Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	CIVIL ENGINEERING STATISTICS
COURSE CODE	:	BFC 34303
PROGRAMME	:	BFF
DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTIONS	:	SECTION A: ANSWER **ALL** QUESTIONS SECTION B: ANSWER **TWO (2)** QUESTIONS ONLY

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THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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SECTION A

Q1 (a) Sketch **TWO (2)** types of hypothesis testing.

(2 marks)

(b) $Z - test$ and $t - test$ are used in one sample test for hypothesis testing. Describe the condition when to apply $Z - test$ and $t - test$ and give one example for each condition.

(8 marks)

(c) An engineer hypothesized that sound pressure levels (in decibel unit, dB) for construction site workers have a mean of 100 with a standard deviation of 10. The engineer thinks that the construction site location that is full with machineries will have a positive or negative effect on workers' sound pressure levels. A sample of 30 workers who work with machineries at the construction site have a mean sound pressure level of 130 dB. Test the hypothesis that the machineries had an effect on workers' sound pressure levels.

(15 marks)

Q2 A researcher in the field of geotechnics is attempting to find a relationship between California bearing ratio (CBR) and maximum dry density (MDD) of fine grained soil that was sampled from a site cleared for construction. **Table Q2** shows the properties of 10 soil samples.

(a) Assuming the relationship between the dependent variable, CBR and the independent variable, MDD is linear, calculate the coefficient of correlation (r) and coefficient of determination (R^2). Comment on these values.

(14 marks)

(b) Using regression analysis, develop a linear equation that relates CBR to MDD.

(6 marks)

(c) Conduct a check for linearity using a residual plot.

(5 marks)

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SECTION B

Q3 (a) Define 'sampling error of a single mean'.

(2 marks)

(b) The amount of sulfur in the daily emissions from a power plant has a normal distribution with a mean of 94 and a standard deviation of 22. For a random sample of 5 days, find the probability that the average amount of sulfur emissions will exceed 80.

(7 marks)

(c) To test the claim that the resistance of electric wire can be reduced by more than 0.050 ohm by alloying, 32 values obtained for standard wire yielded $\bar{x} = 0.136$ ohm and $s_1 = 0.004$ ohm, and 32 values obtained for alloyed wire yielded $\bar{y} = 0.083$ ohm and $s_2 = 0.005$ ohm.

(i) At the 0.05 level of significance, construct a new confidence interval for the difference between the means of resistance for standard wire and alloyed wire.

(6 marks)

(ii) Discuss whether the confidence interval obtained in **Q3(c)(i)** supports the claim.

(2 marks)

(d) **Table Q3(d)** shows the measurements of the heat-producing capacity (in millions of calories per ton) of random specimens of coal from two mines. Construct 99% confidence interval for the difference between the means of these two samples from Mine 1 and Mine 2.

(8 marks)

Q4 **Table Q4** shows the means for the removal reduction of chemical oxygen demand (COD) in wastewater by three different treatment methods. By using One-Way Analysis of Variance (ANOVA), test the validity of hypothesis that there are no differences among the reduction percentage by the treatment method at significance level of 0.05 ($\alpha = 0.05$).

(25 marks)

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Q5 (a) Differentiate between the use of parametric and nonparametric test.

(4 marks)

(b) One of the approaches to improve passenger satisfaction on public bus service is by improving the quality of service. The technique involves increases the frequency of bus trip to the regular schedule particularly during passenger peak period. A pilot randomized trial with 15 bus passengers is designed to evaluate whether passengers participate in the survey are satisfied with the quality of the service. The outcome is the satisfaction scores ranges from 0 to 10. Scores of 7 or higher is considered very satisfied, 4 – 6 moderately satisfied and 0-3 lowly satisfied. The data are shown in **Table Q5(b)**.

(i) Set up the hypotheses and level of significance.

(1 mark)

(ii) Determine which statistical approach is suit for the data.

(2 marks)

(iii) Based on the answer in **Q5(b)(ii)**, set up the decision rule and compute the test statistics.

(16 marks)

(iv) Justify and conclude your answer in **Q5(b)(iii)**.

(2 marks)

- END OF QUESTIONS -

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LISTS OF TABLES

Table Q2: Soil properties

Sample	CBR (%)	MDD (g/cm^3)
1	5.56	1.65
2	5.77	1.71
3	5.69	1.68
4	6.12	1.77
5	5.95	1.73
6	5.75	1.67
7	6.20	1.75
8	5.62	1.70
9	6.05	1.74
10	5.81	1.72

Table Q3(d): Heat-producing capacity of coal specimens from two different mines (Millions of calories per tonne)

Mine 1	8,260	8,130	8,350	8,070	8,340	No data
Mine 2	7,950	7,890	7,900	8,140	7,920	7,840

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LISTS OF TABLES (CONT.)

Table Q4: The mean data for the removal reduction of COD in wastewater for three different treatment methods (in percentage (%))

Treatment 1	Treatment 2	Treatment 3
40	50	60
40	60	70
50	60	90
60	70	90
80	80	80
90	No data	No data

Table Q5(b): Passenger satisfaction scores on public bus service

Before improvement	8	7	6	2	5	8	7	3
After improvement	9	9	7	8	10	9	6	No data

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LISTS OF FORMULAE

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

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

$$e = Y - \hat{Y} \quad \text{or} \quad e = |\bar{x} - \mu| \qquad \mu = \frac{\sum x}{N} \qquad \bar{x} = \frac{\sum x}{n}$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} \qquad Z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} \qquad \sigma_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$\mu_{\bar{x}_1 - \bar{x}_2} = \mu_1 - \mu_2 \qquad s = \sqrt{\Sigma(x_1 - \bar{x})^2 / n - 1} \qquad t = \bar{x} - \mu \Big/ \sqrt{s^2/n}$$

$$v_i = n_i - 1 \qquad F = \frac{s_1^2}{s_2^2} \qquad P(\bar{x} > r) = P\left(Z > \frac{r - \mu_{\bar{x}}}{\sigma_{\bar{x}}}\right)$$

$$P(\bar{x}_1 - \bar{x}_2 > r) = P\left(Z > \frac{r - \mu_{\bar{x}_1 - \bar{x}_2}}{\sigma_{\bar{x}_1 - \bar{x}_2}}\right) \qquad Confidence\ interval = (1 - \alpha)$$

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LISTS OF FORMULAE (CONT.)

$$\bar{x} \pm z_{\alpha/2}(s/\sqrt{n}) \qquad E = Z_{\alpha/2}\left(\frac{\sigma}{\sqrt{n}}\right) \qquad \bar{x} \pm z_{\alpha/2}(\sigma/\sqrt{n})$$

$$T = \frac{\bar{x} - \mu}{\sqrt{s^2/n}} \qquad (\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\left(\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}\right)$$

$$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\left(\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}\right) \qquad (\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,v}\left(\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}\right); v = 2n - 2$$

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,v} S_p\left(\sqrt{\frac{2}{n}}\right); v = 2n - 2 \qquad S_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,v} S_p\left(\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right); v = n_1 + n_2 - 2$$

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2,v}\left(\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}\right); v = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

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LISTS OF FORMULAE (CONT.)

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

$$\bar{\bar{x}} = \frac{\sum X_{ij}}{N} \qquad SST = \sum_{i=1}^{r}\sum_{j=1}^{c}\left(X_{ij} - \bar{\bar{X}}\right)^2 \qquad SSTR = \sum r_j\left(\bar{X}_j - \bar{\bar{X}}\right)^2$$

$$SSE = \sum\sum\left(X_{ij} - \bar{X}_j\right)^2 \qquad MST = \frac{SST}{N-1} \qquad MSTR = \frac{SSTR}{c-1}$$

$$MSE = \frac{SSE}{N-c} \qquad F = \frac{MSTR}{MSE}$$

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LISTS OF STATISTICAL TABLES

Critical Values of the Mann-Whitney U
(Two-Tailed Testing)

n_2	α	n_1																	
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3	.05	--	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
	.01	--	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
4	.05	--	0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14
	.01	--	--	0	0	0	1	1	2	2	3	3	4	5	5	6	6	7	8
5	.05	0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
	.01	--	--	0	1	1	2	3	4	5	6	7	7	8	9	10	11	12	13
6	.05	1	2	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
	.01	--	0	1	2	3	4	5	6	7	9	10	11	12	13	15	16	17	18
7	.05	1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
	.01	--	0	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24
8	.05	2	4	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
	.01	--	1	2	4	6	7	9	11	13	15	17	18	20	22	24	26	28	30
9	.05	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
	.01	0	1	3	5	7	9	11	13	16	18	20	22	24	27	29	31	33	36
10	.05	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
	.01	0	2	4	6	9	11	13	16	18	21	24	26	29	31	34	37	39	42
11	.05	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
	.01	0	2	5	7	10	13	16	18	21	24	27	30	33	36	39	42	45	48
12	.05	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
	.01	1	3	6	9	12	15	18	21	24	27	31	34	37	41	44	47	51	54
13	.05	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
	.01	1	3	7	10	13	17	20	24	27	31	34	38	42	45	49	53	56	60
14	.05	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
	.01	1	4	7	11	15	18	22	26	30	34	38	42	46	50	54	58	63	67
15	.05	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
	.01	2	5	8	12	16	20	24	29	33	37	42	46	51	55	60	64	69	73
16	.05	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
	.01	2	5	9	13	18	22	27	31	36	41	45	50	55	60	65	70	74	79
17	.05	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
	.01	2	6	10	15	19	24	29	34	39	44	49	54	60	65	70	75	81	86
18	.05	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
	.01	2	6	11	16	21	26	31	37	42	47	53	58	64	70	75	81	87	92
19	.05	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
	.01	3	7	12	17	22	28	33	39	45	51	56	63	69	74	81	87	93	99
20	.05	8	14	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127
	.01	3	8	13	18	24	30	36	42	48	54	60	67	73	79	86	92	99	105

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n_2	α	n_1 = 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3	.05	0	0	1	2	2	3	4	4	5	5	6	7	7	8	9	9	10	11
	.01	--	0	0	0	0	0	1	1	1	2	2	2	3	3	4	4	4	5
4	.05	0	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18
	.01	--	--	0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10
5	.05	1	2	4	5	6	8	9	11	12	13	15	16	18	19	20	22	23	25
	.01	--	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6	.05	2	3	5	7	8	10	12	14	16	17	19	21	23	25	26	28	30	32
	.01	--	1	2	3	4	6	7	8	9	11	12	13	15	16	18	19	20	22
7	.05	2	4	6	8	11	13	15	17	19	21	24	26	28	30	33	35	37	39
	.01	0	1	3	4	6	7	9	11	12	14	16	17	19	21	23	24	26	28
8	.05	3	5	8	10	13	15	18	20	23	26	28	31	33	36	39	41	44	47
	.01	0	2	4	6	7	9	11	13	15	17	20	22	24	26	28	30	32	34
9	.05	4	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54
	.01	1	3	5	7	9	11	14	16	18	21	23	26	28	31	33	36	38	40
10	.05	4	7	11	14	17	20	24	27	31	34	37	41	44	48	51	55	58	62
	.01	1	3	6	8	11	13	16	19	22	24	27	30	33	36	38	41	44	47
11	.05	5	8	12	16	19	23	27	31	34	38	42	46	50	54	57	61	65	69
	.01	1	4	7	9	12	15	18	22	25	28	31	34	37	41	44	47	50	53
12	.05	5	9	13	17	21	26	30	34	38	42	47	51	55	60	64	68	72	77
	.01	2	5	8	11	14	17	21	24	28	31	35	38	42	46	49	53	56	60
13	.05	6	10	15	19	24	28	33	37	42	47	51	56	61	65	70	75	80	84
	.01	2	5	9	12	16	20	23	27	31	35	39	43	47	51	55	59	63	67
14	.05	7	11	16	21	26	31	36	41	46	51	56	61	66	71	77	82	87	92
	.01	2	6	10	13	17	22	26	30	34	38	43	47	51	56	60	65	69	73
15	.05	7	12	18	23	28	33	39	44	50	55	61	66	72	77	83	88	94	100
	.01	3	7	11	15	19	24	28	33	37	42	47	51	56	61	66	70	75	80
16	.05	8	14	19	25	30	36	42	48	54	60	65	71	77	83	89	95	101	107
	.01	3	7	12	16	21	26	31	36	41	46	51	56	61	66	71	76	82	87
17	.05	9	15	20	26	33	39	45	51	57	64	70	77	83	89	96	102	109	115
	.01	4	8	13	18	23	28	33	38	44	49	55	60	66	71	77	82	88	93
18	.05	9	16	22	28	35	41	48	55	61	68	75	82	88	95	102	109	116	123
	.01	4	9	14	19	24	30	36	41	47	53	59	65	70	76	82	88	94	100
19	.05	10	17	23	30	37	44	51	58	65	72	80	87	94	101	109	116	123	130
	.01	4	9	15	20	26	32	38	44	50	56	63	69	75	82	88	94	101	107
20	.05	11	18	25	32	39	47	54	62	69	77	84	92	100	107	115	123	130	138
	.01	5	10	16	22	28	34	40	47	53	60	67	73	80	87	93	100	107	114

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