



Strathmore
UNIVERSITY

STRATHMORE INSTITUTE OF MATHEMATICAL SCIENCES

MASTER OF SCIENCE IN STATISTICAL SCIENCES

END OF SEMESTER EXAMINATION

STA 8304: DESIGN OF EXPERIMENTS

DATE: 30th August 2022

Time: 2 Hours

Instructions

1. This examination consists of **FOUR** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

Question 1 (20 marks)

- a) Differentiate between
 - i. Experimental group and control group **(2 marks)**
 - ii. Observational unit and experimental unit **(2 marks)**
- b) The table below contains the results of a completely randomized design experiment. Test the hypothesis that the means for the different treatments are all the same. **(11 marks)**

| Treatment | Rep 1 | Rep 2 | Rep 3 |
|------------------|--------------|--------------|--------------|
| Treatment 1 | 16 | 17 | 20 |
| Treatment 2 | 12 | 14 | 10 |
| Treatment 3 | 10 | 8 | 9 |
| Treatment 4 | 9 | 4 | 3 |

- c) Red clover plants were inoculated with 6 strains of Rhizobium and the nitrogen content of the plants was later determined. Each treatment was replicated 5 times and the experiment was conducted as a completely randomized design. The analysis of variance indicated that there was a highly significant difference between strains. The MSE was 11.79. The treatment means are given in the table below.

| | Rhizobium strains | | | | | |
|-----------------------|-------------------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Mean Nitrogen content | 28.8 | 24.0 | 14.6 | 19.9 | 13.3 | 19.4 |

Compare the treatment means using the Least Significance Difference (LSD) with strain 4 as the reference Strain **(3 marks)**

- d) What are orthogonal contrast **(1 mark)**
- e) What would you consider to be the main objective of the Response Surface Methodology (RSM) **(1 mark)**

Question 2 (20 marks)

- a) Why is randomization important in an experiment? **(3 marks)**
- b) State and explain three basic principles of an experimental design **(6 marks)**
- c) An experimenter randomly allocated 125 male turkeys to five treatment groups: control and treatments A, B, C, and D. There were 25 birds in each group, and the mean results were 2.16, 2.45, 2.91, 3.00, and 2.71, respectively. The sum of squares for experimental error was 153.4. Test the null hypothesis that the five-group means are the same against the alternative that one or more of the treatments differs from the control. **(11 marks)**

Question 3 (20 marks)

- a) What is a two factor factorial design **(2 marks)**
- b) State and explain three advantages of a factorial design **(6 marks)**
- c) The data below is from a complete randomized block design with 3 treatments A, B, and C on 3 blocks. Test whether there is a significant difference in the treatment means. **(12 marks)**

| 1 | 2 | 3 |
|--------|--------|--------|
| 6 (A) | 10 (A) | 12 (B) |
| 4 (B) | 13 (C) | 16 (C) |
| 15 (C) | 6(B) | 12 (A) |

Question 4 (20 marks)

The two tables below show results from repeated experiments using two different multiple-factor experimental design: factorial design and spit-plot design.

| Table 1: Analysis of Variance table for factorial design | | | | | Table 2: Analysis of Variance table for split-plot design | | | | |
|----------------------------------------------------------|--------------------|----------|----|---|-----------------------------------------------------------|--------------------|----------|----|---|
| Source of variation | Degrees of freedom | SS | MS | F | Source of variation | Degrees of freedom | SS | MS | F |
| Factor A | 2 | 166.2917 | * | * | Main plot (A) | 2 | 168.2917 | * | * |
| Factor B | 3 | 371.5 | * | * | Error (A) | 9 | * | | |
| Interaction between A and B | 6 | 183.375 | * | * | Subplot B | 3 | 371.5 | * | * |
| Error | 36 | * | * | | Interaction between A and B | 6 | 183.375 | * | * |
| TOTAL | 47 | 1,283.67 | | | Error (B) | 27 | 263.625 | * | |
| | | | | | TOTAL | 47 | 1,283.67 | | |

- Fill the spaces marked with * (8 marks)
 - Test for factor A, B and interaction effects in the table 1 (6 marks)
 - Test for the effect of the subplot B in table B (2 marks)
- Which of the two designs is the most efficient based on their coefficient of variation values? (4 marks)