NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF THE BUILT ENVIRONMENT

DEPARTMENT OF QUANTITY SURVEYING/CONSTRUCTION MANAGEMENT

STATISTICS

BCS1201

Main Examination Paper

OCTOBER 2024

This examination paper consists of 6 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Statistical Tables, Graph Paper

Examiner's Name: A. Masache (Mr.)

INSTRUCTIONS

1. This paper consists of Section **A** and Section **B.**
2. Section A is compulsory and carries a total of **40 MARKS**.
3. Section B has four questions on which you must answer any three questions.
4. Each question in Section B carries **20 MARKS**.
5. You may use the formulae sheet on page 6.

MARK ALLOCATION

QUESTION	MARKS
A1	5
A2	16
A3	10
A4	9
B5	20
B6	20
B7	20
B8	20

SECTION A: Answer ALL questions in this section (40 marks).

A1. Classify the following characteristics of interests as either a discrete or continuous variable:

(a) Time until a certain construction company wins a tender.

(b) Number of 20 litre buckets needed to paint a standard all weather tennis court.

(c) Amount of prime paint needed for a standard door.

(d) The capacity of a car park area.

(e) The number of major government projects that collapsed every year.

[1 mark each]

A2. The data Table 1 is of twenty cranes that were measured their heights (in metres) and the index on their footing (the slab mechanism where a crane is mounted on).

Table 1: Crane data sets.

Crane Height		Footing Index	
66	71	3.0	3.2
68	71	3.5	2.8
69	72	3.4	3.1
68	69	3.5	3.1
73	70	3.2	3.3
67	72	3.5	3.2
68	69	3.4	3.5
65	70	3.1	2.9
66	70	3.5	3.1
71	71	3.5	3.5

(a) Name the two variables under study in this problem. [2]

(b) State the measurement scales that were used to record each variable. [1]

(c) Construct a box-and-whisker plot of each data set. [10]

(d) Which variable was more consistently measured than the other? Justify your answer. [1,2]

A3. The number of weeks it takes to construct a standard cottage was recorded for several cottages once built, as shown in the data set below.

9	14	8	14	13	15	10	16	15	16	13
14	17	18	9	13	15	11	16	15	14	14

(a) How many weeks would any standard cottage take to be completed? [3]

(b) What is the median days it take to construct a standard cottage? [4]

(c) What is the modal number of days it take to construct a standard cottage? [1]

(d) Which measure of centre would you use to describe the time it takes to construct a standard cottage? Justify your answer. [1,1]

A4. A machine fills packets with a certain grout which is supposed to have a mean weight of 40 grams. A random sample of 16 packets was taken and the mean weight was found to be 42.4 grams with a standard deviation of 6 grams. Test at 1% level of significance whether the machine is filling the packets at the expected weight or not. [9]

SECTION B: Answer ANY THREE questions in this section (60 marks).

B5. (a) With the introduction of STEM programmes, the Ministry of Primary and Secondary Education would like to estimate the average age/ level at which learners should be introduced to scientific (including engineering and surveying) concepts in Primary schools. Some scientists, engineers and surveyors argue that the new curriculum is introducing them at the right age/ level, some are saying it is too early while some are saying it is too late to develop them in those respective professional careers. The ministry considered districts in a particular province of their choice for a survey exercise to investigate the matter.

(i) What would be the sampling units the Ministry should consider? [1]

(ii) State the sampling frame the Ministry would use to extract the sample. [1]

(iii) Advise the Ministry on an appropriate sampling method to use and justify the choice of that sampling method. [3]

(iv) If the Ministry decides to use a questionnaire as their data collection tool then state how they would administer the questionnaire to collect the data. [1]

(v) Justify your answer in part (iv) by explaining three advantages of administering the questionnaire the way you stated. [3]

(b) The following data are cities where a construction company selected for a survey can be found:

Harare	Harare	Bulawayo	Bulawayo	Harare	Kwekwe
Mutare	Masvingo	Bulawayo	Bulawayo	Harare	Harare
Bulawayo	Bulawayo	Mutare	Harare	Bulawayo	Bulawayo
Bulawayo	Mutare	Mutare	Mutare	Bulawayo	Mutare
Mutare	Mutare	Bulawayo	Mutare	Mutare	Bulawayo

(i) Construct a frequency table of the data. [5]

(ii) Hence represent the data on an appropriate graph. [5]

B6. (a) There has been a general perception that civil servants are less remunerated than their counterparts in private entities. As a result, monthly incomes of forty Quantity Surveyors working on different private construction projects and thirty-five Quantity Suveyors working on different state owned construction projects were collected, and summarised as in the following Table 2: Conduct an appropriate

Table 2: Summary of Quantity Suveryors remuneration.

Parameter	Private	State
Mean	\$1060	\$970
Standard Deviation	\$63	\$76

hypothesis test and draw a conclusion thereof. [9]

(b) In order to determine the effectiveness of an industrial safety programme the following data was collected over a period of a year on the average weekly loss of man hours due to accidents in twelve plants, after and before the programme was implemented.

After :	41	75	35	129	60	53	26	85	29	31	48	37
Before :	50	87	37	141	59	65	24	88	25	36	50	35

Use a 1% level of significance test whether the safety programme was effective. [11]

B7. (a) (i) Explain what is a Type I error and a Type II error. [2]

(ii) Give an example of each Type of error. [2]

(b) A study has been prepared with information about book return times at the respective libraries for students in 2 universities: NUST and UZ. Data for return times for each university are shown in the following table.

NUST	UZ
2	3
4.3	6.5
8.5	5
3	7.5
2	8
4	3

Can you conclude that the average return time for students at NUST and UZ is the same? Justify your answer (Use a 10% significance level). [16]

B8. The following are the ages of company owners in the manufacture of construction materials, equipment and machinery, who participated in a survey. The ages in bold are for females and the rest are for males.

52 67 **59** 60 **79 62** 55 52 60 **64** 87 **65 64** 50 71 **72 64 71** 67 40 **56** 74 **69** 66 **67** **81** 77 **77 57** 45 86 **71 79** 88 **43** 54 48 **68 77 63** 70 84 78 **68** 63 **47 56 66** 57 80

(a) Construct a suitable table to show the distribution by gender and age group, grouping the ages into forties, fifties, sixties, etc. [6]

(b) Use the table(s) you constructed in part (a) to construct suitable graphs of each gender. [10]

(c) Comment on the distribution of each gender. [2]

(d) Hence, which sample of gender would you think is more suitable to generalise conclusions for the population it is drawn from? Justify your answer [1,1]

LIST OF SELECTED FORMULAE

1. • $\bar{x} = \dfrac{\sum f_i x_i}{\sum f_i}$

2. • $s^2 = \dfrac{\sum x_i^2 - \frac{(\sum x_i)^2}{n}}{n-1}$

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2. • $M_o = L_{mo} + \dfrac{c\,(f_{mo} - f_{mo-1})}{2f_{mo} - f_{mo-1} - f_{mo+1}}$

   • $M_e = L_{me} + \dfrac{c\left(\frac{n}{2} - F_{me-1}\right)}{f_{me}}$

3. • $z_{calc} = \dfrac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$ and $t_{calc} = \dfrac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$

   • $z_{calc} = \dfrac{\hat{p} - p}{\sqrt{\dfrac{p(1-p)}{n}}}$

4. • $z_{calc} = \dfrac{\bar{x_1} - \bar{x_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$

   • $t_{calc} = \dfrac{\bar{x_1} - \bar{x_2}}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$ where $S_p^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}$

   • $t_{calc} = \dfrac{\bar{d}}{\frac{s_d}{\sqrt{n_d}}}$

5. • $Z_{calc} = \dfrac{\hat{p}_1 - \hat{p}_2}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$

   • $Z_{calc} = \dfrac{\hat{p_1} - \hat{p_2}}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$

   where $\hat{p_1} = \frac{k_1}{n_1}$, $\hat{p_2} = \frac{k_2}{n_2}$ and $\hat{p} = \dfrac{n_1\hat{p}_1 + n_2\hat{p}_2}{n_1 + n_2}$.

6. • $\hat{\beta}_1 = \dfrac{n\sum x_i y_i - \sum x_i \sum y_i}{n\sum x_i^2 - (\sum x_i)^2}$

   • $r = \dfrac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{\left[n\sum x_i^2 - (\sum x_i)^2\right]\left[n\sum y_i^2 - (\sum y_i)^2\right]}}$

   • Total SS=S_{yy}, Regr SS = $\hat{\beta}_1 S_{xy}$

   where $S_{yy} = \sum y^2 - \frac{(\sum y)^2}{n}$ and $S_{xy} = \sum xy - \frac{\sum x \sum y}{n}$

END OF QUESTION PAPER