

**M. SC. (APPLIED STATISTICS)
(MSCAST)**

Term-End Examination

June, 2026

**MST-020 : SURVEY SAMPLING AND DESIGN
OF EXPERIMENTS—II**

Time : 3 Hours

Maximum Marks : 50

Note : (i) *Question No. 1 is compulsory.*

(ii) *Attempt any **four** questions from the remaining Question Nos. 2 to 6.*

(iii) *Use of Scientific Calculator (Non-programmable) is allowed.*

(iv) *Symbols have their usual meanings.*

1. State whether the following statements are True or False. Give reasons in support of your answers : 5×2=10

(a) The Ratio estimator $\hat{R}$ becomes unbiased if correlation between y and x is zero.

- (b) As the sample size increases in cluster sampling the sampling error also increases.
 - (c) If the number of cluster of size $M = m$ selected is equal to the total number of clusters in the population, then cluster sampling becomes two-stage sampling.
 - (d) The error degree of freedom for a 2^2 -Factorial Experiment conducted in 6 randomized blocks is 15.
 - (e) A block design with $v = b = 8$ and $r = k = 3$ is a Balanced Incomplete Block Design.
2. (a) Define the ratio estimators for (i) Population mean and (ii) Population total. Using the large sample approximation theory, obtain the expressions for the biases of both the estimators.

- (b) In a population of size 500, a preliminary sample of size 50 was selected from the population directly with the aim to estimate the population mean of the auxiliary variable X. The sample mean of X in this sample was found to be 670. On the basis of another sample of size 40, selected from the preliminary sample the following sample values were obtained :

$$\bar{y} = 740, \quad \bar{x} = 865, \quad s_y^2 = 9560, \\ s_x^2 = 15300, \quad s_{xy} = 30540 \cdot 2.$$

Obtain the value of regression estimate of the population mean using the double sampling. 4

3. (a) Obtain the expression of the sampling variance of the suggested estimator of population mean in cluster sampling with equal size of clusters. Also obtain the unbiased estimate of the sampling variance. 6

- (b) Define the estimator of the population mean in two-stage sampling. A population of 6 clusters of elementary units each of which consists of 6 elementary units. A sample of 3 clusters from the population was selected at the first stage sampling and then from each of the selected clusters, 3 units were selected in order to constitute the second stage sample. Mention the size of the ultimate sample. 4
4. (a) In a 2^2 -Factorial Experiment with two factors A and B, each with two levels (a_0, a_1) and (b_0, b_1) respectively. Find and define the simple effects, main effects of factors and interaction effect of AB. Also define the contrasts of the treatment means. 5
- (b) Considering a 2^3 -Factorial Experiment, show how would you find a one-half Fractional Factorial Experiment. 5

5. Define Residual and Derived Balance Incomplete Block Designs of a given symmetric Balanced Incomplete Block Design. Mention the rules of construction of a Residual Balanced Incomplete Block Design corresponding to a specific Balanced Incomplete Block Design. Let $X = \{1, 2, 3, 4, 5\}$ and $A = \{1, 2, 3\}$, $\{1, 2, 4\}$, $\{1, 2, 5\}$, $\{1, 3, 4\}$, $\{1, 3, 5\}$, $\{1, 4, 5\}$, $\{2, 3, 4\}$, $\{2, 3, 5\}$, $\{2, 4, 5\}$, $\{3, 4, 5\}$; then (X, A) is a $(5, 3, 3)$. Balance Incomplete Block Design. Find the incidence matrix of this Balance Incomplete Block Design. 10
6. Write short notes on the following : 10
- Randomized Response Technique
 - Product Method of Estimation
 - Split-Plot Design
 - Response Surface Design

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