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MST-020

M. SC. (APPLIED STATISTICS)
(MSCAST)

Term-End Examination

December, 2025

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 (non-programmable) calculator is allowed.*

(iv) *Symbols have their usual meanings.*

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P. T. O.

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

- (a) If Number of treatments $v = 5$, Number of blocks $b = 10$, Size of each block $k = 3$ and Number of replications per treatment $r = 6$ are given, then it is a Balanced Incomplete Block Design (BIBD).
- (b) A one-half fractional design of the 2^6 -factorial experiment is denoted by 2^3 -factorial design.
- (c) If all the elementary units belonging to the selected clusters are selected at the second-stage sample, then two-stage sampling reduces to cluster sampling.
- (d) Cluster sampling would be more efficient than SRSWOR scheme, when $S^2 < \overline{MS}_b^2$.
- (e) If $C_y = 290.90$ and $C_x = 472.00$, then product estimator would be more efficient than simple mean estimator.

2. (a) Obtain the approximate bias and mean square error of the double sampling ratio estimator of population mean. 7
- (b) In a population of size 500, a preliminary sample of size 50 was related 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 the another sample of size 40, selected from the population, the following sample values were obtained :

$$\bar{y} = 740, \bar{x} = 865, s_y^2 = 9560, s_x^2 = 15300$$

and $s_{yx} = 30540.2$.

Estimate the population mean using double sampling regression method of estimation. 3

3. (a) Explain the method of selection of a sample using two-stage sampling with an example. Mention what do you mean by first-stage units and second-stage units in two-stage sampling. 4

- (b) A population consisting of 6 clusters, each of size 6. The values of the study variable Y, noted on each of the units within each cluster are given below. A random sample of size 3 clusters was selected from the population and 3 elementary units from the selected clusters are randomly chosen :

Cluster	Y-values
1	2, 4, 6, 1, 3, 5
2	2, 5, 3, 4, 7, 4
3	4, 3, 6, 2, 1, 5
4	3, 2, 5, 1, 6, 4
5	2, 4, 6, 8, 3, 5
6	4, 1, 2, 7, 5, 3

Estimate the population mean based on the cluster sampling and compare it with the actual value of the population mean. 6

4. (a) What is the concept of a fractional factorial experiment ? Explain the one-half fraction of a 2^k ($k \leq 5$) factorial experiment. 6

- (b) Explain how the main effects and two-factor interaction effects can be represented in terms of treatment combinations for the fractional factorial design. 4
5. (a) Define a Balanced Incomplete Block Design (BIBD) and mention its parameters with their meanings. Give an example of a Balanced Incomplete Block Design. 5
- (b) Let us consider the following Balanced Incomplete Block Design (BIBD) with parameters $v = b = 7$, $r = k = 4$, $\lambda = 2$:

Block Label	Design
I	1, 3, 4, 5
II	1, 4, 6, 7
III	1, 2, 5, 7
IV	3, 5, 6, 7
V	2, 3, 4, 7
VI	1, 2, 3, 6
VII	2, 4, 5, 6

Obtain a derived design from the above Balance Incomplete Block Design (BIBD) and find the parameters of the obtained design. 5

6. (a) Define a product estimator for the parameter $P = \bar{X}.\bar{Y}$ and obtain the Mean Square Error (MSE) of the estimator. 6

- (b) Explain the term 'Design Resolution'. Discuss different types of resolution of design. 4

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