6. In pps with replacement sampling, show that an unbiased estimator of population total Y is

$$\hat{Y}_{pps} = \frac{1}{n}\sum_{i=1}^{n}\frac{y_i}{p_i}.$$

Derive the expression for the variance of $\hat{Y}_{pps}$.

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

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

What would be the above expression if $M_i = M$ and $m_i = m$ for all i?

8. What is questionnaire? Explain. Write down the pre-requisites of a good questionnaire?

9. Write down the principles of experimental design.

10. 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?

11. Consider the partially completed ANOVA table below. Complete the ANOVA table and answer the followings. What design was employed? How many treatments were compared? How many observations were analyzed? At the 0.05 level of significance, can one conclude that the treatments have different effects? Why?

Source	SS	df	MS	F
Treatments	231.50	2		
Blocks		7		
Error	573.75			
Total	903.75	23		

12. Write down statistical model for a Latin Square Design (LSD) and explain it. Also, write down the ANOVA table for LSD.

13. Write down the four treatment combinations of 2^2 experiment using standard notations. Write down the expressions for computing main effects, interaction effect, SS_A, SS_B and SS_{AB} if experiment is replicated r times.