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*(Knowledge for Development)*

**KIBABII UNIVERSITY**  
**UNIVERSITY EXAMINATIONS**  
**2017/2018 ACADEMIC YEAR**  
**FOURTH YEAR FIRST SEMESTER**  
**MAIN EXAMINATION**  
**FOR THE DEGREE OF BACHELOR OF SCIENCE**  
**(MATHEMATICS)**

**COURSE CODE:** STA 449

**COURSE TITLE:** NON-PARAMETRIC METHODS

**DATE:** 21/12/17

**TIME:** 8 AM -10 AM

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**INSTRUCTIONS TO CANDIDATES**

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 5 Printed Pages. Please Turn Over.

**QUESTION 1: ( 30 marks )**

- (a) Prove that under the assumptions required by the Signed- rank test,  $T^+$  ( which is the sum of the ranks assigned to positive differences) is a value of a random variable with mean,

$$\mu = \frac{n(n+1)}{4} \quad ( 5 \text{ marks } )$$

and the variance,

$$\sigma^2 = \frac{n(n+1)(2n+1)}{24} \quad ( 5 \text{ marks } )$$

- (b) The following are the amounts of money (in dollars) spent by 16 persons at an amusement park: 20.15, 19.85, 23.75, 18.63, 21.09, 25.63, 16.65, 19.27, 18.80, 21.45, 20.29, 19.51, 23.80, 20.00, 17.48, and 19.11.

Assuming that this is a random sample from a symmetrical population, use the signed-rank test to test the null hypothesis that on average a person spends \$19.00 at the park against the alternative hypothesis that the figure is too low. ( 10 marks )

( Base the test on the Table of Critical values for the Signed-Rank Test)

- (c) The green pod yield ( in kg) under four treatments is as tabulated below.

No. of plots	Treatment			
	1	2	3	4
1	3.17	3.44	3.15	2.48
2	3.40	2.88	2.69	2.37
3	3.50	2.97	3.10	2.58
4	2.87	3.27	2.80	2.84
5	3.88	3.94	3.45	3.00
6	4.00	3.87		2.48
7	3.60	3.25		

By Kruskal –Walli’s test, determine whether there is no difference among the four treatments at 5% level of significance ( 10 marks )

**QUESTION 2: ( 20 marks )**

- (a) Define a RUN as used in tests involving randomness
- (b) Given the following sequence ; **aabbbabbbaaaabba**, test the null hypothesis that the observations in the sequence occur in a random order against the fact that they do not occur in the said order at 5% level of significance.
- (c) It is claimed that successive last digit of telephone numbers in an alphabetical listing by name constitute a set of random numbers. Opening a telephone directory at random and starting with a randomly selected print, a sequence of 20 last digit is observed since the last digit is equally likely an integer between 0 – 9 inclusive. The population median is 4.5, the numbers obtained were, Last digit: 7 , 0 ,3, 4, 8, 5, 3, 1, 5, 0, 2, 6, 8, 0, 9, 4, 0, 1, 8, 1 for n large.

Test

$H_0$ : The twenty numbers appear in random order verses

$H_1$ : The twenty numbers do not appear in random order, at 5% level of significance

**QUESTION 3: ( 20 marks )**

- (a) Genetic theory indicates that for a certain species of flowers; white, red and blue flowers should occur in the ratio 5:3:1. Suppose that in a random sample of 180 flowers, 90 are white, 65 are red and 25 are blue. What frequencies would we expect if the theory is correct? At 1% level of significance, test the Genetic theory that

$H_0$ : The Genetic theory is correct

$H_1$ : The Genetic theory is incorrect

( 10 marks )

- (b) The number of automobiles declared abandoned and disposed off in a town in 104 weeks is given by the following

No. of Automobiles	0	1	2	3 or more
No. of weeks	40	43	17	4

Test the hypothesis that the number of cars declared abandoned per week is a poisson random variable with parameter  $\lambda=1$  and  $\alpha=0.05$ . ( 10 marks )

**QUESTION 4: ( 20 marks )**

- (a) Twenty-three applicants for a position are interviewed by three administrators and rated on a scale of 5 as to suitability for the position. Each applicant is given a suitability score which is the sum of the three numbers. Although college education is not a requirement for the position, a

personnel director felt that it might have some bearing on suitability for the position. Raters made their ratings on the basis of individual interviews and were not told the education background of the applicants. Twelve of the applicants had completed at least two years of college. Group A had an educational background of less than two years of college, while Group B had completed at least two years of college

**Suitability scores**

Group A: 7 11 9 4 8 6 12 11 9 10 11

Group B: 8 9 13 14 11 10 12 14 13 9 10 8

At 5% level of significance, use the mann whitney U-test to determine whether there was difference in the scores of the two groups. ( 12 marks )

- (b) An experiment was conducted to compare the density of cakes prepared from two different cake mixes X1 and X2. Six cake pans received batter X1 and six received X2. Expecting a variation in oven temperature, the experimenter placed X1 and X2 side by side at six different locations in the oven. The six paired observations are as follows:

<u>Mix</u>	<u>Density(kg/m<sup>3</sup>)</u>					
x <sub>1</sub>	0.135	0.102	0.098	0.141	0.131	0.144
x <sub>2</sub>	0.129	0.120	0.112	0.152	0.135	0.163

Test a hypothesis of no difference in population distributions of cake density for the paired-difference experiment ( 8 marks )

**QUESTION 5: ( 20 marks )**

- (a) Consider two random variables X and Y with a continuous joint density function(cdf)  $F(x,y)$ . Let  $\{(X_i, Y_i), i=1,2,3,\dots,n\}$  be a sequence of independent observations from  $F(x,y)$  where  $U_i = \text{Rank}(X_i)$  and  $V_i = \text{Rank}(Y_i)$ , define the Rank correlation coefficient, R between X and Y. State the range of R.

( 4 marks)

- (b) The marks obtained by 20 students in chemistry and mathematics class are as given below.

<u>Chemistry</u>	<u>Mathematics</u>
84	69
74	64
48	66
54	72
72	85
71	68
96	87
75	86
69	71
100	91
23	31

- (i) Obtain the rank correlation coefficient R ( 6 marks )
- (ii) Test the Hypothesis that the two categories are independent ( 10 marks )