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MST–020

M. SC. (APPLIED STATISTICS)
(MSCAST)
Term-End Examination
June, 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 Q. 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 difference estimator $\hat{\bar{Y}}_D$ is always more efficient than the product estimator $\hat{\bar{Y}}_P$ provided $R \neq \beta$.

(b) The Double Sampling Ratio estimator $\hat{\bar{Y}}_{RD}$ of population mean $\bar{Y}$ is more efficient than the sample mean $\bar{y}$ estimator using SRSWOR under the condition $\rho\frac{C_Y}{C_X} > \frac{1}{2}$.

(c) In two-stage sampling if $n = N$, the two-stage sampling becomes the cluster sampling.

(d) If in a 3^2-factorial experiment, 9 treatment combinations are produced, then the 3^3-factorial experiment produces 18 treatment combinations.

(e) Under the split-plot design, in second stage analysis or sub-plot analysis, the degree of freedom for sub-plot error (E_{II}) is $(p - 1)(q - 1)$.

2. (a) Distinguish between Difference Estimator and Regression Estimator of population mean. 5

(b) In a population of size 500, the population mean of the auxiliary variable X was observed to be 834. On the basis of a sample of size 40, the following sample values were obtained :

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

and $s_{xy} = 30540$.

Obtain the values of the regression estimate and the ratio estimate of the population mean on the basis of the given data. 5

3. (a) What do you mean by Cluster Sampling ? Describe the method of selection of sample of n clusters from the population of N clusters. Suggest the estimator of the population mean. 3

(b) Following data consider a population of 10 clusters of size 3 each, presenting a bunch of students of standard IV in a school. The marks obtained by students in a competitive test (out of 75 marks) have been shown in the dataset. Find

the Relative Efficiency (RE) of the cluster sampling with respect to the Simple Random Sampling Without Replacement scheme : 7

1	56, 34, 28
2	70, 56, 30
3	12, 57, 30
4	24, 70, 35
5	09, 44, 59
6	25, 69, 70
7	14, 38, 50
8	74, 47, 65
9	14, 48, 62
10	56, 59, 39

4. In order to obtain the idea of interation effects of two factors A and B, each available at two levels, a 2^2-factorial experiment was conducted in six randomised blocks. The plan and yields of the experiment are given

below. Analyse the design for finding out if there are any significant treatment effects either main or interaction :

Block–I

a_1b_1	a_1b_2	a_2b_2	a_2b_1
50	46	52	40

Block–II

a_2b_2	a_1b_1	a_1b_2	a_2b_1
39	42	47	49

Block–III

a_1b_1	a_2b_1	a_1b_2	a_2b_2
47	51	42	45

Block–IV

a_2b_2	a_2b_1	a_1b_2	a_1b_1
51	50	47	40

Block–V

a_2b_2	a_1b_2	a_1b_1	a_2b_1
55	48	53	57

Block–VI

a_2b_1	a_1b_1	a_2b_2	a_1b_2
55	52	47	54

(Given that : $F_{(5,15)\ 5\%} = 2.90$ and $(F_{(1,\ 15)5\%} = 4.54)$. 10

5. (a) What is meant by the Incidence Matrix of a Balanced Incomplete Block Design (BIBD) ? Explain how would you obtain the Incidence Matrix of a Balanced Incomplete Block Design. 6

(b) The following table depicts an Incomplete Block Design with $b = 8$, $k = 3$, $\theta = 8$, $r = 3$:

Block	Treatment Labels
I	1 3 8
II	2 4 1
III	3 5 2
IV	4 6 3
V	5 7 4
VI	6 8 5
VII	7 1 6
VIII	8 2 7

Check whether it is a Balanced Incomplete Block Design ? Give the reason(s) of your answer. 4

6. (a) Mentioning the working processes of varietal trials and factorial approach, differentiate between them. 5

(b) Using the large sample approximation theory, obtain an expression for finding the approximate bias of the ratio estimator of population mean. Show that the estimator becomes almost unbiased if the regression line of Y on X passes through the origin. 5

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