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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	CIVIL ENGINEERING STATISTICS
COURSE CODE	:	BFC 34303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. SECTION A: ANSWER **ALL** QUESTIONS 2. SECTION B: ANSWER **TWO (2)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **FOURTEEN (14)** PAGES

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SECTION A

Q1 (a) Write a simple step-by-step procedure for testing a hypothesis involving a sample of more than 30 observations, given the standard deviation of the population is known. Also, suggest a suitable test statistic.

(8 marks)

(b) *Ops Selamat* was conducted on highways during a festive season. One of the objectives was to reduce speed. Previously, the mean speed of vehicles on the highways was 118 km/h. A sample of 12 highways where *Ops Selamat* was conducted yielded a mean speed of 105 km/h and a standard deviation of 25 km/h. Using hypothesis testing at the 0.05 significance level, evaluate the effectiveness of *Ops Selamat* in reducing speed.

(17 marks)

Q2 Suppose an experiment involving five subjects is conducted to determine the relationship between parameter A and parameter B. The data are shown in **Table Q2**.

(a) Draw a scatter plot for the variables.

(3 marks)

(b) Calculate the regression coefficient.

(9 marks)

(c) Determine the regression slope and relationship between the two parameters.

(4 marks)

(d) Determine the coefficient of determination and interpret your answer.

(9 marks)

SECTION B

Q3 (a) Food waste generated daily from school canteens has a normal distribution with a mean of 25 kg and a standard deviation of 8 kg. For a random sample of 5 days, calculate the probability that the average amount of food waste will exceed 30 kg.

(6 marks)

(b) The strengths of stainless steel and carbon steel are being compared. Random samples were selected and tested. **Table Q3** shows the tensile strengths (in MPa) of the steel samples. Construct a 95% confidence interval for the difference between the means of the two steel samples.

(19 marks)

Q4 Suppose the Malaysian Institute of Road Safety Research (MIROS) wants to examine the safety of compact cars, mid-size cars, and full-size cars. It collects a sample of three for each of the treatments (cars types). Using the hypothetical data provided in **Table Q4**, test whether the mean pressure applied to the driver's head during a crash test is equal for each types of car. Use $\alpha = 5\%$.

The steps listed below can guide you to answer this question:

Step 1 : State the hypothesis.
Step 2 : Find the degree of freedom and F critical.
Step 3 : Calculate the mean.
Step 4 : Calculate the variance.
Step 5 : Calculate the F value.
Step 6 : Interpret the F value.

(25 marks)

Q5 A transport engineer conducted a survey involving 100 people in order to study the utilisation of pedestrian bridges among different age groups. **Table Q5** shows the results of the survey.

The following are the null (H_o) and alternative (H_a) hypotheses:

H_o: There is no relationship between utilisation of pedestrian bridge and age group.
H_a: There is a relationship between utilisation of pedestrian bridge and age group.

Using Chi-square test at a significance level of 0.05, determine if there is a significant relationship between utilisation of pedestrian bridge and age group.

(25 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION : II / 2018/2019
COURSE NAME : CIVIL ENGINEERING STATISTICS
PROGRAMME : BFF
COURSE CODE : BFC 34303

TABLE Q2: Experimental results for testing of five subjects

Subject	Parameter A	Parameter B
1	95	85
2	85	95
3	80	70
4	70	65
5	60	70

TABLE Q3: Tensile strength of stainless steel and carbon steel

Steel Type	Tensile Strength (MPa)						
Stainless Steel	520	456	497	425	504	448	470
Carbon Steel	394	410	432	380	416	–	–

TABLE Q4: Pressure applied to drivers' head during a crash test

Compact cars	Mid-size cars	Full-size cars
643	469	484
655	427	456
702	525	402

TABLE Q5: Utilisation of pedestrian bridge based on age groups

Utilisation of Pedestrian Bridge	Age Group			
	Young Adults (18 – 25 years)	Adults (26 – 40 years)	Middle-aged (41 – 60 years)	Elderly (> 60 years)
Yes	10	20	18	14
No	16	12	7	3

FINAL EXAMINATION

SEMESTER/SESSION	:	II / 2018/2019	PROGRAMME	:	BFF
COURSE NAME	:	CIVIL ENGINEERING STATISTICS	COURSE CODE	:	BFC 34303

APPENDIX A: STATISTICAL FORMULAS

The following information may be useful. The symbols have their usual meaning.

Mean and Variance of Ungrouped Data

$$\bar{x} = \frac{\sum x}{n} \qquad s^2 = \frac{\sum (x - \bar{x})^2}{n - 1}$$

Mean and Variance of Grouped Data

$$\bar{x} = \frac{\sum fx}{\sum f} \qquad s^2 = \frac{\sum fx^2 - \frac{(\sum fx)^2}{\sum f}}{(\sum f) - 1}$$

Standard Normal Distribution z-value

$$z = \frac{X - \mu}{\sigma}$$

Central Limit Theorem

$$\mu_{\bar{X}} = \mu \qquad \sigma_{\bar{X}} = \frac{\sigma}{\sqrt{n}} \qquad z = \frac{\bar{X} - \mu}{\left(\frac{\sigma}{\sqrt{n}}\right)}$$

$$\mu = E(X) = \sum x.P(X) \qquad \sigma = Std(X) = \sqrt{E(X^2) - [E(X)]^2} \qquad E(X^2) = \sum x^2.P(X)$$

Difference Between Two Means

$$Z = \bar{X} - \bar{Y} \qquad \mu_{\bar{X}-\bar{Y}} = \mu_{\bar{X}} - \mu_{\bar{Y}} \qquad \sigma_{\bar{X}-\bar{Y}} = \sqrt{\frac{{\sigma_X}^2}{n} + \frac{{\sigma_Y}^2}{m}}$$

FINAL EXAMINATION

SEMESTER/SESSION	:	II / 2018/2019	PROGRAMME	:	BFF
COURSE NAME	:	CIVIL ENGINEERING STATISTICS	COURSE CODE	:	BFC 34303

Confidence Interval

$$\bar{X} \pm z\frac{s}{\sqrt{n}} \qquad \bar{X} \pm t\frac{s}{\sqrt{n}} \qquad t = \frac{\bar{X}-\mu}{s/\sqrt{n}}$$

$$p \pm z\sqrt{\frac{p(1-p)}{n}} \qquad FPC = \sqrt{\frac{N-n}{N-1}} \qquad \bar{X} \pm z\frac{s}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}}$$

$$(\mu_{\bar{X}} - \mu_{\bar{Y}}) \pm t_{\frac{\alpha}{2},df}\left(\sqrt{\frac{s_{\bar{X}}{}^2}{n} + \frac{s_{\bar{Y}}{}^2}{m}}\right) \qquad df = \frac{\left(\frac{s_{\bar{X}}{}^2}{n} + \frac{s_{\bar{Y}}{}^2}{m}\right)^2}{\frac{\left(\frac{s_{\bar{X}}{}^2}{n}\right)^2}{n-1} + \frac{\left(\frac{s_{\bar{Y}}{}^2}{m}\right)^2}{m-1}}$$

One-Sample Hypothesis Testing (z-Test and t-Test)

$$z = \frac{\bar{X}-\mu_o}{\sigma/\sqrt{n}} \qquad z = \frac{\bar{X}-\mu_o}{s/\sqrt{n}} \qquad t = \frac{\bar{X}-\mu_o}{s/\sqrt{n}}$$

Two-Sample Hypothesis Testing (z-Test and t-Test)

$$z = \frac{\bar{X}_X - \bar{X}_Y}{\sqrt{\frac{s_X{}^2}{n} + \frac{s_Y{}^2}{m}}} \qquad t = \frac{\bar{X}_X - \bar{X}_Y}{\sqrt{\frac{s_P{}^2}{n} + \frac{s_P{}^2}{m}}} \qquad s_P{}^2 = \frac{(n-1)s_X{}^2 + (m-1)s_Y{}^2}{n+m-2}$$

Simple Linear Regression

$$Y = a + bX \qquad a = \frac{\sum Y}{n} - b\frac{\sum X}{n} \qquad e = Y - \hat{Y}$$

$$b = \frac{n(\sum XY) - (\sum X)(\sum Y)}{n(\sum X^2) - (\sum X)^2} \qquad r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n(\sum X^2) - (\sum X)^2][n(\sum Y^2) - (\sum Y)^2]}}$$

$$s_{y.x} = \sqrt{\frac{\sum Y^2 - a(\sum Y) - b(\sum XY)}{n-2}}$$

FINAL EXAMINATION

SEMESTER/SESSION : II / 2018/2019 PROGRAMME : BFF
COURSE NAME : CIVIL ENGINEERING STATISTICS COURSE CODE : BFC 34303

F-Test

$$F = \frac{{s_1}^2}{{s_2}^2} \qquad v_1 = n_1 - 1 \qquad v_2 = n_2 - 1$$

One Way ANOVA Test

$$SS = \sum X^2 - \frac{(\sum X)^2}{n} \qquad SST = \sum\left(\frac{{T_c}^2}{n_c}\right) - \frac{(\sum X)^2}{n} \qquad SSE = SS - SST$$

$$MST = \frac{SST}{k-1} \qquad MSE = \frac{SSE}{n-k} \qquad F = \frac{MST}{MSE}$$

$$v_1 = k - 1 \qquad v_2 = n - k$$

Chi-Square Test

$$\chi^2 = \frac{(n-1)s^2}{\sigma^2} \qquad df = n - 1$$

Chi-Square Goodness of Fit Test

$$\chi^2 = \sum\left[\frac{(f_o - f_e)^2}{f_e}\right] \qquad df = k - 1$$

Chi-Square Contingency Table Analysis

$$\chi^2 = \sum\left[\frac{(f_o - f_e)^2}{f_e}\right] \qquad df = (r-1)(c-1)$$

Mann-Whitney Test

$$z = \frac{W - \frac{n_1(n_1 + n_2 + 1)}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}}$$

Mann-Whitney U Test

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \qquad U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

FINAL EXAMINATION

SEMESTER/SESSION : II / 2018/2019 PROGRAMME : BFF
COURSE NAME : CIVIL ENGINEERING STATISTICS COURSE CODE : BFC 34303

APPENDIX B: STATISTICAL TABLES

I. Standard Normal Distribution (Right-Tail) showing P (Z > z)

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002

FINAL EXAMINATION

SEMESTER/SESSION : II / 2018/2019
COURSE NAME : CIVIL ENGINEERING STATISTICS
PROGRAMME : BFF
COURSE CODE : BFC 34303

II. Standard Normal Distribution showing P (0 < Z < z)

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

FINAL EXAMINATION

SEMESTER/SESSION : II / 2018/2019
COURSE NAME : CIVIL ENGINEERING STATISTICS
PROGRAMME : BFF
COURSE CODE : BFC 34303

III. Critical Values of the Student's *t* distribution

df	Level of significance for One-Tailed Test, α/2						
	0.1	0.05	0.025	0.01	0.005	0.001	0.0005
	Level of significance for Two-Tailed Test, α						
	0.2	0.1	0.05	0.02	0.01	0.002	0.001
1	3.078	6.314	12.076	31.821	63.657	318.31	636.62
2	1.886	2.920	4.303	6.965	9.925	22.326	31.598
3	1.638	2.353	3.182	4.541	5.841	10.213	12.924
4	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	1.319	1.714	2.069	2.500	2.807	3.485	3.767
24	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	1.310	1.697	2.042	2.457	2.750	3.385	3.646

FINAL EXAMINATION

SEMESTER/SESSION	:	II / 2018/2019	PROGRAMME	:	BFF
COURSE NAME	:	CIVIL ENGINEERING STATISTICS	COURSE CODE	:	BFC 34303

IV. Critical Values of the Chi-square, χ^2 distribution

df	α					
	0.1	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**
1	2.706	3.841	5.024	6.635	7.879	10.828
2	4.605	5.991	7.378	9.210	10.597	13.816
3	6.251	7.815	9.348	11.345	12.838	16.266
4	7.779	9.488	11.143	13.277	14.860	18.467
5	9.236	11.070	12.833	15.086	16.750	20.515
6	10.645	12.592	14.449	16.812	18.548	22.458
7	12.017	14.067	16.013	18.475	20.278	24.322
8	13.362	15.507	17.535	20.090	21.955	26.124
9	14.684	16.919	19.023	21.666	23.589	27.877
10	15.987	18.307	20.483	23.209	25.188	29.588
11	17.275	19.675	21.920	24.725	26.757	31.264
12	18.549	21.026	23.337	26.217	28.300	32.909
13	19.812	22.362	24.736	27.688	29.819	34.528
14	21.064	23.685	26.119	29.141	31.319	36.123
15	22.307	24.996	27.488	30.578	32.801	37.697
16	23.542	26.296	28.845	32.000	34.267	39.252
17	24.769	27.587	30.191	33.409	35.718	40.790
18	25.989	28.869	31.526	34.805	37.156	42.312
19	27.204	30.144	32.852	36.191	38.582	43.820
20	28.412	31.410	34.170	37.566	39.997	45.315
21	29.615	32.671	35.479	38.932	41.401	46.797
22	30.813	33.924	36.781	40.289	42.796	48.268
23	32.007	35.172	38.076	41.638	44.181	49.728
24	33.196	36.415	39.364	42.980	45.559	51.179
25	34.382	37.652	40.646	44.314	46.928	52.620
26	35.563	38.885	41.923	45.642	48.290	54.052
27	36.741	40.113	43.195	46.963	49.645	55.476
28	37.916	41.337	44.461	48.278	50.993	56.892
29	39.087	42.557	45.722	49.588	52.336	58.301
30	40.256	43.773	46.979	50.892	53.672	59.703

FINAL EXAMINATION

SEMESTER/SESSION : II / 2018/2019
COURSE NAME : CIVIL ENGINEERING STATISTICS
PROGRAMME : BFF
COURSE CODE : BFC 34303

V. Critical Values of the Mann-Whitney U (Two-tailed)

		n_1												
n_2	α	3	4	5	6	7	8	9	10	11	12	13	14	15
3	0.05	0	0	0	1	1	2	2	3	3	4	4	5	5
	0.01	0	0	0	0	0	0	0	0	0	1	1	1	2
4	0.05	0	0	1	2	3	4	4	5	6	7	8	9	10
	0.01	0	0	0	0	0	1	1	2	2	3	3	4	5
5	0.05	0	1	2	3	5	6	7	8	9	11	12	13	14
	0.01	0	0	0	1	1	2	3	4	5	6	7	7	8
6	0.05	1	2	3	5	6	8	10	11	13	14	16	17	19
	0.01	0	0	1	2	3	4	5	6	7	9	10	11	12
7	0.05	1	3	5	6	8	10	12	14	16	18	20	22	24
	0.01	0	0	1	3	4	6	7	9	10	12	13	15	16
8	0.05	2	4	6	8	10	13	15	17	19	22	24	26	29
	0.01	0	1	2	4	6	7	9	11	13	15	17	18	20
9	0.05	2	4	7	10	12	15	17	20	23	26	28	31	34
	0.01	0	1	3	5	7	9	11	13	16	18	20	22	24
10	0.05	3	5	8	11	14	17	20	23	26	29	33	36	39
	0.01	0	2	4	6	9	11	13	16	18	21	24	26	29
11	0.05	3	6	9	13	16	19	23	26	30	33	37	40	44
	0.01	0	2	5	7	10	13	16	18	21	24	27	30	33
12	0.05	4	7	11	14	18	22	26	29	33	37	41	45	49
	0.01	1	3	6	9	12	15	18	21	24	27	31	24	37
13	0.05	4	8	12	16	20	24	28	33	37	41	45	50	54
	0.01	1	3	7	10	13	17	20	24	27	31	34	38	42
14	0.05	5	9	13	17	22	26	31	36	40	45	50	55	59
	0.01	1	4	7	11	15	18	22	26	30	34	38	42	46
15	0.05	5	10	14	19	24	29	34	39	44	49	54	59	64
	0.01	2	5	8	12	16	20	24	29	33	37	42	46	51

FINAL EXAMINATION

SEMESTER/SESSION	:	II / 2018/2019	PROGRAMME	:	BFF
COURSE NAME	:	CIVIL ENGINEERING STATISTICS	COURSE CODE	:	BFC 34303

VI. Critical Values of the Mann-Whitney U (One-tailed)

		n_1												
n_2	α	3	4	5	6	7	8	9	10	11	12	13	14	15
3	0.05	0	0	1	2	2	3	4	4	5	5	6	7	7
	0.01	0	0	0	0	0	0	1	1	1	2	2	2	3
4	0.05	0	1	2	3	4	5	6	7	8	9	10	11	12
	0.01	0	0	0	1	1	2	3	3	4	5	5	6	7
5	0.05	1	2	4	5	6	8	9	11	12	13	15	16	18
	0.01	0	0	1	2	3	4	5	6	7	8	9	10	11
6	0.05	2	3	5	7	8	10	12	14	16	17	18	21	23
	0.01	0	1	2	3	4	6	7	8	9	11	12	13	15
7	0.05	2	4	6	8	11	13	15	17	19	21	24	26	28
	0.01	0	1	3	4	6	7	9	11	12	14	16	17	19
8	0.05	3	5	8	10	13	15	18	20	23	26	28	31	33
	0.01	0	2	4	6	7	9	11	13	15	17	20	22	24
9	0.05	4	6	9	12	15	18	21	24	27	30	33	36	39
	0.01	1	3	5	7	9	11	14	16	18	21	23	26	28
10	0.05	4	7	11	14	17	20	24	27	31	34	37	41	44
	0.01	1	3	6	8	11	13	16	19	22	24	27	30	33
11	0.05	5	8	12	16	19	23	27	31	34	38	42	46	50
	0.01	1	4	7	9	12	15	18	22	25	28	31	34	37
12	0.05	5	9	13	17	21	26	30	34	38	42	47	51	55
	0.01	2	5	8	11	14	17	21	24	28	31	35	38	42
13	0.05	6	10	15	19	24	28	33	37	42	47	51	56	61
	0.01	2	5	9	12	16	20	23	27	31	35	39	43	47
14	0.05	7	11	16	21	26	31	36	41	46	51	56	61	66
	0.01	2	6	10	13	17	22	26	30	34	38	43	47	51
15	0.05	7	12	18	23	28	33	39	44	50	55	61	66	72
	0.01	3	7	11	15	19	24	28	33	37	42	47	51	56