

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION SEMESTER I SESSION 2016/2017

COURSE NAME

CIVIL ENGINEERING

STATISTICS

COURSE CODE

BFC 34303

PROGRAMME CODE :

BFF

EXAMINATION DATE :

DECEMBER 2016 / JANUARY 2017

TERBUKA

DURATION

3 HOURS

INSTRUCTION

ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSISTS OF NINE (9) PAGES

CONFIDENTIAL

Q1 The following data are the daily average of PM₁₀ concentration in $\mu g/m^3$ in UTHM Campus for the first 50 days in 2016:

18	11	40	44	51	50	33	49	57	22
36	57	83	22	51	40	26	21	24	67
45	51	66	32	64	51	44	31	60	70
33	49	25	61	80	33	90	17	28	45
26	44	56	72	34	71	77	78	81	33

(a) Construct a stem and leaf diagram and state the type of the data distribution.

(5 marks)

(b) Summarize the data in a box-and-whiskers plot.

(10 marks)

(c) Calculate standard deviation and interpret this value.



- Q2 (a) Before any 250 m length of a pavement is accepted by the Public Works Department, the thickness of a 30 cm is monitored by an ultrasonic instrument to verify compliance to specification. Each section is rejected if the measured thickness is less than 10 cm; otherwise, the entire section is accepted. From past experience, the State Highway Engineer knows that 85% of all sections constructed by the contractor comply with specifications. However, the reliability of ultrasonic thickness testing is only 75%, so that there is a 25% chance of erroneous conclusions based on the determination of thickness with ultrasonic. Find
 - (i) the probability that a poorly constructed section is accepted on the basis of the ultrasonic test.

(4 marks)

(ii) the probability that if a section is well constructed but will be rejected on the basis of the ultrasonic test.

(4 marks)

- (b) The tensile strength in a structural material is found to be highly variable, although tests showed that there is an increasing number of specimens of high strengths with a possible limit of 20 N/mm² in strength. Based on observations and as a first approximation, the probability density function of tensile strength X is represented by the function $f(x) = \alpha x^2$ for $0 \le x \le 20$ N/mm². Find
 - (i) the value of the constant a in the function.

(3 marks)

(ii) the probability of $X > 10 \text{ N/mm}^2$.

(4 marks)

(iii) the cumulative distribution function for X.

(5 marks)



- Q3 (a) In any large shipment of tiles from a particular factory, it is known that 2% are broken. Upon arrival of a shipment at a receiving depot, random samplings with replacement are conducted.
 - (i) Calculate the probability of getting at most one broken tile in a sample of size 20.

(4 marks)

(ii) If the sample size is 1000, approximate the probability of getting not more than eight broken tiles.

(6 marks)

- (b) The volumes of concrete cube in particular project site are normally distributed with a mean of 22 kilograms and standard deviation of 8 kilograms. A random sample of 100 cubes is taken.
 - (i) Estimate the standard error of the mean.

(2 marks)

(ii) Find the probability that the mean mass of the sample is less than 20 kilograms.

(3 marks)

(iii) Find the probability that the mean mass of the sample differ from the population mean by less than 1 kilogram.

(5 marks)

Q4 (a) A manufacturer claims that the length of a concrete steel nail is 3 cm with the variance of 0.15 cm². A project manager wants to test the validity of manufacturer's claims. He takes a sample of 60 concrete steel nails and finds the mean length is 3.04 cm. Assuming the length is normally distributed, test the hypothesis whether the mean length differs from 3 cm at 4% level of significance.

(8 marks)

(b) The followings are the compressive strengths of a material in N/mm², manufactured by two different methods A and B.

A: 60.3 50.2 56.5 60.6 59.3 49.7 50.8 59.8 52.5 57.4 55.8 54.5 53.6 56.7 B: 56.0 56.2 55.1 59.2 62.3 54.5 56.5 57.1 56.2 56.1 58.5 63.5 58.2 48.9

Apply the Wilcoxon signed-rank sum test to investigate whether method B is superior to method A as claimed, assuming that the values represent independent random variables. Use $\alpha=0.05$.

(12 marks)

Q5 (a) An air quality study was conducted to investigate the relationship between sulphur dioxide (SO₂) and PM₁₀ concentration in Johor Bahru. The following data was obtained:

SO_2 (ppi	n) 0.27	0.28	0.28	0.29	0.31	0.33	0.34	0.34	0.31
PM ₁₀ (μg/	(m^3) 30	20	33	24	23	21	44	43	40

Fit a simple linear regression model.



(10 marks)

(b) Table below shows the results of first quiz in Engineering Statistics for five different groups.

Group A	Group B	Group C	Group D	Group E
7	3	1	2	4
8	6	2	4	5
12	3	1	3	2
6	2	3	4	3
8	5	-	-	-

Test if there are differences in mean of results among these five groups. Use $\alpha = 0.05$.

(10 marks)

-END OF QUESTIONS-

SEMESTER / SESSION: SEM I / 2016/2017

PROGRAMME CODE: BFF

COURSE NAME : CIVIL ENGINEERING

COURSE CODE: BFC 34303

STATISTICS

Lists of Formulae

$$Mode = L_{\text{mode}} + \left(\frac{d_1}{d_1 + d_2}\right)c$$

$$\textit{Median} = L_{\text{m}} + \left(\frac{\frac{1}{2}n - F}{f}\right)c$$

$$Q_{k} = L_{Q_{k}} + \left(\frac{\frac{k}{4}n - F}{f}\right)c$$

$$P_{k} = L_{P_{k}} + \left(\frac{\frac{k}{100}n - F}{f}\right)c$$
TERBUKA

$$s^{2} = \frac{\sum x^{2} - \frac{\left(\sum x\right)^{2}}{n}}{n-1}$$
 (ungrouped data)

$$s^{2} = \frac{\sum fx^{2} - \frac{\left(\sum fx\right)^{2}}{\sum f}}{\sum f - 1} \text{ (grouped data)}$$

SEMESTER / SESSION: SEM I / 2016/2017

PROGRAMME CODE: BFF

COURSE NAME : CIVIL ENGINEERING

COURSE CODE: BFC 34303

STATISTICS

Lists of Formulae

$$t_m = \frac{\overline{x} - \mu_0}{\sqrt[S]{\sqrt{n}}}$$

$$U = n1 \times n2 + nx \times \frac{(nx+1)}{2} - Tx$$

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$$

$$\hat{\beta}_1 = \frac{S_{XY}}{S_{XX}}$$

TERBUKA

$$\hat{\beta}_0 = \overline{y} - \hat{\beta}_1 \overline{x}$$

$$S_{XY} = \sum xy - \frac{1}{n} \left(\sum x \right) \left(\sum y \right)$$

$$S_{XX} = \sum x^2 - \frac{1}{n} \left(\sum x\right)^2$$

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

SEMESTER / SESSION: SEM I / 2016/2017

PROGRAMME CODE: BFF

COURSE NAME : CIVIL ENGINEERING

COURSE CODE: BFC 34303

STATISTICS

Lists of Formulae

Analysis of Variance:

$$MSB = \frac{SSB}{k-1}$$

$$MSE = \frac{SSE}{N - k}$$

$$SST = SSE + SSB$$

$$F_{C} = \frac{MSB}{MSE}$$

$$SST = \sum \sum x^2 - CF$$

$$CF = \frac{\left(\sum \sum x_i\right)^2}{N}$$

TERBUKA

$$SSB = \left(\sum_{i=1} \frac{(x_i)^2}{n_i}\right) - CF$$

$$SSE = SST - SSB$$

SEMESTER / SESSION: SEM I / 2016/2017

PROGRAMME CODE: BFF

COURSE NAME : CIVIL ENGINEERING STATISTICS

COURSE CODE: BFC 34303

5111101

Lower Percentage Points of the Wilcoxon Signed-rank Distribution

- .0312 - 2 .0234 0 .0078 - 4 .0273 2 .0117 0 6 .0273 2 .0117 0 8 .0244 5 .0098 3 11 .0269 7 .0093 3 14 .0261 10 .0105 7 17 .0239 13 .0107 10 21 .0247 16 .0101 13 22 .0247 16 .0101 13 30 .0253 24 .0107 10 34 .0247 38 .0104 28 46 .0247 38 .0104 49 56 .0256 56 .0104 49 66 .0256 56 .0104 49 73 .0245 62 .0098 55 81 .0245 62 .0098 54 90 .0258 77 .0101 61	α	0.05	Nearer exact probability	0.025	Nearer exact probability	0.01	Nearer exact probability	0.005	Nearer exact probability	0.001
2 .0469 1 .0312 - 4 .0547 2 .0234 0 .0078 - 8 .0547 2 .0234 0 .0078 - 1 .0587 4 .0273 2 .0117 0 .0039 11 .0527 8 .0244 5 .0098 3 .0049 14 .0568 11 .0269 7 .0093 5 .0049 17 .0461 14 .0269 7 .0093 5 .0049 21 .0461 14 .0269 7 .0093 5 .0049 22 .0520 .01 .0107 .0 .0105 .0 .0 24 .047 .05 .0247 .0 .0 .0 .0 .0 25 .0523 .0 .0 .0 .0 .0 .0 .0 .0 36	11		.0625	. 1		ı		-		Plantagia and property and a second
4 .0547 2 .0234 0 .0078 - 8 .0547 4 .0273 2 .0117 0 .0039 11 .0527 8 .0273 2 .0117 0 .0059 11 .0528 11 .0269 7 .0093 3 .0049 17 .0568 11 .0269 7 .0093 5 .0049 17 .0461 14 .0269 7 .0093 5 .0049 17 .0461 17 .0239 13 .0107 10 .0052 26 .0520 21 .0247 16 .0101 13 .0045 30 .0473 25 .0244 16 .0107 20 .0052 41 .0492 36 .0242 38 .0102 32 .0047 54 .0521 46 .0242 38 .0102 32 .004	9	7	.0469	_	.0312	1		ı		
6 .0547 4 .0273 2 .0117 0 .0039 11 .0527 8 .0244 5 .0098 3 .0049 14 .0508 11 .0269 7 .0093 5 .0049 17 .0461 14 .0261 10 .0105 7 .0049 17 .0461 14 .0261 10 .0105 7 .0049 17 .0461 14 .0261 19 .0107 10 .0049 26 .0520 21 .0247 16 .0107 13 .0047 36 .0473 35 .0240 28 .0107 20 .0047 41 .0492 40 .0244 38 .0104 28 .0047 54 .0516 59 .0242 38 .0104 49 .0051 60 .0487 59 .0242 38 .0104	7	4	.0547	2	.0234	0	8200.	. 1		I I
8 .0488 6 .0273 3 .0098 2 .0059 11 .0527 8 .0244 5 .0098 3 .0049 14 .0508 11 .0269 7 .0093 3 .0049 17 .0461 14 .0269 13 .0107 10 .0049 21 .0471 17 .0239 13 .0107 10 .0049 26 .0520 21 .0240 20 .0101 13 .0049 30 .0473 25 .0240 20 .0108 16 .0051 30 .0523 30 .0253 24 .0107 20 .0045 47 .0492 35 .0253 28 .0101 23 .0047 47 .0494 40 .0244 33 .0104 28 .0051 48 .0516 59 .0244 38 .0102	∞	9	.0547	4	.0273	2	.0117	0	0039	
11 .0527 8 .0244 5 .0098 3 .0049 14 .0508 11 .0269 7 .0093 5 .0049 17 .0461 14 .0261 10 .0105 7 .0049 21 .0471 17 .0239 13 .0107 10 .0042 36 .0520 21 .0247 16 .0101 13 .0044 36 .0523 30 .0253 24 .0107 20 .0045 41 .0492 35 .0253 24 .0107 20 .0047 47 .0494 40 .0244 38 .0104 28 .0047 47 .0494 40 .0245 38 .0104 28 .0047 54 .0521 43 .0096 38 .0047 43 .0051 68 .0545 56 .0245 56 .0104	6	∞	.0488	9	.0273	c	8600	7	.0059	1
14 .0508 11 .0269 7 .0093 5 .0049 17 .0461 14 .0261 10 .0105 7 .0049 21 .0471 17 .0239 13 .0107 10 .0045 26 .0520 21 .0247 16 .0101 13 .0045 30 .0473 25 .0240 20 .0108 16 .0054 41 .0492 35 .0253 24 .0107 20 .0047 47 .0494 40 .0244 33 .0104 28 .0047 47 .0494 40 .0244 38 .0102 28 .0047 54 .0521 46 .0247 38 .0102 32 .0047 60 .0487 52 .0247 38 .0104 49 .0051 75 .0490 73 .0245 62 .0098	10	11	.0527	00	.0244	5	8600	(°	0049	c
17 .0461 14 .0261 10 .0105 7 .0046 21 .0471 17 .0239 13 .0107 10 .0052 26 .0520 21 .0247 16 .0101 13 .0052 30 .0473 25 .0240 20 .0108 16 .0051 41 .0492 35 .0253 24 .0107 23 .0047 47 .0494 40 .0241 38 .0101 28 .0057 54 .0521 46 .0247 38 .0102 28 .0047 60 .0487 52 .0247 38 .0102 32 .0047 68 .0516 59 .0251 49 .0096 38 .0053 75 .0490 73 .0245 62 .0098 55 .0048 110 .0507 90 .0258 77 .0101 </td <td>11</td> <td>14</td> <td>.0508</td> <td>11</td> <td>.0269</td> <td>7</td> <td>.0093</td> <td>· v</td> <td>0049</td> <td>· -</td>	11	14	.0508	11	.0269	7	.0093	· v	0049	· -
21 .0471 17 .0239 13 .0107 10 .0052 26 .0520 21 .0247 16 .0101 13 .0054 30 .0473 25 .0240 20 .0108 16 .0054 36 .0523 30 .0253 24 .0107 20 .0055 41 .0494 40 .0253 28 .0104 28 .0047 47 .0494 40 .0244 38 .0104 28 .0047 60 .0487 52 .0247 38 .0102 32 .0047 68 .0516 59 .0242 43 .005 38 .0053 75 .0490 73 .0242 62 .0096 55 .0051 83 .0490 73 .0242 69 .0097 43 .0048 110 .0507 90 .0245 69 .0096 </td <td>12</td> <td>17</td> <td>.0461</td> <td>14</td> <td>.0261</td> <td>10</td> <td>.0105</td> <td></td> <td>0046</td> <td>, (</td>	12	17	.0461	14	.0261	10	.0105		0046	, (
26 .0520 21 .0247 16 .0101 13 .0054 30 .0473 25 .0240 20 .0108 16 .0051 36 .0523 30 .0253 24 .0107 20 .0051 41 .0492 35 .0253 28 .0101 23 .0047 54 .0494 40 .0241 33 .0104 28 .0047 60 .0487 52 .0242 43 .0096 38 .0047 68 .0516 59 .0251 49 .0096 38 .0053 75 .0492 66 .0250 56 .0104 49 .0053 83 .0490 73 .0245 62 .0098 55 .0048 110 .0507 90 .0258 77 .0101 68 .0048 110 .0502 107 .0245 93 .010	13	21	.0471	17	.0239	13	0107	10	0052	1 <
30 .0473 25 .0240 20 .0108 16 .0051 36 .0523 30 .0253 24 .0107 20 .0055 41 .0492 35 .0253 28 .0101 23 .0047 47 .0494 40 .0241 33 .0104 28 .0047 54 .0521 46 .0242 38 .0102 32 .0047 60 .0487 52 .0242 43 .0096 38 .0053 75 .0492 66 .0250 56 .0104 49 .0051 75 .0490 73 .0242 62 .0098 55 .0051 83 .0490 73 .0245 62 .0098 55 .0048 110 .0507 90 .0245 62 .0098 55 .0048 120 .0507 10 .0254 93 .0102	14	26	.0520	21	.0247	. 16	.0101	13	.0054	9
36 .0523 30 .0253 24 .0107 20 .0055 41 .0492 35 .0241 33 .0104 28 .0055 47 .0494 40 .0241 33 .0104 28 .0052 54 .0521 46 .0247 38 .0104 28 .0052 60 .0487 52 .0242 43 .0096 38 .0047 68 .0516 59 .0251 49 .0097 43 .0051 75 .0490 73 .0245 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 110 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0246 93 .0100 84 .0051 130 .0504 117 .0253 111 .0	15	30	.0473	25	.0240	20	0108	16	0051	œ
41 .0492 35 .0253 28 .0101 23 .0047 47 .0494 40 .0241 33 .0104 28 .0052 54 .0521 46 .0247 38 .0104 28 .0052 60 .0487 52 .0242 43 .0096 38 .0047 68 .0516 59 .0251 49 .0097 43 .0051 75 .0490 73 .0242 62 .0098 55 .0051 83 .0505 81 .0245 69 .0098 55 .0048 110 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 120 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0249 120 <td< td=""><td>16</td><td>36</td><td>.0523</td><td>30</td><td>.0253</td><td>24</td><td>.0107</td><td>20</td><td>.0055</td><td>=</td></td<>	16	36	.0523	30	.0253	24	.0107	20	.0055	=
47 .0494 40 .0241 33 .0104 28 .0052 54 .0521 46 .0247 38 .0102 32 .0047 60 .0487 52 .0242 43 .0096 38 .0053 68 .0516 59 .0251 49 .0097 43 .0051 75 .0492 66 .0250 56 .0104 49 .0051 83 .0490 73 .0242 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 110 .0507 90 .0258 77 .0101 68 .0048 120 .0502 107 .0246 93 .0102 76 .0051 130 .0504 127 .0249 120 .0098 109 .0049 152 .0502 137 .0249 120 <	17	41	.0492	35	.0253	28	.0101	23	.0047	1 4
54 .0521 46 .0247 38 .0102 32 .0047 60 .0487 52 .0242 43 .0096 38 .0053 68 .0516 59 .0251 49 .0097 43 .0051 75 .0492 66 .0250 56 .0104 49 .0051 83 .0490 73 .0242 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 110 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 130 .0496 117 .0252 102 .0102 84 .0052 141 .0504 127 .0249 120 .0098 109 .0049 152 .0505 137 .0249 120	18	47	.0494	40	.0241	33	.0104	78	0052	. 2
60 .0487 52 .0242 43 .0096 38 .0053 68 .0516 59 .0251 49 .0097 43 .0051 75 .0492 66 .0250 56 .0104 49 .0052 83 .0490 73 .0245 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 101 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0246 93 .0100 84 .0051 120 .0502 107 .0246 93 .0100 84 .0052 141 .0504 127 .0249 120 .0098 109 .0049 152 .0502 137 .0249 120 .0098 109 .0053	19	54	.0521	46	.0247	38	.0102	32	.0047	21
68 .0516 59 .0251 49 .0097 43 .0051 75 .0492 66 .0250 56 .0104 49 .0051 83 .0490 73 .0245 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 101 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0249 120 .0098 109 .0050	20	09	.0487	52	.0242	43	9600.	38	0053	96
75 .0492 66 .0250 56 .0104 49 .0052 83 .0490 73 .0242 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 101 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0253 111 .0101 100 .0049 152 .0502 137 .0249 120 .0098 109 .0050	21	89	.0516	59	.0251	49	7600.	43	.0051	30
83 .0490 73 .0242 62 .0098 55 .0051 92 .0505 81 .0245 69 .0097 61 .0048 101 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0249 120 .0098 109 .0050	22	75	.0492	99	.0250	26	.0104	49	.0052	32
92 .0505 81 .0245 69 .0097 61 .0048 101 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0249 120 .0098 109 .0050 152 .0502 137 .0249 120 .0098 109 .0050	23	83	.0490	73	.0242	62	8600.	55	.0051	40
101 .0507 90 .0258 77 .0101 68 .0048 110 .0497 98 .0247 85 .0102 76 .0051 120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0253 111 .0101 100 .0049 152 .0502 137 .0249 120 .0098 109 .0050	24	92	.0505	81	.0245	69	7600.	61	.0048	45
110 .0497 98 .0247 85 .0102 76 .0051 120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0253 111 .0101 100 .0049 152 .0502 137 .0249 120 .0098 109 .0050	25	101	.0507	06	.0258	77	.0101	89	0048	15
120 .0502 107 .0246 93 .0100 84 .0052 130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0253 111 .0101 100 .0049 152 .0502 137 .0249 120 .0098 109 .0050	26	110	.0497	86	.0247	85	.0102	26	.0051	. %
130 .0496 117 .0252 102 .0102 92 .0051 141 .0504 127 .0253 111 .0101 100 .0049 152 .0502 137 .0249 120 .0098 109 .0050	27	120	.0502	107	.0246	93	.0100	84	.0052	64
141 .0504 127 .0253 111 .0101 100 .0049 152 .0502 137 .0249 120 .0098 109 .0050	28	130	.0496	117	.0252	102	.0102	92	.0051	71
152 .0502 137 .0249 120 .0098 109 .0050	29	141	.0504	127	.0253	111	.010	100	.0049	79
	30	152	.0502	137	.0249	120	8600.	109	.0050	98