SLR-MM – 512

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
STATISTICS (Paper – VII)
Linear Models (New) (CGPA)

Day and Date : Thursday, 19-11-2015 Max. Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

Instructions : *1) Attempt **five** questions.*

*2) Q. No. **(1)** and Q. No. **(2)** are **compulsory**.*

*3) Attempt **any three** from Q. No. **(3)** to Q. no. **(7)**.*

*4) Figures to the **right** indicate **full** marks.*

1. A) Select the correct alternative :

1) In general linear model, $y = X\beta + \varepsilon$

a) $\text{rank}[X'X, X'y] = \text{rank}\,[X'X]$ b) $\text{rank}[X'X, X'y] \leq = \text{rank}\,[X'X]$

c) $\text{rank}[X'X, X'y] \geq = \text{rank}\,[X'X]$ d) $\text{rank}[X'X, X'y] < \text{rank}\,[X'X]$

2) In one-way ANOVA model $y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$; $i = 1, 2, ...k$; $j = 1, 2, ... n_i$, the dimension of estimation space is

a) $k - 1$ b) n_i c) $n_i - 1$ d) k

3) In two-way ANOVA model $y_{ij} = \mu + \alpha_i + \beta_i + \varepsilon_{ij}$; $i = 1, 2, ...p$; $j = 1, 2, ... q$ the test statistic for testing the equality of β_j's has F distribution with .....d.f.

a) $(p - 1), (p - 1)(q - 1)$ b) $(q - 1), (p - 1)(q - 1)$
c) $(p - 1), pq - p - q + 2$ d) $(p - 1), pq - p - q - 2$

4) A balanced design is _____ connected.

a) sometimes b) always c) never d) generally

5) For a BIBD with usual notation, $\lambda(v - 1) =$

a) $k(r - 1)$ b) $k(r + 1)$ c) $r(k + 1)$ d) $r(k - 1)$

(1×5)

P.T.O.

B) Fill in the blanks :

1) In general linear model $y = X\beta + \in$, the quantity $XS^{-}X'$ is _____ under the choice of g-inverse of $S = X'X$.

2) In general linear model, $y = X\beta + \varepsilon, V(\lambda'\beta) =$ _____

3) A connected block design can not be _____

4) A block design is _____ if and only if $CR^{-\delta}N = 0$.

5) The degrees of freedom of error SS in two-way without interaction ANOCOVA model with p rows, q columns, 1 observation per cell, and m covariate is _____ **(1×5)**

C) State **true** or **false**.

1) The degree of freedom of error SS in two-way ANOVA with interaction model with p rows and q columns and with one observation per cell is one.

2) In general linear model, any linear function of the LHS of normal equations is the BLUE of its expected value.

3) BIBD is not orthogonal.

4) A connected design is always balanced. **(1×4)**

2. a) i) Show that any solution of normal equations minimizes the residual sum of squares.

ii) Examine whether the following block design is connected.

$$B_1 = \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix},\ B_2 = \begin{bmatrix} 1 \\ 3 \\ 5 \end{bmatrix}, \text{ and } B_3 = \begin{bmatrix} 2 \\ 4 \\ 3 \end{bmatrix}. \quad \textbf{(3+3)}$$

b) Write short notes on the following :

i) Tuckey's test of non-additivity

ii) Dual of a BIBD. **(4+4)**

3. a) Prove that in general model $y = X\beta + \in$, the BLUE of every estimable linear parametric function is a linear function of the LHS of normal equations, and conversely, any linear function of the LHS of normal equations is the BLUE of its expected value.

   b) Prove that in general linear model $y = X\beta + \in$, a necessary and sufficient condition for the estimability of a linear parametric function $\lambda'\beta$ is that $\lambda' = \lambda' H$, where $H = S^{-}S, S = X'X$. **(7+7)**

4. a) Derive the test for testing the hypothesis of the equality of treatment effects in one-way ANOVA model.

   b) Describe two-way ANOVA without interaction model with one observation per cell and obtain the least square estimates of its parameters. **(7+7)**

5. a) Describe Tuckey's and Scheff's procedures of multiple comparisons.

   b) Describe ANOCOVA model is general and obtain the least square estimates of its parameters. **(7+7)**

6. a) Derive a test for testing a general linear hypothesis in a general linear model.

   b) prove that RBD is connected, orthogonal and balanced. **(7+7)**

7. a) State and prove a necessary and sufficient condition for orthogonality of a connected block design.

   b) Prove that in a BIBD, the number of blocks is greater than or equal to the number of treatments. **(7+7)**

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SLR-MB – 614

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2016
STATISTICS (Paper – VII)
Linear Models (New CBCS)

Day and Date : Friday, 1-4-2016 Total Marks : 70
Time : 10.30 a.m. to 1.00 p.m.

Instructions *: 1) Attempt **five** questions.*
*2) Q. No. **(1)** and Q. No. **(2)** are **compulsory**.*
*3) Attempt **any three** from Q. No. **(3)** to Q. No. **(7)**.*
*4) Figures to the **right** indicate **full** marks.*

1. A) Select the correct alternative :

1) In general linear model, $y = X\beta + \varepsilon$, _____
   a) y is known and x is unknown
   b) y and X both are unknown
   c) y is known and β is unknown
   d) X is unknown and β is known

2) The degrees of freedom of SSE in one-way ANOVA model with N observations and k levels of treatments are _____
   a) N – k – 1 b) k – 1
   c) k d) N – k

3) In a connected block design with v treatments and b blocks, rank of C matrix is _____
   a) v b) b c) b – 1 d) v – 1

4) For a BIBD with usual notation, $\lambda(v-1) =$ _____
   a) k(r – 1) b) k(r + 1)
   c) r(k + 1) d) r(k – 1)

5) A balanced design is _____ connected.
   a) Sometimes b) Always
   c) Never d) Generally **(1×5)**

P.T.O.

B) Fill in the blanks :

1) In general linear model $y = X\beta + \in$, a particular solution of the normal equations is _____

2) The dimension of the estimation space in two-way ANOVA without interaction model with p rows and q columns and with one observation per cell is _____

3) The physical variables other than the response variable involved in ANOCOVA model are called _____

4) A connected block design can not be _____

5) In a BIBD, the number of blocks is _____ the number of treatment. **(1×5)**

C) State **true** or **false** :

1) In general linear model, if S^- is a g-inverse of $S = X'X$, its transpose is also g-inverse of S.

2) In general linear model, any linear function of the LHS of normal equations is the BLUE of its expected value.

3) BIBD is not orthogonal.

4) A balanced design is always connected. **(1×4)**

2. a) i) Explain the three types of error levels in multiple comparison procedures.

ii) Show that for a connected block design, the vector of adjusted treatment totals Q is given by $Q = T - \frac{G}{n}r$, where T is the vector of treatment totals, r is the vector of replication numbers of the treatments, G is the grand total of the observations and n is the total number of observations. **(3+3)**

b) Write short notes on the following :

i) Estimation space

ii) Tuckey's test of non-additivity. **(4+4)**

3. a) Prove that in general linear model $y = X\beta + \in$, the BLUE of every estimable linear parametric function is a linear function of the LHS of normal equations, and conversely, any linear function of the LHS of normal equations is the BLUE of its expected value.

   b) Define error space for general linear model $y = X\beta + \in$. Prove that a linear function of observations $a'y$ belongs to the error space if and only if the coefficient vector a is orthogonal to the columns of X. **(7+7)**

4. a) Derive the test for testing the hypothesis of the equality of treatment effects in one-way ANOVA model.

   b) Describe two-way ANOVA without interaction and with one observation per cell model and obtain the least square estimates of its parameters. **(7+7)**

5. a) Describe Tuckey's and Bonferroni's procedures of multiple comparisons.

   b) Describe ANOCOVA model in general and obtain the least square estimates of its parameters. **(7+7)**

6. a) State and prove a necessary and sufficient condition for orthogonality of a general block design.

   b) Define BIBD and show that it is balanced. **(7+7)**

7. a) Describe two-way with interaction ANOVA model with $r > 1$ observations per cell and obtain the least square estimates of its parameters.

   b) Prove that in general linear model $y = X\beta + \in$, a necessary and sufficient condition for the estimability of a linear parametric function $\lambda'\beta$ is that λ' is a linear combination of the rows of X. **(7+7)**

SLR-BP – 478

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
STATISTICS (Paper – VII)
Linear Models (New)

Day and Date : Saturday, 18-4-2015 Total Marks : 70
Time : 11.00 a.m. to 2.00 p.m.

Instructions *: 1) Attempt **five** questions.*
*2) Q. No. **(1)** and Q. No. **(2)** are **compulsory**.*
*3) Attempt **any three** from Q. No. **(3)** to Q. No. **(7)**.*
*4) Figures to the **right** indicate **full** marks.*

1. A) Select the correct alternative :
   1) In general linear model, $y = X\beta + \varepsilon$, _____
      a) y is known and X is unknown b) y and X both are unknown
      c) y is known and β is unknown d) X is unknown and β is known
   2) In two-way ANOVA model $y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$; $i = 1, 2, \ldots p$; $j = 1, 2, \ldots q$, _____ is estimable.
      a) $\mu + \alpha_1$ b) $\alpha_1 - \alpha_2$ c) $\alpha_1 + \alpha_2$ d) $\alpha_1 + \beta_2$
   3) In a connected block design with v treatments and b blocks, rank of D matrix is _____
      a) v b) b c) b – 1 d) v – 1
   4) For a BIBD with usual notation, bk = _____
      a) rv b) r(v – 1) c) r(k – 1) d) λ(v – 1)
   5) A connected design is _____ balanced.
      a) sometimes b) always c) never d) generally **(1×5)**

   B) Fill in the blanks :
   1) In general linear model $y = X\beta + \in$, a particular solution of the normal equations is _____
   2) The rank of the estimation space in two-way ANOVA with interaction model with p rows and q columns and with one observation per cell is _____
   3) The BLUE of a treatment contrast $\sum_i c_i\alpha_i$ in a two-way ANOVA model is _____
   4) The physical variables other than the response variable involved in ANOCOVA model are called _____
   5) A connected block design is orthogonal if and only if _____ **(1×5)**

P.T.O.

C) State **true** or **false** :

1) In general linear model, not every solution of normal equations minimizes residual sum of squares.
2) In two-way ANOVA model with interaction and one observation per cell the degrees of freedom of SSE is 1.
3) In general linear model, the BLUE of every estimable linear parametric function is a linear function of the LHS of normal equations.
4) In a connected block design, all elementary treatment contrasts are estimable. **(1×4)**

2. a) i) Show that in general linear model, the normal equations are consistent.
   ii) Define complete block design, connected block design and orthogonal block design. **(3+3)**

   b) Write short notes on the following :
   i) Estimation space.
   ii) C matrix in a general block design. **(4+4)**

3. a) State and prove Gauss-Morkoff theorem.

   b) Define error space for general linear model $y = X\beta + \in$. Prove that a linear function of observations $a'y$ belongs to the error space if and only if the coefficient vector a is orthogonal to the columns of X. **(7+7)**

4. a) Describe error rates in multiple comparisons.

   b) Derive a test for testing a general linear hypothesis in a general linear model. **(7+7)**

5. a) Obtain the rank of the estimation space and a complete set of linearly independent estimable linear parametric function in one-way ANOVA model and show that only contrasts of treatment effects are estimable.

   b) Derive the test for testing the hypothesis of the equality of column effects in two-way ANOVA without interaction model with one observation per cell. **(7+7)**

6. a) Describe ANOCOVA model in general and obtain an expression for error SS.

   b) Describe two-way ANOCOVA model and obtain the least square estimates of its parameters. **(7+7)**

7. a) State and prove a necessary and sufficient condition for orthogonality of a general block design.

   b) Prove that in a BIBD, the number of blocks is greater than or equal to the number of treatments. **(7+7)**

SLR-BP – 478

Seat No.	

M.Sc. (Part – I) (Semester – II) Examination, 2015
STATISTICS (Paper – VII)
Linear Models (New)

Day and Date : Saturday, 18-4-2015 Total Marks : 70
Time : 11.00 a.m. to 2.00 p.m.

Instructions *: 1) Attempt **five** questions.*
*2) Q. No. **(1)** and Q. No. **(2)** are **compulsory**.*
*3) Attempt **any three** from Q. No. **(3)** to Q. No. **(7)**.*
*4) Figures to the **right** indicate **full** marks.*

1. A) Select the correct alternative :
   1) In general linear model, $y = X\beta + \varepsilon$, _____
      a) y is known and X is unknown b) y and X both are unknown
      c) y is known and β is unknown d) X is unknown and β is known
   2) In two-way ANOVA model $y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$; $i = 1, 2, \ldots p$; $j = 1, 2, \ldots q$, _____ is estimable.
      a) $\mu + \alpha_1$ b) $\alpha_1 - \alpha_2$ c) $\alpha_1 + \alpha_2$ d) $\alpha_1 + \beta_2$
   3) In a connected block design with v treatments and b blocks, rank of D matrix is _____
      a) v b) b c) b – 1 d) v – 1
   4) For a BIBD with usual notation, bk = _____
      a) rv b) r(v – 1) c) r(k – 1) d) λ(v – 1)
   5) A connected design is _____ balanced.
      a) sometimes b) always c) never d) generally **(1×5)**

   B) Fill in the blanks :
   1) In general linear model $y = X\beta + \in$, a particular solution of the normal equations is _____
   2) The rank of the estimation space in two-way ANOVA with interaction model with p rows and q columns and with one observation per cell is _____
   3) The BLUE of a treatment contrast $\sum_i c_i\alpha_i$ in a two-way ANOVA model is _____
   4) The physical variables other than the response variable involved in ANOCOVA model are called _____
   5) A connected block design is orthogonal if and only if _____ **(1×5)**

P.T.O.

C) State **true** or **false** :

1) In general linear model, not every solution of normal equations minimizes residual sum of squares.
2) In two-way ANOVA model with interaction and one observation per cell the degrees of freedom of SSE is 1.
3) In general linear model, the BLUE of every estimable linear parametric function is a linear function of the LHS of normal equations.
4) In a connected block design, all elementary treatment contrasts are estimable. **(1×4)**

2. a) i) Show that in general linear model, the normal equations are consistent.
   ii) Define complete block design, connected block design and orthogonal block design. **(3+3)**

   b) Write short notes on the following :
   i) Estimation space.
   ii) C matrix in a general block design. **(4+4)**

3. a) State and prove Gauss-Morkoff theorem.

   b) Define error space for general linear model $y = X\beta + \in$. Prove that a linear function of observations $a'y$ belongs to the error space if and only if the coefficient vector a is orthogonal to the columns of X. **(7+7)**

4. a) Describe error rates in multiple comparisons.

   b) Derive a test for testing a general linear hypothesis in a general linear model. **(7+7)**

5. a) Obtain the rank of the estimation space and a complete set of linearly independent estimable linear parametric function in one-way ANOVA model and show that only contrasts of treatment effects are estimable.

   b) Derive the test for testing the hypothesis of the equality of column effects in two-way ANOVA without interaction model with one observation per cell. **(7+7)**

6. a) Describe ANOCOVA model in general and obtain an expression for error SS.

   b) Describe two-way ANOCOVA model and obtain the least square estimates of its parameters. **(7+7)**

7. a) State and prove a necessary and sufficient condition for orthogonality of a general block design.

   b) Prove that in a BIBD, the number of blocks is greater than or equal to the number of treatments. **(7+7)**
