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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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1. State whether the following statements are True *or* False. Give reasons in support of your answers : 5×2=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-factorical 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 $S^2 < M\bar{S}_b^2$.

   (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 $P = \overline{X}.\overline{Y}$ 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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