothesis of the correlation at the 0.01 level of significance using Spearman's rank test.

(8 Marks)

QUESTION FOUR (20 MARKS)

a) Outline the procedure of conducting Kolmogorov Smirnov one sample test. (4 Marks)

b) The following data relate to sole horn moisture content from a study on cows with and without laminitis.

32.2, 33.3, 32.3, 37.6, 35.2, 36.5, 33.1, 34.5, 36.8, 35.3, 37.0, 33.2

Use Kolmogorov Smirnov test to test whether the data was drawn a normal distribution of mean 35.0 and standard deviation 2.0. (10 Marks)

c) Consider the following data from two samples;

X: 206 238 224 257 230 309

Y: 236 209 278 276 252 251

Use K-S test to test the hypothesis H_0: $f(x) = f(y)$ against H_1: $f(x) \neq g(y)$ at $\alpha = 0.05$. (6 Marks)

QUESTION FIVE (20 MARKS)

a) The operations manager of a company that manufactures tires wants to determine whether there are any differences in the quality of work among the three daily shifts. She randomly selects 496 tires and carefully inspects them. Each tire is either classified as perfect, satisfactory, or defective, and the shift that produced it is also recorded. The two categorical variables of interest are the shift and condition of the tire produced. The data on findings can be summarized by the accompanying two-way table.

Shift	**Condition of the Tire Produced**			**Total**
	Perfect	**Satisfactory**	**Defective**	
Shift 1	106	124	1	**231**
Shift 2	67	85	1	**153**
Shift 3	37	72	3	**112**
Total	**210**	**281**	**5**	**496**

Does the data provide sufficient evidence at the 5% significance level to infer that there are differences in quality among the three shifts? (10 Marks)

b) Students are randomly assigned to groups which are taught Kiswahili by three different methods: classroom instruction and language laboratory (I), only classroom instruction (II) and only self-study in language laboratory (III). The following are the final examination scores of samples of students from the three groups:

Method I	94, 88, 91, 74, 86, 97
Method II	85, 82, 79, 84, 61, 72, 80
Method III	89, 67, 72, 76, 69

Use the Kruskal-Wallis test at 5% level of significance to test whether the teaching methods differ. (10 Marks)