



RAN-2403081803033001

M. Sc. (Sem. - III) Examination October - 2025 Applied Statistics (Paper - MAS:303) Sampling Theory - II

Time: 3 Hours]

[Total Marks: 70

સૂચના : / Instructions

- (1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the above details on your answer book.
- (2) Attempt all questions.
- (3) Each question carries 14 marks.
- (4) Answer any two out of the three bits given in each question.
- (5) Draw the figure and give example wherever necessary.

Seat No.:

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Student's Signature

- Q. 1.** i. Prove or disprove that a systematic sample has same precision as compared to stratified random sample with one unit per stratum if $\rho_{wst} = 0$.
- ii. In usual notations, show that the mean of a systematic sample is more efficient than the mean of a simple random sample if $S_w^2 > S^2$. State the main drawback of this sampling scheme.
- iii. Discuss a comparison of systematic sampling with SRS and stratified random sampling under linear trend.
- Q. 2.** i. Explain the rationale behind the use of auxiliary variable X, highly negatively correlated to the character under study Y. Construct the product estimator for population total based on a SRSWOR sample. Obtain its bias and variance of the proposed estimator,
- ii. Define regression estimator with pre-assigned b_0 for finite population mean. Compare its efficiency with that of mean per unit estimator, after obtaining required expressions.
- iii. What is the rationale behind the use of ratio method of estimation? Obtain MSE to the first order of approximation for the ratio estimator defined to estimate the population mean. Derive the condition under which it will be at least equivalent to the regression estimator.
- Q. 3.** i. Why do we need two stage sampling? Explain the process to get a two stage sample with real life applications. Discuss estimation of the population mean under two stage sampling with unequal sized PSUs.
- ii. Write a detailed note on two stage sampling with unequal PSUs.
- iii. Discuss double sampling for regression estimator in detail.
- Q. 4.** i. Discuss the planning of a survey on "Assessing Smartphone Usage Patterns Among College Students registered with VNSGU".
- ii. Discuss the planning of a survey on "Estimating Household Expenditure on Online Shopping in Semi-Urban Areas of Gujarat".
- iii. Discuss the planning of a survey on "Estimating the Average Daily Commuting Time of Office Workers in a Metro City".

- Q. 5.** i. What is PPS sampling? What is the rationale behind the use of it? Explain its methods.
- ii. Discuss the justification for using varying probability of selection in surveys. If π_i and π_{ij} denote the inclusion probabilities when a sample of size n is selected with varying probabilities and without replacement from a population of size N , prove the following:
- i.
$$\sum_{i=1}^N \pi_i = n$$
- ii.
$$\sum_{i(\neq j)=1}^N \pi_{ij} = (n-1) \pi_j$$
- iii.
$$\sum_{i(\neq j)=1}^N \sum_{j=1}^N \pi_{ij} = n(n-1)$$
- iii. Define Horvitz-Thompson (H-T). Obtain the expression of variance this estimator. State the unbiased estimator of this variance suggested by Horvitz-Thompson.
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