# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

SORS 1201

FACULTY OF APPLIED SCIENCE

**DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH**

SORS1201: APPLIED STATISTICS

MARCH 2025 EXAMINATION

Time : 3 hours

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.

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

(a) Weekly salaries of all employees of a company. [2]

(b) Cattle owned by 100 farmers in Gwanda. [2]

(c) A group of 25 patients selected to test new drug. [2]

(d) Number of computers sold during the past week at all computer stores in Mashonaland Province. [2]

**A2.** A survey was conducted to investigate the number of laptops distributed to 18 departments at a certain college. The following data represents the findings:
34 2 12 39 16 7 9 63 23 15 0 19 34 12 43 6 16 19

(a) Calculate the mean, [2]

(b) Calculate the standard deviation for the data. [3]

(c) Construct a box and whisker plot for the data and comment on the distribution of the data. [5]

**A3.** Three income groups are defined as high, medium and low. A sample of 250 households from Selborne Park and 150 households from Mahatshula was taken and recorded in the following contingency Table 1 showing information on their income.

Table 1: Income Groups

| | Income Group | | |
|---|---|---|---|
| | High income | Medium income | Low income |
| Selborne Park | 70 | 80 | 100 |
| Mahatshula | 34 | 40 | 76 |

Using the 1% significance level, test the null hypothesis that the distribution of households with regard to income levels is similar (homogeneous) for the two suburbs. [10]

**A4.** 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. [2]

(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? [6]

## SECTION B

**B5.** (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 3:

Table 3: 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 4:

Table 4: 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]

**B6.** Table 5 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 5: 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) Scatterplots give a visual impression of how two variables behave together. Draw diagrams showing relationships of variables that have a:

(i) strong negative linear relationship. [2]

(ii) weak positive linear relationship. [2]

(b) Most Zimbabwean power stations are coal-fired. Assume a random sample of 10 power stations was selected and their coal usage and electricity generated for 2021 was obtained and is as shown in Table 6.

Table 6: Coal usage and Electricity generated

| Coal used (million tonnes) | 15 | 6 | 10 | 18 | 9 | 7 | 14 | 11 | 5 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| Electricity generated (million Kwts) | 35 | 18 | 24 | 32 | 24 | 20 | 32 | 29 | 14 | 22 |

(i) Plot a scatter diagram for the data stating which one is the dependent variable and independent variable. Comment on your scatter diagram. [3]

(ii) Calculate the correlation coefficient for the two variables and comment. [3]

(iii) Fit the least squares regression line to the data. [4]

(iv) Estimate the level of electricity generated when coal usage is 10 tonnes. [1]

(v) Determine whether there is evidence to indicate a linear relationship between the two variables. [5]

**B8.** Aircraft primer paints are applied to aluminum surfaces by two methods; dipping and spraying. The purpose of the primer is to improve paint adhesion, and some parts can be primed using either application method. The process engineering group responsible for this operation is interested in learning whether three different primers differ in their adhesion properties. A factorial experiment was performed to investigate the effect of paint primer type and application method on paint adhesion. Three specimens were painted with each primer using each application method, a finish paint was applied and the adhesion force was measured. The data from the experiment are shown in Table 7:

Table 7: Paint primer type and application method on paint adhesion

| Primer Type | Dipping | Spraying |
|---|---|---|
| 1 | 4.0,4.5,4.3 | 5.4,4.9,5.6 |
| 2 | 5.6,4.9,5.4 | 5.8,6.1,6.3 |
| 3 | 3.8,3.7,4.0 | 5.5,5.0,5.0 |

Using a 0.05 level of significance,

(a) Construct a two way table of totals. [2]

(b) Carry out a preliminary ANOVA to test for the significance of treatment combinations. [6]

(c) Carry out a complete ANOVA to test for the significance of the main effects and interaction. [12]

END OF QUESTION PAPER