UNIVERSITY OF ESWATINI

DEPARTMENT OF STATISTICS AND DEMOGRAPHY

RE-SIT EXAMINATION PAPER 2020/2021

TITLE OF PAPER : Nonparametric Methods

COURSE CODE : STA 409

TIME ALLOWED : 2 Hours

REQUIREMENTS : Statistical Tables and Calculator

INSTRUCTIONS

1) Answer any three (3) questions
2) Show clearly all your working

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Question 1 [*12+2+6 marks*]

Let $Z_i = Y_i - X_i$, consider the sign test statistic

$$B = \sum_{i=1}^{n} \psi_i,$$

where ψ_i is the indicator variable

$$\psi_i = \begin{cases} 1, & \text{if} Z_i > 0 \\ 0, & \text{if} Z_i < 0. \end{cases}$$

a. For the case of $n = 3$, derive the distribution of B under H_0 when there are no zero Z values.

b. Using your answer from (a) above:

   i. Find $P_0(B \geq 2)$

   ii. Calculate the mean and variance of B under the null hypothesis.

Question 2 [*10+10 marks*]

a. Forsman and Lindell (1993) studied swallowing performance of adders (snakes). Captive snakes were fed with dead field voles (rodents) of differing body masses and the number of successful swallowing attempts was recorded. Out of 67 runs resulting in swallowing attempts, 58 where successful and 9 failed. (A failure was easy to detect because the fur of a partly swallowed and regurgitated vole is slick and sticks to the anterior part of the body.) Test the hypothesis that $p = .6$ against the alternative $p > .6$.

b. In an investigation to determine the effect of aspirin on bleeding time and platelet adhesion, Bick, Adams, and Schmalhorst (1976) studied the reactions of normal subjects to aspirin. A subset of their data is presented in table below, where the X observation for each subject is the bleeding time (in seconds) before ingestion of 600 mg of aspirin and the Y observation is the bleeding time (again in seconds) 2 hours after administration of the aspirin

Sub i:	1	2	3	4	5	6	7	8	9	10	11	12	13	14
X_i :	270	150	270	420	202	255	165	220	305	210	240	300	300	70
Y_i :	525	570	190	395	370	210	490	250	360	285	630	385	195	295

Perform a sign test to test that a 600-mg dose of aspirin leads to an increase in bleeding time at 5% level of significance. You may use a large sample approximation.

Question 3 [*10 + 10 marks*]

A graduate student performed a pilot study for his dissertation. He wanted to examine the effects of animal companionship on elderly males. He selected 10 male participants from a nursing home. Then he used an

ABAB research design, where A represented a week with the absence of a cat and B represented a week with the presence of a cat. At the end of each week, he administered a 20-point survey to measure quality of life satisfaction. The survey results are presented in table that follow;

Participant	Week 1	Week 2	Week 3	Week 4
1	7	6	8	9
2	9	8	10	7
3	15	18	16	17
4	7	6	8	9
5	7	8	10	11
6	10	14	13	11
7	12	19	11	13
8	7	4	2	5
9	8	7	9	5
9	12	16	14	15

(a) Use an appropriate test to determine if one or more of the groups are significantly different. Since this is pilot study, use $\alpha = 0.10$.

(b) On 20 successive trips between Manzini and Mbabane a bus carried 24, 19, 32, 28, 21, 23, 26, 17, 20, 28, 30, 24, 13, 35, 26, 21, 19, 29, 27, and 23 passengers. Test whether it is reasonable to treat these data as if they constitute a random sample at $\alpha = 0.01$. Use large sample aproximation.

Question 4 [*20 marks*]

Each person in a random sample of n=10 employees was asked about X, the daily time wasted at work doing non-work activities, such as surfing the internet and emailing friends. The resulting data, in minutes, are as follows:

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108 112 117 130 111 131 113 113 105 128
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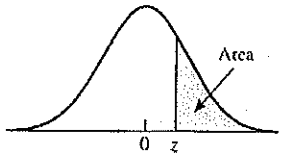
Is it okay to assume that these data come from a normal distribution with mean 120 and standard deviation 10? Use Kolmogorov goodness-of-fit test at $\alpha = 0.01$. The table value is 0.37.

Table 4 Normal Curve Areas
Standard normal probability in right-hand tail
(for negative values of z, areas are found by symmetry)



	Second decimal place of z									
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0722	.0708	.0694	.0681
1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.8	.0359	.0352	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
2.9	.0019	.0018	.0017	.0017	.0016	.0016	.0015	.0015	.0014	.0014
3.0	.00135									
3.5	.000 233									
4.0	.000 031 7									
4.5	.000 003 40									
5.0	.000 000 287									

From R. E. Walpole, *Introduction to Statistics* (New York: Macmillan, 1968).

TABLE B.5 Critical Values for the Friedman Test Statistic F_r.

k	N	$\alpha \leq 0.10$	$\alpha \leq 0.05$	$\alpha \leq 0.025$	$\alpha \leq 0.01$
3	3	6.000	6.000		
	4	6.000	6.500	8.000	8.000
	5	5.200	6.400	7.600	8.400
	6	5.333	7.000	8.333	9.000
	7	5.429	7.143	7.714	8.857
	8	5.250	6.250	7.750	9.000
	9	5.556	6.222	8.000	8.667
	10	5.000	6.200	7.800	9.600
	11	4.909	6.545	7.818	9.455
	12	5.167	6.500	8.000	9.500
	13	4.769	6.000	7.538	9.385
	14	5.143	6.143	7.429	9.000
	15	4.933	6.400	7.600	8.933
4	2	6.000	6.000		
	3	6.600	7.400	8.200	9.000
	4	6.300	7.800	8.400	9.600
	5	6.360	7.800	8.760	9.960
	6	6.400	7.600	8.800	10.200
	7	6.429	7.800	9.000	10.371
	8	6.300	7.650	9.000	10.500
	9	6.467	7.800	9.133	10.867
	10	6.360	7.800	9.120	10.800
	11	6.382	7.909	9.327	11.073
	12	6.400	7.900	9.200	11.100
	13	6.415	7.985	7.369	11.123
	14	6.343	7.886	9.343	11.143
	15	6.440	8.040	9.400	11.240
5	2	7.200	7.600	8.000	8.000
	3	7.467	8.533	9.600	10.133
	4	7.600	8.800	9.800	11.200
	5	7.680	8.960	10.240	11.680
	6	7.733	9.067	10.400	11.867
	7	7.771	9.143	10.514	12.114
	8	7.800	9.300	10.600	12.300
	9	7.733	9.244	10.667	12.444
	10	7.760	9.280	10.720	12.480
6	2	8.286	9.143	9.429	9.714
	3	8.714	9.857	10.810	11.762
	4	9.000	10.286	11.429	12.714
	5	9.000	10.486	11.743	13.229
	6	9.048	10.571	12.000	13.619
	7	9.122	10.674	12.061	13.857

(*Continued*)