

The Open University of Sri Lanka  
Faculty of Engineering Technology  
Department of Agricultural and Plantation Engineering



Study Programme: Bachelor of Industrial Studies Honours (Agriculture)

Name of the Examination : Final Examination

**Course Code and Title : AGZ5367 Experimental Design**

Academic Year : 2024/2025

Date: 14.02.2026

Time: 13.30 to 16.30hrs

Duration: **3 hours**

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**General Instructions**

1. This is an **Open Book Test**.
2. This question paper consists of **six (6)** questions.
3. **Answer only four (4)** questions.
4. Read the questions carefully before answering.
5. Answer for each question should commence from a new page in the answer book.
6. Do not use red colour pens.

**In case of doubt, please consult the supervisor or an invigilator in the examination hall.**

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1.
  - i. Explain why hypothesis formulation is important before conducting an experiment. **(3 marks)**
  - ii. Explain the difference between independent variables and dependent variables. **(3 marks)**
  - iii. Explain how randomization and replication improve the reliability of an experiment. **(5 marks)**
  - iv. In an agricultural experiment, explain how the number of replications required would be decided **(6 marks)**
  - v. Compare and contrast factorial experiments and split-plot designs, highlighting their advantages, limitations, and typical applications in agricultural research. **(8 marks)**

2. A study was conducted to compare the effects of **three (03)** fertilizer levels on papaya yield. Eighteen papaya plants of the *Red Lady* variety, all of the same age and planted in rows with even space were selected from a field for this experiment. The three fertilizer treatments were randomly assigned to the plants. Yield data (kg per plant) were recorded annually, and the observed yields for each plant are presented in the table below.

|       | F1 | F2 | F3 |
|-------|----|----|----|
| Row 1 | 30 | 50 | 65 |
| Row 2 | 41 | 45 | 60 |
| Row 3 | 35 | 38 | 62 |
| Row 4 | 33 | 45 | 61 |
| Row 5 | 34 | 39 | 60 |
| Row 6 | 40 | 52 | 64 |

- Identify the experimental unit of this study. **(1 mark)**
  - How many replicates are there in the study? **(1 mark)**
  - If the papaya plants are grown in a field that is homogeneous in both directions, identify the most appropriate experimental design for this study and justify your answer briefly. **(2 marks)**
  - Describe the procedure used to randomly allocate fertilizer treatments to each experimental unit. **(2 marks)**
  - Suppose the papaya plants are arranged in three rows, and a moisture gradient exists from top to down within each row. Identify the most suitable experimental design under these conditions. Illustrate the experimental layout showing the random allocation of fertilizer treatments to each plant. **(3 marks)**
  - Clearly state the null and alternative hypotheses to be tested in this study. **(3 marks)**
  - Given that the correction factor and total sum of squares are 40,517.56 and 2,438.44 respectively, calculate the relevant sums of squares and construct the ANOVA table. Test the stated hypothesis at an appropriate level of significance and interpret the results. **(10 marks)**.
  - Calculate the mean square error for the design identified in part (c) and determine the relative efficiency of the design proposed in part (e). **(3 marks)**
3. A Research Officer (RO) wishes to evaluate the effect of four potassium levels ( $K_1$ ,  $K_2$ ,  $K_3$ , and  $K_4$ ) . yield of tomato plants grown under homogeneous greenhouse conditions. The experiment is planned with three replicates.
- Identify the most appropriate experimental design for this study and justify your choice. **(3 marks)**

- b. The treatment means (kg per plant) and the mean square error (MSE) obtained from the experiment are given below.

| Treatment | Mean (kg/plant) |
|-----------|-----------------|
| K1        | 23.00           |
| K2        | 24.00           |
| K3        | 29.00           |
| K4        | 30.00           |
| MSE       | 3.50            |

- i. Compare the treatment means using an appropriate mean separation technique **(6 marks)**.
  - ii. Present and interpret the results using a table with letter groupings. **(5 marks)**
- c. If the RO is specifically interested in comparing Treatment K<sub>1</sub> with each of the other treatments:
  - i. Identify the most suitable mean comparison method for this objective and justify your choice. **(3 marks)**
  - ii. Using the method proposed in part (d), compare the treatment means and interpret the results using letter notations. **(8 marks)**
4. A field experiment is planned to study the effects of tillage method and nitrogen fertilizer level on maize yield. Three tillage methods (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>) require heavy machinery and are difficult to change frequently, while four nitrogen levels (N<sub>1</sub>, N<sub>2</sub>, N<sub>3</sub>, N<sub>4</sub>) can be applied easily within smaller areas of land.
  - a. Which experimental design is most appropriate for this study? **(5 marks)**
  - b. Justify the choice of this experimental design, clearly identifying the different types of plots required. **(5 marks)**
  - c. Write the statistical model for the analysis of variance (ANOVA) for this experiment, clearly indicating the error terms. **(5 marks)**
  - d. Construct the ANOVA table for this experiment, showing only the sources of variation and their corresponding degrees of freedom. **(10 marks)**
5. A researcher conducts a study to examine the relationship between a farmer's **farm size category** and the **frequency of extension service visits** received during a cultivation season. The data below represent the responses obtained from a random sample of **200 farmers** included in the study.

| Farm size category | Number of visits |              |                    | Row sums |
|--------------------|------------------|--------------|--------------------|----------|
|                    | 0 visits         | 1 – 5 visits | More than 5 visits |          |
| Small              | 20               | 16           | 20                 | 56       |
| Medium             | 30               | 14           | 15                 | 59       |
| Large              | 45               | 28           | 12                 | 85       |
| Column sums        | 95               | 58           | 47                 | 200      |

- Write down the hypothesis to be tested. (5 marks)
  - Identify the independent variable and the dependent variable in the study? (2 marks)
  - Calculate the expected values of each of the observations. (10 marks)
  - What are the degrees of freedom and the Chi-Square value at the 5% level of significance for testing the hypothesis? (3 marks)
  - If the calculated Chi Square value is 10.16, test the hypothesis and interpret the results. (5 marks)
6. Suppose you want to study the effects of two different nitrogen levels on three tomato varieties.
- Which statistical design would be most suitable for testing the effects of nitrogen level and variety? (2 marks)
  - State one advantage of the experimental design selected in (a). (3 marks)
  - Using appropriate graphs, illustrate the following two situations: (5 marks)
    - An interaction between tomato variety and nitrogen level
    - No interaction between tomato variety and nitrogen level
  - Consider the following  $2 \times 3$  factorial experiment where treatments are arranged in a Completely Randomized Design (CRD).  
Calculate the sum of squares, construct the ANOVA table, and interpret the results. You may assume that the correction factor (CF) and the total sum of squares (TSS) are 18,753.39 and 1911.61, respectively. (15 marks)

| Treatment combinations | Replicates |    |    |
|------------------------|------------|----|----|
|                        | 1          | 2  | 3  |
| $N_1V_1$               | 20         | 15 | 18 |
| $N_1V_2$               | 22         | 26 | 20 |
| $N_1V_3$               | 25         | 33 | 35 |
| $N_2V_1$               | 50         | 47 | 45 |
| $N_2V_2$               | 42         | 38 | 37 |
| $N_2V_3$               | 36         | 33 | 39 |