

2026

STATISTICS — HONOURS

Paper : DSCC-8

(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.*

Group - A

Answer **any five** questions.

2×5

1. Distinguish between fixed and random effects with one example each.
2. Why randomization is considered the basis of valid statistical inference in experimental design?
3. An RBD consists of 6 treatments and 8 blocks. The calculated F-value for treatments is 5.12. If the tabulated value at 5% level is 2.66, what conclusion will you draw?
4. How random numbers are used to select population units randomly in a sample? Explain with an example.
5. Give one practical situation where snowball sampling is more appropriate than simple random sampling.
6. Explain the difference between sampling error and non-sampling error with one example each.
7. Two SRSWOR samples of unequal sizes are drawn independently from a population. Which sample mean is expected to have smaller variance? Justify.
8. What is finite population correction (FPC)? When is it important?

Group - B

Answer **any four** questions.

5×4

9. Consider the one-way fixed effects ANOVA model,

$$y_{ij} = \mu + \alpha_i + \epsilon_{ij}, j = 1, 2, \dots, 6, i = 1, 2, \dots, 10,$$

where notations have usual meanings and ϵ_{ij} are i.i.d. with $E(\epsilon_{ij}) = 0$.

Show that $\sum_{i=1}^{10} l_i \bar{y}_{i0}$ unbiasedly estimates $\sum_{i=1}^{10} l_i \alpha_i$ when $\sum_{i=1}^{10} l_i = 0$ and $\sum_{i=1}^{10} \alpha_i = 0$.

Please Turn Over

(7158)

10. Derive the variance of the estimator of the population proportion π under SRSWOR and compare it with that under SRSWR.
11. A researcher wishes to estimate the average CGPA of post-graduate students of a University. The students belong to the Science, Social Science and Commerce faculties. Instead of selecting students randomly from the entire University, the researcher first divides the students according to faculty and then selects students independently from each faculty by SRSWOR.
- Identify the sampling design.
 - Explain why faculty is a suitable stratification variable.
 - State two advantages of this design.
 - Give an unbiased estimator of the overall average CGPA.

12. An agricultural scientist compares four fertilizers using a CRD and assumes the following linear model :

$$y_{ij} = \mu + \tau_i + \epsilon_{ij}, j = 1, 2, \dots, 6, i = 1, 2, 3, 4.$$

where notations have usual meanings. If it is known that $\sum_{i=1}^4 \tau_i = 0$, ϵ_{ij} are i.i.d. with $E(\epsilon_{ij}) = 0$ and $Var(\epsilon_{ij}) = \sigma^2$, write down the expression of SSE and find its expected value.

13. An SRSWR (n) sample is selected from a population of N units. Find the probability that a specified unit is selected exactly $(n - 1)$ times.
14. A researcher proposes the following two sampling designs for estimating the average annual income of households in a district with 100 villages.

Method I : Select 600 households directly by SRSWOR.

Method II : Select 40 villages by SRSWOR and then select 15 households from each selected village by SRSWOR.

Discuss which sampling method you would recommend from above under each of the following situations :

- A complete list of all households is unavailable.
- The travel cost between villages is very high.
- Households within the same village have similar incomes.

Justify your answers.

Group - C

Answer **any three** questions.

15. A biologist studies the effects of four fertilizers and three irrigation schedules taking 6 observations on each combination.
- Write down the statistical model with all necessary assumptions.
 - Develop a test procedure for testing the absence of treatment effects.

5+10

16. (a) Explain the analysis of an RBD with one missing observation.
 (b) Explain the principle of optimum allocation in stratified random sampling and derive the appropriate optimum allocation formula when unit costs differ among strata. 10+5
17. A public health department wishes to estimate the average number of children vaccinated in a district. Instead of preparing a list of all children, it first selects 25 villages by SRSWOR. From each selected village, it selects 15 children by SRSWOR.
 (a) What are the first-stage and second-stage sampling units?
 (b) Mention two practical advantages of this design over SRSWOR of all children.
 (c) Give an unbiased estimator of the average number of children vaccinated and derive its variance. 3+2+10
18. A pharmaceutical company wishes to compare five formulations of a drug. Thirty patients are randomly allocated equally among the formulations.
 (a) Suggest a suitable design for the above with proper justification. State the statistical model with all necessary assumptions.
 (b) Develop a procedure for testing the significance of treatment effects.
 (c) If your conclusion in (b) is that the treatments differ significantly, how do you identify the treatment performing best? 4+6+5
19. (a) With reference to a one way fixed effects ANOVA model with usual assumptions, derive

$$\text{Cov}(\bar{e}_{i0} - \bar{e}_{00}, e_{ij} - \bar{e}_{i0}),$$
 where e_{ij} are unobserved and uncorrelated errors and $\bar{e}_{i0} = \left(\frac{1}{n_i}\right) \sum_j e_{ij}$, $\bar{e}_{00} = \sum_i n_i \bar{e}_{i0} / \sum_i n_i$.
 (b) Explain the concept of uniformity trial. How can it be used to compare the efficiencies of CRD, RBD and LSD? 8+7