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SUMMER 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

The decision rule for rejecting the null hypothesis requires the test statistic to be less or greater than the critical value depending on the statistical test used. State the decision rule for the following non-parametric tests; (i) Mann–Whitney U Test, (ii) Wilcoxon Signed Rank test, (iii) Spearman correlation Test and (iv) Kruskal-Wallis Test (v) Pearson Correlation Test (vi) Chi-square of Association Test. (6)

QUESTION 2

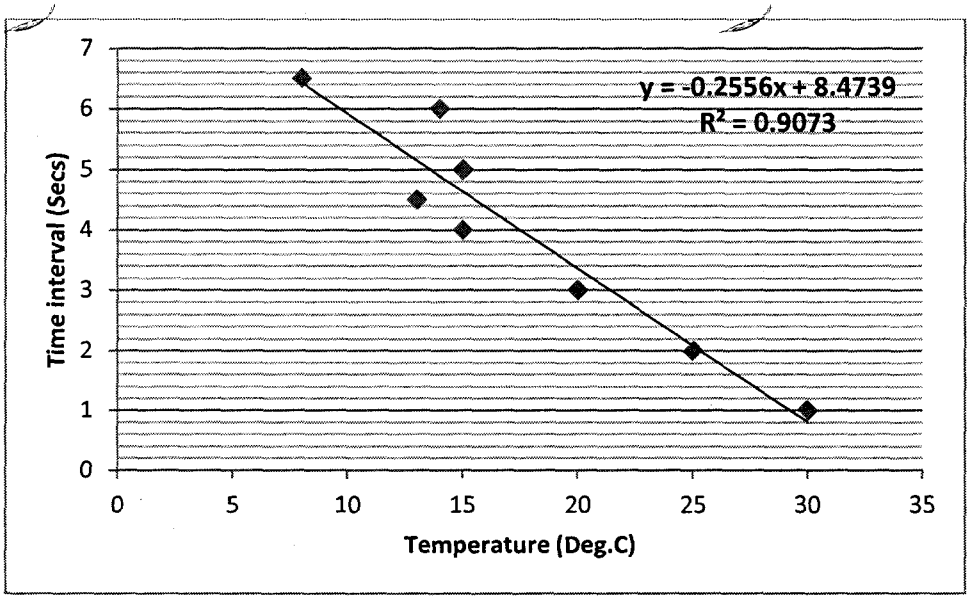
Box and whisker plots (box plots) and error bars and confidence intervals are good ways of comparing two variables. Explain the differences between these two ways of displaying and summarising two or more variables. (4)

QUESTION 3

Compare and contrast conditions for a The Mann-Whitney U test and a Wilcoxon Signed-rank Test. (10)

QUESTION 4

The graph below shows a simple linear regression analysis of the relationship between ambient temperature (in °C) and the time interval (in seconds) between mating calls of a frog.



(a) State the Null and alternative hypotheses of this investigation. (2)
(b) Identify the predictor and response variables. (2)
(c) Comment on the reliability of this relationship. (2)
(d) Calculate the time interval between calls if the ambient temperature is 11.5°C. (2)

QUESTION 5

You are interested in finding out if the number of bacteria species differs between smokers' and non-smokers' saliva. You get one volunteer who smokes and one non-smoker volunteer of same age and same gender. You ask each of them to spit a bit of saliva on agar in 10 petri

dishes. You incubate the petri dishes for some hours and then identify the bacteria using established laboratory tests and compare the number of species.

(a) Explain the problem with this experimental design. (3)

(b) Describe how you would improve the design in order to rectify the problem identified in (a) above. (3)

QUESTION 6

List the advantages and disadvantages of the Randomised Block Design. (6)

SECTION B

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

QUESTION 7

Ten plants of *Cullen obtusifolia* exposed to Hexa Chromium Cr(VI) polluted soils were compared with ten *Cullen obtusifolia* plants from an area not exposed to Hexa Chromium Cr(VI) Cr(VI) in terms of accumulated Cr(VI) in the leaves. A researcher wishes to determine if there is a significant difference in the amount of Cr(VI) accumulated in the leaves of these plants. The data in the Table below are the concentrations of Cr(VI) in grams/litre.

Not Exposed to Cr(VI)	Exposed to Cr(VI)
17	114
90	121
358	474
330	225
56	118
80	366
59	471
155	7
51	162
113	94

(a) Considering that the data are not normally distributed, which statistical test will you use to test if there is a difference between the concentrations of Cr(VI) in exposed and unexposed plants and why? (2)

(b) State the null and alternative hypotheses for this investigation. (2)

(c) What are the assumptions of this test? (2)

(d) Perform the test and consult the Table to answer the question. (7)

(e) What do you conclude? (2)

QUESTION 8

The Table below reflects the river's flow rate in seconds at 12 sites along the Kavango River in Namibia. It shows flow rates before and after an irrigation scheme. A researcher wishes to establish whether there is a difference in flow rates before and after irrigation schemes.

Irrigation Scheme	Before	After
Rundu	20.55	60
Mashare	12.63	44.64
Shitemo	17.17	15.12
Quito	21	20.0
Shadikongoro	10	87
Divundu	22.33	21.03

(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 flow rate of the river differs before and after the irrigation schemes? (8)
(e) What do you conclude? (2)

SECTION C

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

QUESTION 9

A geneticist was attempting to cross a tiger and a cheetah. She predicted a phenotypic outcome of the traits she was observing to be in the following ratio:

4 stripes only : 3 spots only : 9 both stripes and spots.

When the cross was performed and she counted the individuals she found 50 with stripes only, 41 with spots only and 85 with both. Test whether she got the predicted outcome. Include the Null and alternative hypotheses. (15)

QUESTION 10

The following results were obtained by a researcher who investigated how species richness of ticks was influenced by host species (sheep, goats and pigs) and the age of the host (sub-adults and adults). Data were collected from a number of animals of each species (experimental units) on a farm. The data were analysed by Two-Way ANOVA and a partial output is given below.

Source	SS	df	MS	F
Host	418.234		209.117	
Age	413.178	1	413.178	
Host x Age	559.509	2	279.755	
Within (Error)	2421.718		59.066	
Total	9252.550	47		

(a) How many experimental units did the researcher measure? Justify your answer. (2)

(b) Calculate the missing df and F values. Re-draw the Table and insert the missing values in the appropriate cells. (5)

(c) Test if there is any statistically significant:

(i). Main effect of host. (2)

(ii). Main effect of age. (2)

(iii). Interaction effect. (2)

(d) List any two assumptions of an ANOVA test. (2)

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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:**
   $r = n\sum xy - \sum x \sum y$/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**
   $r_s = 1 - [6\sum d^2/n^3 - n]$
   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 QUESTION PAPER*****