



<b>FACULTY</b>	AGRICULTURE, ENGINEERING & NATURAL SCIENCES		
<b>DEPARTMENT</b>	ENVIRONMENTAL SCIENCE		
<b>SUBJECT</b>	BIOMETRICS II		
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<b>DURATION</b>	2 HOURS	<b>MARKS</b>	70

### **REGULAR EXAMINATION**

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This Question Paper consists of **five (5) pages**, including the cover page

#### **Instructions**

1. Read all the instructions carefully.
2. There are three Sections in this paper: Answer all questions from Section A, one question from Section B and one question from Section C.
3. Statistical tables are attached to the Question Paper.
4. You may use Scientific Calculators.
5. Selected formulae are given at the end of the Memorandum

**UNIVERSITY OF NAMIBIA EXAMINATIONS**

## SECTION A

This section is worth 40 marks. Answer ALL questions.

### QUESTION 1

- (a) The Kruskal-Wallis test is the equivalent of the Mann-Whitney U-test when there are more than two groups. Briefly explain the statistical reason behind using Kruskal-Wallis Test in cases of comparing medians of more than two groups instead of performing multiple Mann-Whitney U tests. (4)
- (b) State the conditions that are required for using the Kruskal-Wallis Test instead of a One-way ANOVA. (4)
- (c) With respect to the Kruskal-Wallis test, H statistic is not calculated directly from the original measurements. (i) What does it use instead? (ii) What distribution do you compare the H statistic in order to make a statistical conclusion? (2)
- (d) The Kruskal-Wallis test does not tell you which group(s) is (are) significantly different from the others in the case where the null hypothesis is rejected. Which test is used after obtaining statistically significant Kruskal-Wallis results? (2)

### QUESTION 2

Explain the procedure for manually performing a Mann-Whitney U Test. (8)

### QUESTION 3

A researcher compared the moisture content of the bark of mopane trees between summer and winter. She collected 11 pieces of bark from one tree in summer and 15 bark pieces from another tree in winter. All other growing conditions for the trees were the same except the seasons. After doing the moisture determinations of each piece of bark, the differences in moisture between the two seasons were statistically compared by an appropriate test.

- (a) Explain the problems with this experimental design. (3)
- (b) Describe, in detail, how you would correct the problem identified in (a) above. (4)
- (c) After correcting the design and re-doing the experiment, what test should be used to test for the differences in moisture content, if the data are:
- (i). normally distributed, and the variances are homoscedastic? (1)
- (ii). Not normally distributed? (1)

### QUESTION 4

Describe how you would design a balanced, fully replicated one-factor experiment to test the null hypothesis that *There is no significant difference in the growth rates between seedlings of lemon and orange*. Seedlings of the same age will be used, and all site conditions will be the same. (4)

### QUESTION 5

Research was conducted to determine if there was a significant linear relationship between the number of hours spent collecting wild fruits and the amount (mass in kg) of fruits collected. Simple Linear Regression Analysis was used to analyse the data, and the following were obtained:

$$R^2 = 0.7696$$

$$\text{Standard Error} = 6.17$$

$$F = 23.377$$

$$P = 0.0019$$

$$\text{Intercept} = 42.9$$

Slope = 13.69

- (a) Identify the predictor and response variables in this investigation. (2)
- (b) Comment on the significance and reliability of the relationship. (2)
- (c) Write down the equation which describes this relationship. (1)
- (d) Calculate the number of hours a collector would have to collect in order to obtain 80 kg fruits. (2)

## SECTION B

**This section is worth 15 marks. Answer ONE question only.**

### QUESTION 6

Hexavalent chromium (Cr-VI) in drinking water is likely to be carcinogenic at a certain level. The table below shows chromium concentrations (mg/L) for both surface water and bottom water at eight different Kuiseb River locations. A Biometrics student wishes to know if there is a significant difference in chromium concentrations between the bottom and surface water in the Kuiseb River.

Location	Bottom	Surfaced
1	0.430	0.415
2	0.266	0.238
3	0.567	0.390
4	0.531	0.410
5	0.707	0.605
6	0.716	0.609
7	0.750	0.650
8	0.700	0.700

- (a) Considering that the data are not normally distributed, which test would you use to address this question? (1)
- (b) State the assumptions of this test. (2)
- (c) State the null hypothesis and the alternative hypothesis. (2)
- (d) At the 5% significance level, do the data provide sufficient evidence to conclude that the Hexavalent chromium (Cr-VI) concentrations differ between the bottom and surface water in the Kuiseb River?  
(8)
- (e) What do you conclude? (2)

### QUESTION 7

A Biology student wants to investigate whether there is a relationship between an individual's arm span and the individual's height. To test this hypothesis, the student used a random sample of 10 students and obtained the following data.

Student	Height (cm)	Arm span (cm)
1	59.5	62
2	69	65.5
3	77	76
4	59.5	63
5	74.5	74
6	63	66
7	61.5	61
8	67.5	69
9	73	70
10	69	71

Assuming that the data are not normally distributed, answer the following questions:

- Which test would you use to test address this question and why? (3)
- What are the assumptions of this test? (3)
- Perform the test and consult the table to answer the question. (7)
- What do you conclude? (2)

**Please note:** The formulae are given at the end of this question paper

### SECTION C

**This section is worth 15 marks. Answer ONE question only.**

#### **QUESTION 8**

Observations of springbok populations in Etosha National Park have indicated that there are always 80% adults, 8% sub-adults, 6% adolescents and 6% young ones. One researcher came across a springbok population in Etosha National Park and counted 78 adults, 22 sub-adults, 19 adolescents and 16 young ones. At  $p = 0.05$ , are these numbers the same as the proportions observed in other springbok populations in the Park? State the Null hypothesis before doing the test. Use three decimal places. (15)

#### **QUESTION 9**

A study was conducted to determine how gender and education level may influence people's general knowledge about environmental issues. The data collected were analysed by Two-Way ANOVA, and the following partial output was generated:

Source	SS	df	MS	F
Gender	8.420	1	8.420	
Education level	5446.697	2	2723.349	
Gender x Education Level	210.338	2	105.169	
Within (Error)	747.644	52	14.378	
Total	6413.099	57		

- (a) State the three null hypotheses for this investigation (in statistical format). (3)  
 (b) How many people took part in this study? Justify your answer. (2)  
 (c) How many education levels were considered in this study? Justify your answer. (2)  
 (d) Show that gender does not have a significant effect on people's general knowledge on the environmental. (4)  
 (e) Show that the interaction effect is significant. (4)

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### Formulae

#### 1. Mann-Whitney U test

Calculate the test statistic  $U_1$  and  $U_2$  from

$$U_1 = n_1n_2 + [n_2(n_2+1)/2] - R_2$$

$$U_2 = n_1n_2 + [n_1(n_1+1)/2] - R_1$$

Where  $R_1$  = sum of the ranks of Sample 1 and  $R_2$  = sum of the ranks of Sample 2.

#### 2. Kruskal-Wallis Test

The test statistic  $H$ , is obtained by multiplying  $\sum (R^2/n)$  by a factor  $12/N(N+1)$  and then subtracting  $3(N+1)$  where the numbers 12 and 3 are constants peculiar to this formula:

$$H = [\sum (R^2/n) \times 12/N(N+1)] - 3(N+1)$$

#### 3. Product Moment Correlation formula:

$$r = \frac{n\sum xy - \sum x \sum y}{\text{square root of } [n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}$$

#### 4. The Spearman Rank Correlation Coefficient $r_s$

$$r_s = 1 - \frac{6\sum d^2}{n^3 - n}$$

Where  $n$  is the number of units in a sample,  $d$  is the difference between ranks,  $\sum$  is the "sum of" and six is a constant peculiar to this formula.

\*\*\* END OF EXAMINATION\*\*\*