Universiti Tun Hussein Onn Malaysia

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
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 The following data are the daily average of PM_{10} 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.

(5 marks)

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/mm^2 in strength. Based on observations and as a first approximation, the probability density function of tensile strength X is represented by the function $f(x) = ax^2$ for $0 \leq x \leq 20$ N/mm^2. Find

(i) the value of the constant a in the function.

(3 marks)

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

(4 marks)

(iii) the cumulative distribution function for X.

(5 marks)

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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 cm^2. 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/mm^2, 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 (SO_2) and PM_{10} concentration in Johor Bahru. The following data was obtained:

SO_2 (ppm)	0.27	0.28	0.28	0.29	0.31	0.33	0.34	0.34	0.31
PM_{10} ($\mu g/m^3$)	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-

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Lists of Formulae

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

$$Median = L_m + \left(\frac{\frac{1}{2}n - F}{f}\right)c$$

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

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

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

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

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$$t_m = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

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

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

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

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

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

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

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

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Lists of Formulae

Analysis of Variance :

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

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

$$SST = SSE + SSB$$

$$F_C = \frac{MSB}{MSE}$$

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

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

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

$$SSE = SST - SSB$$

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Lower Percentage Points of the Wilcoxon Signed-rank Distribution

α	0.05	Nearer exact probability	0.025	Nearer exact probability	0.01	Nearer exact probability	0.005	Nearer exact probability	0.001
$n = 5$	1	.0625	–		–		–		–
6	2	.0469	1	.0312	–		–		–
7	4	.0547	2	.0234	0	.0078	–		–
8	6	.0547	4	.0273	2	.0117	0	.0039	–
9	8	.0488	6	.0273	3	.0098	2	.0059	–
10	11	.0527	8	.0244	5	.0098	3	.0049	0
11	14	.0508	11	.0269	7	.0093	5	.0049	1
12	17	.0461	14	.0261	10	.0105	7	.0046	2
13	21	.0471	17	.0239	13	.0107	10	.0052	4
14	26	.0520	21	.0247	16	.0101	13	.0054	6
15	30	.0473	25	.0240	20	.0108	16	.0051	8
16	36	.0523	30	.0253	24	.0107	20	.0055	11
17	41	.0492	35	.0253	28	.0101	23	.0047	14
18	47	.0494	40	.0241	33	.0104	28	.0052	18
19	54	.0521	46	.0247	38	.0102	32	.0047	21
20	60	.0487	52	.0242	43	.0096	38	.0053	26
21	68	.0516	59	.0251	49	.0097	43	.0051	30
22	75	.0492	66	.0250	56	.0104	49	.0052	35
23	83	.0490	73	.0242	62	.0098	55	.0051	40
24	92	.0505	81	.0245	69	.0097	61	.0048	45
25	101	.0507	90	.0258	77	.0101	68	.0048	51
26	110	.0497	98	.0247	85	.0102	76	.0051	58
27	120	.0502	107	.0246	93	.0100	84	.0052	64
28	130	.0496	117	.0252	102	.0102	92	.0051	71
29	141	.0504	127	.0253	111	.0101	100	.0049	79
30	152	.0502	137	.0249	120	.0098	109	.0050	86