UNAM
UNIVERSITY OF NAMIBIA

FACULTY	AGRICULTURE, ENGINEERING & NATURAL SCIENCES
DEPARTMENT	ENVIRONMENTAL SCIENCE
SUBJECT	BIOMETRICS II
SUBJECT CODE	BLG3622
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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 60 marks. Answer ALL questions.

QUESTION 1

(a) Distinguish between descriptive and inferential statistics. (6)

(b) Briefly explain the concept of hypothesis testing. (4)

QUESTION 2

Distinguish between parametric and non-parametric tests using a Table.
(12)

QUESTION 3

(a) Describe the characteristics of a normal distribution. (4)

(b) Distinguish between a bar graph and a histogram. (4)

QUESTION 4

A survey of 1000 randomly selected students was conducted to determine which Subjects they preferred among four Subjects, namely Biology, Maths, Geology and Physics. The numbers of students who preferred each Subject are shown in the Table below.

SUBJECT	NUMBER OF STUDENTS
Biology	278
Maths	223
Geology	269
Physics	230
TOTAL	1000

At $\alpha = 0.05$, is there enough evidence to conclude that the numbers of students preferring each subject are the same? Use three decimal places in your calculations. (13)

QUESTION 5

You want to test the null hypothesis that hyena cubs raised in artificial boxes suffer equal tick infestations to those raised in underground dens. To test this, you count the number of ticks on 10 cubs from one artificial box and 10 cubs from one underground den. You then use an appropriate statistical test to compare the numbers of ticks on the two groups. Such a design will constitute pseudoreplication.

(a) Define pseudoreplication in statistical terms. (2)

(b) Explain how this experiment is pseudoreplicated. (2)

(c) Suggest how you would improve this design to eliminate pseudoreplication. (2)

(d) After improving the design to avoid pseudoreplication, how would you analyse the data if they are:

(i). normally distributed? (1)

(ii). not normally distributed? (1)

QUESTION 6

Suppose you want to answer the question: Does food type affect a dog's running speed? You have access to a wide range of dogs of the same breed but of different ages and want to test their running speed after you feed them on three different diets, A, B and C. Design an experiment to carry out this investigation. (9)

SECTION B

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

QUESTION 7

Suppose we grow large plots of two varieties of lettuce, "Gigantic" and "Enormous," which are both mature and ready for harvest at the same time. Weights of ten plants of lettuces were measured from the two varieties. Five plants from each variety were measured to the nearest kg. The researcher wishes to determine whether the weights of the two varieties are the same. The distribution that these data are drawn from is not normal.

Variety A (Gigantic)	Variety B (Enormous)
500	430
450	464
475	513
435	498
525	443

(a) What statistical test will you use to test if there is a difference between the weights of the two varieties 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)

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

QUESTION 8

A researcher wishes to compare two soils for how well ten horticultural plant species (effectively the replicates) grow in them when in containers. The data in the Table below are the dry weights in grams of the aerial parts of the plant when ready for sale.

Plant species	Soil A	Soil B
1	5.8	5.7
2	12.4	11.9
3	1.4	1.6
4	3.9	3.8
5	24.4	24.0
6	16.4	15.8
7	9.2	9.0
8	10.4	10.2
9	6.5	6.4
10	0.3	0.3

(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 median dry plant weights differ between the two soils? (8)
(e) 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 9

A biologist measured the time interval (in seconds) between the mating calls of a frog species and the ambient temperature (in ^{o}C). The data were analysed by Simple Linear Regression Analysis, and the following obtained.

Regression Statistics	
Multiple R	0.95252604
R Square	0.90730586
Adjusted R Square	0.89185684
Standard Error	0.62765444
Observations	8

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	23.13629944	23.1362994	58.729011	0.000258056
Residual	6	2.363700565	0.39395009		
Total	7	25.5			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	8.47387006	0.624543919	13.5680931	9.945E-06
Temperature	-0.2556497	0.033359457	-7.6634856	0.0002581

(a) Write down the Null and Alternative hypotheses. (2)
(b) Identify the predictor and response variables. (2)
(c) How much variation in time interval is accounted for by changes in temperature? (2)
(d) Comment on the nature of the relationship between temperature and time interval. (2)
(e) Determine if your Null hypothesis is rejected or accepted. Justify your answer. (2)
(f) Write down the equation which describes this relationship. NB: You must write the actual names of variables instead of x and y. (1)
(g) If the time interval between mating calls is 5.5 Secs, what is the temperature? (2)
(h) What would be the time interval if the ambient temperature is 22^{o}C? (2)

QUESTION 10

Research was conducted to examine the impact of social distancing on adolescents' risk of being infected by COVID-19. Half of the subjects did not social distance while the other half did. All of the adolescents, both male and female, were tested for COVID-19 after a while and results are shown below (low scores represent high risk).

Gender	No social distancing	Practiced social distancing
Males	10	5
	7	4
	9	7
	6	4
	8	5
Females	5	3
	4	4
	6	5
	3	1
	2	2

(a) Redraw and complete the following Table arising from a Two-Way ANOVA test of the data. (6)

Source	**SS**	**df**	**MS**	**F**
Social distancing status	20	1		
Gender	45	1		
Social distancing status X Gender	5	1		
Within	36	16	2.25	
Total	106	19		

(b) Are there any significant main effects and interaction effect? (6)

(c) Draw a graph to show the main effects. (3)

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Formulae

1. **Mann-Whitney U test**
   Calculate the test statistic U_1 and U_2 from
   $U_1 = n_1 n_2 + [n_2(n_2+1)/2] - R_2$
   $U_2 = n_1 n_2 + [n_1(n_1+1)/2] - R_1$
   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:**
   $r = n\sum xy - \sum x \sum y / \text{square root of } [n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]$

4. **The Spearman Rank Correlation Coefficient r_s**
   $r_s = 1 - [6\sum d^2/n^3 - n]$
   Where n is the number of units in a sample, d is the difference between ranks, $\sum$ is the "sum of" and 6 is a constant peculiar to this formula.

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

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TABLES OF CRITICAL VALUES

Pearson's Correlation

d.f.	0.05	0.01
1	0.997	0.9999
2	0.950	0.990
3	0.878	0.959
4	0.811	0.917
5	0.754	0.874
6	0.707	0.834
7	0.666	0.798
8	0.632	0.765
9	0.602	0.735
10	0.576	0.708
11	0.553	0.684
12	0.532	0.661
13	0.514	0.641
14	0.497	0.623
15	0.482	0.606
16	0.468	0.590
17	0.456	0.575
18	0.444	0.561
19	0.433	0.549
20	0.423	0.537
21	0.413	0.526
22	0.404	0.515
23	0.396	0.505
24	0.388	0.496
25	0.381	0.487
26	0.374	0.479
27	0.367	0.471
28	0.361	0.463
29	0.355	0.456
30	0.349	0.449
32	0.339	0.436
34	0.329	0.424

d.f.	0.05	0.01
35	0.325	0.418
36	0.320	0.413
38	0.312	0.403
40	0.304	0.393
42	0.297	0.384
44	0.291	0.376
45	0.288	0.372
46	0.284	0.368
48	0.279	0.361
50	0.273	0.354
55	0.261	0.338
60	0.250	0.325
65	0.241	0.313
70	0.232	0.302
75	0.224	0.292
80	0.217	0.283
85	0.211	0.275
90	0.205	0.267
95	0.200	0.260
100	0.195	0.254
125	0.174	0.228
150	0.159	0.208
175	0.148	0.193
200	0.138	0.181
300	0.113	0.148
400	0.098	0.128
500	0.088	0.115
1,000	0.062	0.081

Spearman's Rank Correlation

	Level of significance for one-tailed test			
	0.05	0.025	0.01	0.005
	Level of significance for two-tailed test			
n	0.10	0.05	0.02	0.01
5	0.900	—	—	—
6	0.829	0.886	0.943	—
7	0.714	0.786	0.893	—
8	0.643	0.738	0.833	0.881
9	0.600	0.683	0.783	0.833
10	0.564	0.648	0.745	0.794
11	0.523	0.623	0.736	0.818
12	0.497	0.591	0.703	0.780
13	0.475	0.566	0.673	0.745
14	0.457	0.545	0.646	0.716
15	0.441	0.525	0.623	0.689
16	0.425	0.507	0.601	0.666
17	0.412	0.490	0.582	0.645
18	0.399	0.476	0.564	0.625
19	0.388	0.462	0.549	0.608
20	0.377	0.450	0.534	0.591
21	0.368	0.438	0.521	0.576
22	0.359	0.428	0.508	0.562
23	0.351	0.418	0.496	0.549
24	0.343	0.409	0.485	0.537
25	0.336	0.400	0.475	0.526
26	0.329	0.392	0.465	0.515
27	0.323	0.385	0.456	0.505
28	0.317	0.377	0.448	0.496
29	0.311	0.370	0.440	0.487
30	0.305	0.364	0.432	0.478

Mann-Whitney U Test (two-tailed) test)
P=0.05

n_1 \ n_2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2								0	0	0	0	1	1	1	1	1	2	2	2	2
3					0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
4				0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	13
5			0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6			1	2	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
7			1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8		0	2	4	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9		0	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
10		0	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11		0	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12		1	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13		1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14		1	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15		1	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16		1	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17		2	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18		2	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19		2	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
20		2	8	13	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127

Critical Values of the Wilcoxon Signed Ranks Test

n	Two-Tailed Test		One-Tailed Test	
	$\alpha = .05$	$\alpha = .01$	$\alpha = .05$	$\alpha = .01$
5	--	--	0	--
6	0	--	2	--
7	2	--	3	0
8	3	0	5	1
9	5	1	8	3
10	8	3	10	5
11	10	5	13	7
12	13	7	17	9
13	17	9	21	12
14	21	12	25	15
15	25	15	30	19
16	29	19	35	23
17	34	23	41	27
18	40	27	47	32
19	46	32	53	37
20	52	37	60	43
21	58	42	67	49
22	65	48	75	55
23	73	54	83	62
24	81	61	91	69
25	89	68	100	76
26	98	75	110	84
27	107	83	119	92
28	116	91	130	101
29	126	100	140	110
30	137	109	151	120

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of x^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57
22	9.542	12.338	14.041	17.240	21.337	26.04	30.81	33.92	40.29
24	10.856	13.848	15.659	19.037	23.337	28.24	33.20	36.42	42.98
26	12.198	15.379	17.292	20.843	25.336	30.43	35.56	38.89	45.64
28	13.565	16.928	18.939	22.657	27.336	32.62	37.92	41.34	48.28
30	14.953	18.493	20.599	24.478	29.336	34.80	40.26	43.77	50.89
40	22.164	26.509	29.051	33.660	39.335	45.62	51.80	55.76	63.69
50	27.707	34.764	37.689	42.942	49.335	56.33	63.17	67.50	76.15

F - Distribution ($\alpha = 0.05$ in the Right Tail)

Denominator Degrees of Freedom df_2 \ df_1	Numerator Degrees of Freedom								
	1	2	3	4	5	6	7	8	9
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
2	18.513	19.000	19.164	19.247	19.296	19.330	19.353	19.371	19.385
3	10.128	9.5521	9.2766	9.1172	9.0135	8.9406	8.8867	8.8452	8.8123
4	7.7086	9.9443	6.5914	6.3882	6.2561	6.1631	6.0942	6.0410	6.9988
5	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725
6	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2067	4.1468	4.0990
7	5.5914	4.7374	4.3468	4.1203	3.9715	3.8660	3.7870	3.7257	3.6767
8	5.3177	4.4590	4.0662	3.8379	3.6875	3.5806	3.5005	3.4381	3.3881
9	5.1174	4.2565	3.8625	3.6331	3.4817	3.3738	3.2927	3.2296	3.1789
10	4.9646	4.1028	3.7083	3.4780	3.3258	3.2172	3.1355	3.0717	3.0204
11	4.8443	3.9823	3.5874	3.3567	3.2039	3.0946	3.0123	2.9480	2.8962
12	4.7472	3.8853	3.4903	3.2592	3.1059	2.9961	2.9134	2.8486	2.7964
13	4.6672	3.8056	3.4105	3.1791	3.0254	2.9153	2.8321	2.7669	2.7144
14	4.6001	3.7389	3.3439	3.1122	2.9582	2.8477	2.7642	2.6987	2.6458
15	4.5431	3.6823	3.2874	3.0556	2.9013	2.7905	2.7066	2.6408	2.5876
16	4.4940	3.6337	3.2389	3.0069	2.8524	2.7413	2.6572	2.5911	2.5377
17	4.4513	3.5915	3.1968	2.9647	2.8100	2.6987	2.6143	2.5480	2.4943
18	4.4139	3.5546	3.1599	2.9277	2.7729	2.6613	2.5767	2.5102	2.4563
19	4.3807	3.5219	3.1274	2.8951	2.7401	2.6283	2.5435	2.4768	2.4227
20	4.3512	3.4928	3.0984	2.8661	2.7109	2.5990	2.5140	2.4471	2.3928
21	4.3248	3.4668	3.0725	2.8401	2.6848	2.5727	2.4876	2.4205	2.3660
22	4.3009	3.4434	3.0491	2.8167	2.6613	2.5491	2.4638	2.3965	2.3419
23	4.2793	3.4221	3.0280	2.7955	2.6400	2.5277	2.4422	2.3748	2.3201
24	4.2597	3.4028	3.0088	2.7763	2.6207	2.5082	2.4226	2.3551	2.3002
25	4.2417	3.3852	2.9912	2.7587	2.6030	2.4904	2.4047	2.3371	2.2821
26	4.2252	3.3690	2.9752	2.7426	2.5868	2.4741	2.3883	2.3205	2.2655
27	4.2100	3.3541	2.9604	2.7278	2.5719	2.4591	2.3732	2.3053	2.2501
28	4.1960	3.3404	2.9467	2.7141	2.5581	2.4453	2.3593	2.2913	2.2360
29	4.1830	3.3277	2.9340	2.7014	2.5454	2.4324	2.3463	2.2783	2.2229
30	4.1709	3.3158	2.9223	2.6896	2.5336	2.4205	2.3343	2.2662	2.2107
40	4.0847	3.2317	2.8387	2.6060	2.4495	2.3359	2.2490	2.1802	2.1240
60	4.0012	3.1504	2.7581	2.5252	2.3683	2.2541	2.1665	2.0970	2.0401
120	3.9201	3.0718	2.6802	2.4472	2.2899	2.1750	2.0868	2.0164	1.9588
∞	3.8415	2.9957	2.6049	2.3719	2.2141	2.0986	2.0096	1.9384	1.8799