

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH
APPLIED STATISTICS

BSc. OPERATIONS RESEARCH & STATISTICS: PART I

AUGUST 2024 SUPPLEMENTARY EXAMINATION

Time : 3 hours

Total Marks: 100

Candidates may attempt **ALL** Questions in Section **A** and at most **THREE** Questions in Section **B**. For all questions where necessary clearly show your work to indicate how you obtained the answer. You may use a calculator and Statistical Tables will be provided.

SECTION A: Attempt all questions in this section (40 marks).

A1. Explain whether each of the following constitutes a population or a sample.

- (i) Weekly salaries of all employees of a company. [1]
- (ii) Cattle owned by 100 farmers in Gwanda. [1]
- (iii) A group of 25 patients selected to test new drug. [1]
- (iv) Number of computers sold during the past week at all computer stores in Mashonaland Province. [1]

A2. (a) Traffic authorities claim that traffic lights are red for a time that is normal with mean of 30 seconds and standard deviation 1.4 seconds. To test this claim, a sample of 40 traffic lights was checked. If the average time of the 40 red lights observed was 32.2 seconds, can we conclude, at 5 percent level of significance, that the authorities are incorrect? [6]

(b) Find a 99% confidence interval for the mean time. [4]

A3. Thirty three students were given a test in Statistics and the results are as shown:

84 17 38 45 47 53 76 22 66 65 55
 54 51 44 39 19 54 72 15 25 29 16
 40 46 57 58 67 68 64 83 91 94 23

- (a) Plot a five number summary for the data above. [5]
 (b) Comment on the performance of the students. [1]

A4. An anti-malaria drug was given to 1500 men, and 15 of them showed an anaphylactic reaction. Of the 1400 women given the same drug, 40 showed an anaphylactic reaction. Complete the following table 1 and then test at 5% level of significance whether an association exists between gender and anaphylactic reaction to the drug.

Table 1: Anti-malaria drug reaction

Anaphylactic reaction	Male	Female	Total
Present			
Absent			
Total	1500	1400	

[10]

A5. Below is a partially completed ANOVA table for a completely randomised design

Table 2: Analysis of Variance

Source	df	SS	MS	F
Treatments	**	2709.20	**	35.81
Error	36	**	**	
Total	39	3617.06		

- (a) State the number of treatments involved in the experiment. [1]
 (b) Copy and complete the ANOVA table. [4]
 (c) Investigate at $\alpha = 0.01$ whether the data provide sufficient evidence to indicate a difference among the treatment means? [5]

SECTION B: Attempt any three questions in this section (60 marks).

- B6.** Given the following frequency distribution in Table 3 of the plant heights of 405 plants in centimeters (cm).

Table 3: Height of plants

Plant Height	8-12	13-17	18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57
No. of plants	6	17	25	86	125	77	55	9	4	1

- (a) On a graph paper, draw a fully labelled histogram to represent the data. [4]
- (b) Using the formulae for grouped data, calculate the following:
- (i) Mean. [4]
 - (ii) Median, [4]
 - (iii) Mode, [4]
 - (iv) Variance. [4]
- B7.** (a) A random sample of 167 people who own mobile phones was used to collect data on the amount of time they spent per day using their phones. The results are displayed in the table 4:

Table 4: Time spent on mobile phones

Time spent (t minutes)	0-15	15-30	30-45	45-60	60-75	75-90
Number of people	21	32	35	41	27	11

- (i) State the modal group. [1]
- (ii) Calculate the approximate values of the mean and standard deviation of the time spent per day on these mobile phones, [6]
- (iii) On graph paper, draw a fully labelled histogram to represent the data. [3]

- (b) A company is interested in hiring a new secretary. Several candidates are interviewed and the choice is narrowed to two possibilities. The final choice will be based on typing ability. Six letters are randomly selected from the company's files, and each candidate is required to type each one. The number of words typed per minute is recorded for each candidate-letter combination. The data are listed in the table 5:

Table 5: Number of words typed per minute

Candidate 1	62	60	65	58	59	64
Candidate 2	59	60	61	57	55	60

Investigate at $\alpha = 0.10$ whether the data provide sufficient evidence to indicate a difference in the mean number of words typed per minute by the two candidates. [10]

- B8.** Suppose that the following results are from an experiment in which we measured the growth of a cell culture (as optical density) at different pH levels.

Table 6: Growth of a cell culture at different pH levels

pH	3	4	4.5	5	5.5	6	6.5	7	7.5
Optical Density	0.1	0.2	0.25	0.32	0.33	0.35	0.47	0.49	0.53

- (a) Plot a scatter diagram for the data stating which one is the dependent variable and independent variable. Comment on your scatter diagram. [4]
- (b) Calculate the correlation coefficient for the two variables and comment. [4]
- (c) Find the linear regression model equation that represents this data and plot it onto the graph in (a) above. [4]
- (d) Estimate the growth of the cell culture when pH level is 5.8 tonnes. [2]
- (e) Determine whether there is evidence to indicate a linear relationship between the two variables. [6]

- B9.** An experiment was conducted to determine the effects of four different pesticides on the yield of the fruit from three different varieties of citrus trees. Eight trees were randomly selected from each variety, and four pesticides were randomly assigned to the trees (two trees of a particular variety to a pesticide). The yields of fruit, per tree, obtained after the application of pesticide are given in the following table:

Table 7: Yields of fruit per tree

Variety	Pesticides			
	1	2	3	4
1	49	50	43	53
	39	55	38	48
2	55	67	53	85
	41	58	42	73
3	66	85	69	85
	68	92	62	99

Using a 0.05 level of significance,

- (a) Carry out a preliminary ANOVA to test for the significance of treatment combinations. [8]
- (b) Carry out a complete ANOVA to test for the significance of the main effects and interaction. [12]

END OF QUESTION PAPER