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FACULTY	AGRICULTURE, ENGINEERING & NATURAL SCIENCES		
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SUPPLEMENTARY/SPECIAL EXAMINATION

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This Question paper consists of **six (6) 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 ordinal and nominal data. (4)

(b) Briefly explain the concept of statistical inference. (4)

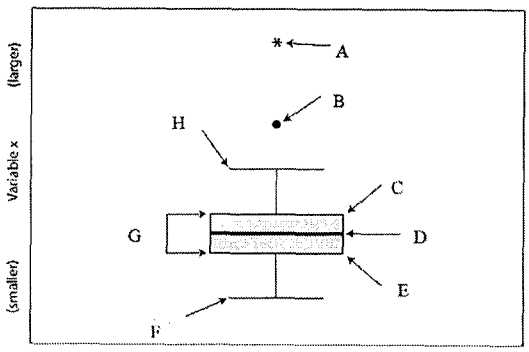
(c) Briefly explain the following concepts of hypothesis testing: (7)

(i). Null hypothesis
(ii). Alternative hypothesis
(iii). Level of significance
(iv). The power of a statistical test
(v). One-tailed test
(vi). Two-tailed test
(vii). P-value

QUESTION 2

(a) Plotting the data is also critically important for understanding statistical results. Explain the use of a box and whisker plot. (2)

(b) Label the elements A to H of the box plot as shown in the Figure below: (8)



QUESTION 3

(a) Describe the conditions that necessitate the use of non-parametric statistics. (3)

(b) Briefly explain the disadvantages of non-parametric tests. (2)

QUESTION 4

Describe how you would design a balanced, fully replicated one-factor experiment to test the hypothesis that there is no difference in the growth rates (height measurements) among three species of fruit trees: lemon, orange and clementine. (6)

QUESTION 5

You want to compare the amount of soil Carbon between clay soils and sandy soils in Ohangwena Region. You collect 10 soil samples from a patch of clay soil in one area and then collect 16 soil samples from a patch of sandy soil at another site. You then chemically

analyse all the samples using appropriate laboratory analyses and statistically compare the soil Carbon between the two sets of soils.

(a) Explain how this investigation is pseudoreplicated. (2)
(b) Explain how you would re-design this investigation to remove pseudoreplication. (3)
(c) What test would you use to analyse the data of they are:
  (i). Not normally distributed? (1)
  (ii). Normally distributed? (1)

QUESTION 6

Perching preferences of species of bird was studied and compared between males and females. Observations were made of birds perching on top of the tree, on the middle branches and on the bottom branches. The length of time each bird stayed in that position was recorded and tested with a Two-Way ANOVA.

(a) Calculate the missing df, MS and F-values and write them in the Table (redraw the Table below and insert the calculated values). The SS values have been calculated for you. (7)

Source	SS	df	MS	F
Position (on the tree)	180	2		
Gender	30	1		
Position x Gender	0	2	0.00	
Within (Error)	44		1.83	
Total	254			

(b) Determine if:
  (i). There is any statistically significant main effect of position on length of stay. (2)
  (ii). There is any statistically significant main effect of gender on satisfaction rate. (2)
  (iii). There is any statistically significant interaction effect. (2)

QUESTION 7

List the advantages of Completely Randomized Designs (CRD). (4)

SECTION B

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

QUESTION 8

The Table below shows the Dissolved Oxygen concentrations (in mg/ℓ) at the six irrigation sites along Kavango River. A researcher wishes to find out if there is a significant difference in dissolved Oxygen before and after the irrigation schemes.

Irrigation Scheme	Before	After
Rundu	7.7	8
Mashare	2	1.36
Shitemo	1.42	1.62
Quito	1.2	3.19
Shadikongoro	9.3	7.5
Divundu	8.9	9.2

(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 dissolved oxygen concentrations differ before and after the irrigation schemes? (8)
(e) What do you conclude? (2)

QUESTION 9

Ten plants of *Rumex lanceolatus* exposed to Hexa Chromium Cr(VI) polluted soils were compared with ten *Rumex lanceolatus* plants from an area not exposed to Hexa Chromium 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)
44	539
698	955
222	754
340	162
479	194
154	608
694	401
103	778
166	967
396	463

(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)

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 10

A research team set out to determine if any linear relationship existed between blood pressure and the ages of patients. The data were analysed by simple Linear Regression analysis, and the following obtained.

Regression Statistics	
Multiple R	0.701337528
R Square	0.491874327
Adjusted R Square	0.390249193
Standard Error	27.18114655
Observations	7

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3575.926361	3575.926361	4.840085377	0.079091965
Residual	5	3694.073639	738.8147278		
Total	6	7270			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	45.46741307	34.96687799	1.300299474	0.250205731
Age (years)	1.509466594	0.686115128	2.200019404	0.079091965

(a) Write down the Null and Alternative hypotheses. (2)
(b) Identify the predictor and response variables. (2)
(c) How much variation in blood pressure is accounted for by changes in the age of the patient? (2)
(d) Comment on the nature of the relationship between age and blood pressure. (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 blood pressure is 90mmHg, what is the age of the patient? (2)
(h) What would be the blood pressure be if the age is 40 years? (2)

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)

df_2 \ df_1	Numerator Degrees of Freedom								
Denominator 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	6.9443	6.5914	6.3882	6.2561	6.1631	6.0942	6.0410	5.9988
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