

**B.Sc. (Honours) Examination, 2019**  
**Semester-IV**  
**Statistics**  
**Course : CC-9**  
**(Linear Models)**

**Time : 3 Hours**

**Full Marks : 40**

Questions are of value as indicated in the margin

Answer **any four** questions

1. Let  $y_1, y_2, y_3$  are three uncorrelated random variables having common variance  $\sigma^2$ . If

$$E(y_1) = \theta_1 - \theta_2$$

$$E(y_2) = 2\theta_1 + \theta_2$$

$$E(y_3) = \theta_1 - 2\theta_2$$

Obtain the unbiased estimators of  $\theta_1$  and  $\theta_2$ . Also obtain their variances and the covariances. Are your above obtained estimates have minimum variances? If not then indicated how can you obtain that. 10

2. Consider the Gauss Markov Model

$$E(y_1) = 2\theta_1 + \theta_2$$

$$E(y_2) = \theta_1 - \theta_2$$

$$E(y_3) = \theta_1 - \alpha\theta_2$$

With usual assumptions. Determine  $\alpha$  such that the best linear estimartess (BLUEs) of  $\theta_1$  and  $\theta_2$  are uncorrelated. 10

3. a) Clearly state the assumptions that are made in the analysis of variance. 3  
 b) State how violations of these assumptions affect the analysis and how the violations in the assumptions may be avoided. 7
4. Describe how would you test for the relationship between two variables using ANOVA technique. 10
5. Show that for a set of two-way classified data with one observation per cell having the model set up. 10

$$y_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$$

with  $\sum_i \alpha_i = \sum_j \beta_j = 0$  and  $e_{ij} \stackrel{iid}{\sim} N(0, \sigma^2)$  the following is true

$$\sum_i \sum_j (y_{ij} - \mu - \alpha_i - \beta_j)^2 = pq(\bar{y}_{00} - \bar{\mu})^2 + q \sum_i (\bar{y}_{i0} - \bar{y}_{00} - \alpha_i)^2 + p \sum_j (\bar{y}_{0j} - \bar{y}_{00} - \beta_j)^2 + \sum_i \sum_j (y_{ij} - \bar{y}_{i0} - \bar{y}_{0j} + \bar{y}_{00})^2$$

Use the above relation to obtain the least square estimates of the parameter of the model. Use this to obtain also SSE, SSA and SSB.

(2)

6. a) When would you use ANCOVA model? Under one way lay out with fixed effect model and one concomitant variable state the ANCOVA model clearly and explain how the hypothesis of equality of factor effects can be tested. 8
- b) Give two real life examples where ANCOVA model would be appropriate to apply. 2
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