

**4 SEM TDC STSH (CBCS) C 9**

**2 0 2 2**

( June/July )

**STATISTICS**

( Core )

Paper : C-9

**( Linear Models )**

Full Marks : 50

Pass Marks : 20

Time : 2 hours

*The figures in the margin indicate full marks  
for the questions*

1. Choose the correct answer from the alternatives given in each question :  $1 \times 5 = 5$

(a) In the linear model,  $y = X\beta + \epsilon$ , the Gauss-Markov setup can be expressed as

(i)  $(y, X\beta, \sigma^2 I)$

(ii)  $E(y) = X\beta$  and  $\text{cov}(y) = \sigma^2 I$

(iii)  $E(\epsilon) = 0 \forall X$  and  $\text{cov}(\epsilon) = \sigma^2 I$

(iv) All of the above

- (b) In multiple linear regression model
- (i) if  $R^2 = 0$ ,  $F = 0$
  - (ii) larger the  $R^2$ , greater the  $F$  value
  - (iii) in the limit when  $R^2 = 1$ ,  $F$  is infinite
  - (iv) All of the above
- (c) In ANOVA, test of significance is done with the help of
- (i)  $F$ -test
  - (ii)  $\chi^2$ -test
  - (iii)  $t$ -test
  - (iv) None of the above
- (d) ANCOVA is a combination of
- (i) ANOVA and correlation analysis
  - (ii) ANOVA and regression analysis
  - (iii) correlation and regression analysis
  - (iv) None of the above
- (e) For a set of explanatory variables  $X_2$  and  $X_3$ , if the coefficient of correlation is equal to 1, then in between  $X_2$  and  $X_3$ , there exists
- (i) no collinearity
  - (ii) low level of collinearity
  - (iii) perfect collinearity
  - (iv) very high collinearity

2. Answer the following questions in brief :

2×5=10

(a) In Gauss-Markov setup, what do you mean by estimability of linear parametric functions?

(b) State and explain the multiple linear regression model.

(c) Point out the differences between the fixed effects model and random effects model.

(d) When do you use analysis of covariance (ANCOVA) in real life?

(e) Explain the consequences of violating the assumption concerning homoscedasticity in linear regression model.

3. (a) State and prove Gauss-Markov theorem.

7

Or

(b) Estimate the error variance or residual sum of squares of the general linear model in matrix form.

7

4. (a) What is the simple linear regression model, which is based on a set of assumptions made? What are the assumptions? If  $\beta_1$  denotes regression coefficient, obtain a test for  $H_0: \beta_1 = 0$  and construct a confidence interval for  $\beta_1$ .

1+1+3+2=7

Or

(b) For multiple linear regression model with usual notation, prove the following (in matrix form) :

(i) If  $E(y) = X\beta$ , then  $\hat{\beta}$  is an unbiased estimator for  $\beta$ . 3

(ii) If  $\text{cov}(y) = \sigma^2 I$ , the covariance matrix for  $\hat{\beta}$  is given by  $\sigma^2 (X'X)^{-1}$ . 4

5. Answer any two questions : 7×2=14

(a) Describe the fixed effects mathematical model for ANOVA testing in one-way classification, stating clearly—

(i) the assumptions involved;

(ii) the symbols used;

(iii) the hypothesis to be tested. 4+3=7

(b) (i) In ANOVA, what would be the data like if—

(1)  $F$  test resulted in  $F = 0$ ;

(2)  $F \rightarrow \infty$ ? 2

(ii) Suppose that you were given the mean, the standard deviation and the sample size for each of three groups. Could you carry out an ANOVA to these three groups, or would you need more information? 5

- (c) Outline the various steps in carrying out the ANOVA of a two-way classified data with one observation per cell, stating clearly—
- (i) the fixed effects mathematical model;
  - (ii) the assumptions used;
  - (iii) the hypothesis to be tested;
  - (iv) the partitioning of various sum of squares and d.f.;
  - (v) the ANOVA table. 7
- (d) What do you mean by analysis of covariance? Work out the analysis of covariance for one-way layout. 7
6. (a) What is the usual assumption of linear regression model concerning independence of regressors? If that assumption is violated in the regression model, then describe the effect of presence of collinearity in estimating parameters. 7

Or

- (b) Write an explanatory note on quantile-quantile plot. 7

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