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MST-013

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

Term-End Examination

June, 2024

**MST-013 : SURVEY SAMPLING AND DESIGN OF
EXPERIMENTS-I**

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.*

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

(a) Sampling error occurs in both census and sample survey.

(b) In systematic sampling, first k units are selected randomly and remaining $(n - k)$

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units are selected in a systematic way, where $k = N/n$ and $k > 1$ is an integer.

- (c) The error degrees of freedom in an one-way analysis of variance of population means at 4 levels of a factor with total 20 observations will be 16.
 - (d) If there is one missing value in a Latin Square Design with 4 treatments, the error degrees of freedom will be 5.
 - (e) If strata are heterogeneous within themselves, then stratified sampling scheme provides estimates with greater precision.
2. A population has 7 units 1, 2, 3, 4, 5, 6 and 7. List all possible random samples of size 2 using SRSWOR, which can be drawn from the given population. Show that sample mean is an unbiased estimator of the population mean. Compare the sampling variance of the sample mean estimator under SRSWOR and SRSWR.

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3. A random sample of 60 persons is to be drawn from a population consisting of 600 persons belonging to two villages A and B. The mean

and standard deviation of their daily wages (in ₹) are given below :

| Village | Stratum size (N_i) | Mean (\bar{X}_i) | Standard Deviation (σ_i) |
|---------|------------------------|----------------------|-----------------------------------|
| A | 400 | 60 | 20 |
| B | 200 | 120 | 80 |

Obtain the sample sizes for each village using proportional and Neyman allocations. Also obtain the variances of the sample mean estimator under both allocations. 10

4. An experiment is performed to determine the effect of two advertising campaigns on three kinds of cake mixes. Sales of each mix were recorded after the first advertising campaign and then after the second advertising campaign. This experiment was repeated three times for each advertising campaign and the following results were obtained :

| | Campaign I | Campaign II |
|-------|---------------|------------------|
| Mix 1 | 574, 564, 550 | 1092, 1086, 1065 |
| Mix 2 | 524, 573, 551 | 1028, 1073, 998 |
| Mix 3 | 576, 540, 592 | 1066, 1045, 1055 |

Perform an analysis of variance technique to determine at 5% level of significance whether there is a significant difference (a) between the cake mixes and (b) between the campaigns. 10
 [You may use $F_{(1,12)} = 6.55$ and $F_{(2,12)} = 5.10$]

5. An experiment was planned to study the effect of sulphate, potash and superphosphate on the yield of potatoes. All the combinations of two level of superphosphate [0 cent (p_0) and 5 cent (p_1)/acre] and two levels of sulphate and potash [0 cent (k_0) and 5 cent (k_1)/acre] were arranged in a randomised block design with 4 replications each. The yields (in/kg) obtained are as follows :

| Blocks | Yields | | | |
|--------|--------|-----|-----|------|
| | 1 | k | p | kp |
| I | 23 | 25 | 22 | 38 |
| II | 26 | 36 | 40 | 38 |
| III | 29 | 20 | 20 | 30 |
| IV | 28 | 31 | 24 | 34 |

Analyse the data and give your conclusions at $\alpha = 0.05$.

[You may use $F_{(3,9)} = 5.08$]

6. (a) 30 books of Statistics are arranged in serial numbers 1 to 30 in a library. Select all possible systematic random samples of 10 books. 3
- (b) The following figures related to production (in kg) of three varieties P, Q and R of rice in 12 plots :

| | | | | | | |
|---|---|----|----|----|----|----|
| P | : | 14 | 16 | 16 | | |
| Q | : | 14 | 13 | 15 | 22 | |
| R | : | 18 | 16 | 19 | 15 | 20 |

Is there any significant difference in the production of these varieties at 5% level of significance ? 7

[You may use $F_{(2,9)} = 5.71$]