2026

STATISTICS — MINOR

Paper : MN-4

(Design of Experiments I and Sample Survey I)

Full Marks : 75

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer ***any five*** questions : 2×5

(a) Define the term 'experimental error' in the context of agricultural field experiments.

(b) Differentiate between fixed effects and random effects models.

(c) State the primary purpose of conducting a uniformity trial.

(d) Why is the Latin Square Design (LSD) considered a two-way elimination of heterogeneity?

(e) Distinguish between sampling error and non-sampling error.

(f) What is snowball sampling? When is it typically used?

(g) Write down the probability of selecting a specific sample of size n from a population of size N using Simple Random Sampling With Replacement (SRSWR).

(h) Define purposive sampling with a real-world example.

2. Answer ***any four*** questions : 5×4

(a) Explain the three basic principles of experimental design as formulated by R.A. Fisher.

(b) Show that in a one-way analysis of variance (ANOVA) with equal observations per cell, the sum of squares due to error and sum of squares due to treatments are independently distributed.

(c) Describe the missing plot technique in a Randomized Block Design (RBD) when one observation is missing. Derive the formula for the estimated value of the missing observation.

(d) Describe how you would use a random number table to select a sample of 15 households from a village containing 450 households.

(e) Derive the standard error of the sample mean under Simple Random Sampling Without Replacement (SRSWOR).

(f) Explain the concept of Two-Stage Sampling where primary units are of equal size. Give a practical scenario where this technique is applicable.

3. Answer ***any three*** questions :

(a) (i) Set up the linear statistical model for a two-way classified data with one observation per cell. State your assumptions clearly.

(ii) Derive the least-squares estimates of the parameters and construct the complete Analysis of Variance (ANOVA) table for this model. 5+10

(b) (i) Provide the statistical model, underlying assumptions and layout preparation for a Latin Square Design (LSD).

(ii) Derive the formula for estimating one missing value in an $m \times m$ Latin Square Design. Explain how this missing value affects the final ANOVA table analysis. 6+9

(c) (i) Prove that under SRSWOR, the sample mean square (s^2) is an unbiased estimator of the population mean square (S^2).

(ii) If a population has a proportion P of individuals possessing a certain attribute, find the unbiased estimator of the variance of the sample proportion p under SRSWOR. 8+7

(d) (i) In stratified random sampling, ignore costs and derive the expression for the allocation of sample sizes to different strata that minimizes the variance of the estimated population mean (Neyman/Optimum Allocation).

(ii) Compare the precision of stratified random sampling under proportional allocation with that of a Simple Random Sampling of the same total sample size taken from the entire population. 9+6

(e) (i) Discuss the relative merits and demerits of a complete enumeration (census) versus a sample survey. Under what conditions is a sample survey preferred?

(ii) For a two-stage sampling design with N primary sampling units (PSUs) each containing M secondary sampling units (SSUs), find an unbiased estimator for the population total when n PSUs and m SSUs are selected at random without replacement. 8+7
