

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH

APPLIED STATISTICS

BSc. OPERATIONS RESEARCH & STATISTICS: PART I

SEPTEMBER 2024 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.

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

**A1.** Researchers want to investigate whether taking aspirin regularly reduces the risk of heart attack. Four hundred men between the ages of 50 and 84 are recruited as participants. The men are divided randomly into two groups: one group will take aspirin, and the other group will take a placebo. Each man takes one pill each day for three years, without knowing whether he is taking aspirin or the placebo. At the end of the study, researchers count the number of men in each group who have had heart attacks.

Identify the following from this study:

- (i) Population, [1]
- (ii) Sample, [1]
- (iii) Experimental units, [1]
- (iv) Explanatory variable, [1]
- (v) Treatment, [1]
- (vi) Response variable. [1]

- A2.** The following Table 1 shows the systolic blood pressure readings (in mmHg) taken on both arms of each member of a sample of ten students from the 2024 SORS1201 class with 36 students in total:

Table 1: Blood Pressure readings

Student	1	2	3	4	5	6	7	8	9	10
Left arm	128	142	112	160	146	123	111	114	120	117
Right arm	121	146	105	141	138	121	124	112	122	123

Test at the 5% level of significance whether there is any significant difference in systolic blood pressure readings between the left and right arms. [10]

- A3.** Table 2 is a partially completed ANOVA table for a completely randomised design

Table 2: Analysis of Variance

Source	df	SS	MS	F
Treatments	**	**	**	**
Error	20	130.17	**	
Total	23	512.96		

- (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]
- A4.** The following ten observations are a sample from a normal population:
- 5.1 2.6 3.4 6.3 2.8  
4.5 5.9 1.7 3.7 8.0
- (a) Compute the mean and standard deviation of this sample. [6]
- (b) Test  $H_0 : \mu = 4$  versus  $H_1 : \mu \neq 4$ . [4]
- (c) Find a 99% confidence interval for the population mean  $\mu$ . [4]

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

- B5. (a) A machine is supposed to cut lengths of rod 50cm long. A sample of 20 rods gave the following results for the length of  $x$ :

$$\sum fx = 997$$

$$\sum fx^2 = 49711$$

(i) Calculate the mean length of the 20 rods. [3]

(ii) Calculate the variance of the lengths of the 20 rods. [4]

- (b) Given the following data set:

130 186 178 157 155 148 139 120 127 115 163 134

155 175 185 183 125 157 175 150 136 144 150 196

Present the data graphically using:

(i) a stem and leaf diagram, [4]

(ii) a histogram, [4]

(iii) a five number summary. [5]

- B6. The following Table 3 shows yields in hundreds of kg obtained from an experiment to compare four strains of finger millet in a randomised block design with four blocks where the blocking criterion was the soil fertility trend:

Table 3: Effects of soil fertility on yield

Finger Millet Strain	Blocks			
	I	II	III	IV
A	32.3	34.0	34.3	35.0
B	33.3	33.0	36.3	36.8
B	30.8	34.3	35.3	32.3
D	29.3	26.0	29.8	28.0

Using the 5% level of significance:

(a) Carry out an analysis of variance to test whether there are significant differences in mean yield among the four strains of finger millet. [15]

(b) Was blocking according to soil fertility trend of any significance? [5]

- B7.** A university wishes to analyse the performance of its students on a particular degree course. It records the scores obtained by a sample of 12 students at entry to the course, and the scores obtained in their final examinations by the same students. The results are shown in Table 4.

Table 4: Performance of students

Student	A	B	C	D	E	F	G	H	I	J	K	L
Entrance exam score $x(\%)$	86	53	71	60	62	79	66	84	90	55	58	72
Final paper score $y(\%)$	75	60	74	68	70	75	78	90	85	60	62	70

- (a) Plot a scatter diagram for the data and comment. [3]
- (b) Fit a straight line to the data by estimating the slope,  $\beta_1$ , and the intercept,  $\beta_0$ . Draw the fitted line on your scatter plot. [6]
- (c) Estimate the final paper score when the entrance exam score is 95%. [2]
- (d) Carry out an analysis of variance to test the significance of the slope at the 5% level of significance. [6]
- (e) Calculate the proportion of variation explained by the model. Hence, comment on the fit of the model. [3]

- B8.** 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 5:

Table 5: 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**