

6. In two stage sampling with simple random sampling without replacement at both stages, an unbiased estimator of Y is

$$\bar{Y} = \frac{N}{n} \sum_{i=1}^n \frac{M_i}{j=1} y_{ij}$$

Derive the variance of the above estimator.

7. Clearly state the procedure of drawing a sample random sampling without replacement of n clusters from a population of N clusters each containing M elements, derive an unbiased estimator of the parameter \bar{Y} , population mean per element.
8. Describe census and sample survey. Write down the advantages of sample survey over census. Write down the major steps involved in a sample survey.
9. Explain the terms – factor, experimental units, treatment and experimental error with suitable examples.
10. Write down (a) layout of two way ANOVA with its assumptions, (b) effect model and (c) ANOVA table.
11. In a single factor model $y_{ij} = \mu + \tau_i + e_{ij}$, show that

$$\sum_{i=1}^a \sum_{j=1}^n (y_{ij} - \bar{y})^2 = n \sum_{i=1}^a (\bar{y}_i - \bar{y})^2 + \sum_{i=1}^a \sum_{j=1}^n (y_{ij} - \bar{y}_i)^2.$$

What is the significance of this result in experimental design?

12. Fill in the (_____) in the following ANOVA table of Latin Square Design.

Source of variation	Sum of squares	Degrees of freedom	Mean square	F-Value
Rows	_____	72	_____	2
Columns	_____	_____	36	_____
Treatments	_____	180	_____	_____
Error	6	_____	12	_____
Total	_____	_____	_____	_____

13. The results of 2^2 experiment with 3 replications are presented below. Estimate the main effects, interaction effects, SS_A , SS_B and SS_{AB} . Which effects appear to be large?

Treatment Combination	Replication		
	I	II	III
(1)	22	30	25
A	32	42	29
B	35	33	50
ab	55	45	46