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*(The University Of Choice)*

**MASINDE MULIRO UNIVERSITY OF  
SCIENCE AND TECHNOLOGY  
(MMUST)**

**MAIN  
UNIVERSITY EXAMINATIONS  
2021/2022 ACADEMIC YEAR**

**MAIN CAMPUS**

**FOURTH YEAR SECOND SEMESTER EXAMINATIONS**

**FOR THE DEGREE  
OF  
BACHELOR OF MATHEMATICS AND IT**

**COURSE CODE: STA 444**

**COURSE TITLE: NON-PARAMETRIC STATISTICS**

**DATE: 25/04/2022**

**TIME: 12:00 – 2:00PM**

**INSTRUCTIONS TO CANDIDATES:**

Answer Question one and any other two questions.

**TIME: 2 HOURS**

**QUESTION ONE (30 MARKS)**

- a) Define the following terms used in statistics (5marks)
- i. Population
  - ii. Sample
  - iii. Parameters
  - iv. Statistic
  - v. Hypothesis
- b) Differentiate between parametric test and non-parametric tests. (4marks)
- c) State four assumptions of parametric test. (4marks)
- d) Researchers were interested in differences in heart rate of men and women whilst waiting for an interview. Use a Mann-Whitney U test to test if heart rate differs between men and women at the 95% level.

Heart rate for women (bmp)	Heart rate for men (bmp)
84	80
81	74
80	73
70	72
72	78
69	75
65	70
74	74
80	69

- i. State  $H_0$  and  $H_1$  (2marks)
  - ii. Identify  $n_1$  and  $n_2$  and use these to calculate  $R_1, R_2$  and  $U$  (5marks)
  - iii. Compare  $U$  to the critical value in the table that corresponds to  $n_1$  and  $n_2$  and determine if the test is significant. Interpret the result. (3marks)
- e) In order to study the arrival pattern of customers at a Supermarket, the manager noted down the arrival sequence of customers, sex-wise (M and W denote man and woman arrival). The sequence is:  
 MM WWW M WW MM WWW MMM WW MM W MMM WWW MM WW MM WW  
 M WW MM WW M WW MM WW  
 In order to conclude the randomness of the arrival pattern of the customers. Test the hypothesis that the arrival pattern, sex-wise, of the customers at the supermarket is random (6marks)

**QUESTION TWO (20 MARKS)**

- a) Apply the Wilcoxon rank-sum test to the following problem

**Pig Blood Loss Data (ml)**

Control Group pigs	Treatment Group pigs
786	743
375	766
3446	655
1886	923
478	1916
587	897
434	3028
3764	1351
2281	902
2837	1378
Sample mean = 1687.40	Sample mean = 1255.90

Do the results differ from the standard two-sample  $t$  test with pooled variance? Are the  $p$ -values similar? ( $\alpha = 0.05$ ) (10marks)

- b) The table below shows the hours of relief provided by two analgesic drugs in 12 patients suffering from arthritis. Is there any evidence that one drug provides longer relief than the other? ( $\alpha = 0.05$ ) (10marks)

Case	1	2	3	4	5	6	7	8	9	10	11	12
Drug A	2.0	3.6	2.6	2.6	7.3	3.4	14.9	6.6	2.3	2.0	6.8	8.5
Drug B	3.5	5.7	2.9	2.4	9.9	3.3	16.7	6.0	3.8	4.0	9.1	20.9

**QUESTION THREE (20 MARKS)**

- a) Lamb's-quarter is a common weed that interferes with the growth of corn. A researcher planted corn at the same rate in 16 small plots of ground, then randomly assigned the plots to four groups. He weeded the plots by hand to allow a fixed number of lamb's-quarter plants to grow in each meter of corn row. These numbers were 0, 1, 3, and 9 in the four groups of plots. No other weeds were allowed to grow, and all plots received identical treatment except for the weeds. Here are the yields of corn (bushels per acre) in each of the plots. Use Kruskal-Wallis test at  $\alpha = 5\%$  to test whether the data provides sufficient evidence to indicate any difference all the four means are equal. (10marks)

Weeds per meter	Corn yield	Weeds per meter	Corn yield	Weeds per meter	Corn yield	Weeds per meter	Corn yield
0	166.7	1	166.2	3	158.6	9	162.8
0	172.2	1	157.3	3	176.4	9	142.4
0	165.0	1	166.7	3	153.1	9	162.7
0	176.9	1	161.1	3	156.0	9	162.4

- b) The compressive strength of insulating blocks used in the construction of new houses is tested by a civil engineer. The engineer needs to be certain at the 5% level of significance that the median compressive strength is at least 1000 psi. Twenty randomly selected blocks give the following results:

Observation	Compressive Strength	Observation	Compressive Strength	Observation	Compressive Strength	Observation	Compressive Strength
1	1128.7	6	718.4	11	1167.1	16	1153.6
2	679.1	7	787.4	12	1387.5	17	1423.3
3	1317.2	8	1562.3	13	679.9	18	1122.6
4	1001.3	9	1356.9	14	1323.2	19	1644.3
5	1107.6	10	1153.2	15	788.4	20	737.4

Test (at the 5% level of significance) the null hypothesis that the median compressive strength of the insulating blocks is 1000 psi against the alternative that it is greater. (10marks)

#### QUESTION FOUR (20 MARKS)

- a) An experiment to compare completion time for 3 technical task was performed in the following manner because completion time may vary considerable from person to person. Each of the 6 technician was allowed to perform the task. Task was presented to each technician with suitable time between the tasks

Technician	TASKS		
	A	B	C
1	1.21	1.56	1.48
2	1.63	2.01	1.63
3	1.42	1.70	2.06
4	1.16	1.27	1.27
5	2.43	2.64	1.98
6	1.94	2.81	2.44

Test using Friedman test whether the tasks provide sufficient evidence to indicate that distribution of completion times for the three tasks differ at  $\alpha = 0.05$  (5marks)

- b) 1000 students at college level are graded according to their IQ and their economic conditions. Using the chi-square test, find out at 5% confidence interval whether there is any association between economic conditions and the level of IQ. (10 Marks)

ECONOMIC	IQ		
	High	Medium	Low
Conditions			
Rich	160	300	140
Poor	140	100	160

- c) A researcher planted corn at the same rate in 8 small plots of ground, then weeded the corn rows by hand to allow no weeds in 4 randomly selected plots and exactly 3 lamb's-quarter plants per meter of row in the other 4 plots. Here are the yields of corn (bushels per acre) in each of the plots:

0 weeds per meter	166.7	172.2	165.0	176.9
3 weeds per meter	158.6	176.4	153.1	156.0

Does the presence of small numbers of weeds reduce the yield of corn? (5marks)

#### QUESTION FIVE (20 MARKS)

- a) The study of weight and height was carried on the university students and the measurement for each was recorded as shown below;

Heights (x)	177	163	168	174	184	180	171	173
Weights (y)	71	67	62	73	80	85	69	77

- i. Find the Spearman's rank correlation coefficient for the following data and interpret the value (7marks)
  - ii. Test whether there is a relationship between height and weight of the students at 5% level of significance (3marks)
- b) A sample of 48 tools produced by a machine shows the following sequence of good (G) and defective (D) tools:  
 GG GGG GDD GGG GGG GGG GGG DDDD GGGGG GDG

GGG GGGGGDDGGGGGDGGDGD .

Test the randomness of the sequence at the 0.05 significance level. (5marks)

- c) 10 professional football player are placed on a potato and banana diet for one month. The weight before and after one month on the diet are given

<b>Player</b>	<b>Before</b>	<b>After</b>
1	187	175
2	205	193
3	165	197
4	193	190
5	199	197
6	286	240
7	212	210
8	187	189
9	242	221
10	253	225

Determine whether diet is not effective in reducing weight at 11% level of significance

(5marks)