(3 Hours)   **[Total Marks: 60]**

N.B.: (1) Attempt any four questions.
**   (2) Figures to the right indicate full marks.**
**   (3) Simple non-programmable calculator is allowed.**

1. (a) Define a contrast, orthogonal contrast and mutual orthogonality of   (07)
         contrasts. Given a set of n values $y_1, y_2, \ldots, y_n$, show that the
         maximum number of mutually orthogonal contrasts is n-1 among
         them.

    (b) Write the mathematical model for a generalized block design with   (04)
         assumptions. Derive its normal equations using least square
         method.

    (c) Define 'connected block design'. Show that block design is   (04)
         connected iff rank(C) = v-1.

2. (a) Define BIBD with parameters (v, b, r, k, λ). Prove that BIBD is (05)
         connected and balanced design.

    (b) A layout of the block design with four treatments A, B, C and D in   (05)
         six blocks is given below,
         B_1: A B , B_2 : A C , B_3 : A D , B_4 : B C , B_5 : B D , B_6 : C D
         Identify the design and verify the parametric relations. Obtain C
         matrix of this design.

    (c) Define E-optimality of block design. Prove that BIBD is E-optimal.   (05)

3. (a) Consider a 2^3 factorial experiment in r replicates having 3   (10)
         quantitative factors.
         (i)   Give the table of algebraic signs for calculating
                effects.
         (ii)   Explain the procedure to prepare ANOVA table
                showing sum of squares due to main effects and
                interaction each carrying one d.f.
         (iii) Construct 100 (1-α)%,confidence interval for any
                main effect.

(b) Write down the steps for normal probability plot to detect the significant effects of a single replicate of a 2^k factorial design. What is the drawback of this method and how to overcome it? (05)

4. (a) For 2^3 factorial experiment with r replicates define main effects and interaction effects. Describe Yate's method to estimate the main effects and interaction effects and prepare ANOVA of this design. (7)

(b) Explain the concept of blocking and confounding in factorial design. Define partial confounding and total confounding . (3)

(c) Construct a 2^4 factorial design in 4 blocks of size 4 each such that the interaction effects ACD and BCD should be confounded with blocks. If there are two such replicates what will be the degrees of freedom for error in the ANOVA? (5)

5. (a) Define RBD with b blocks and v treatments. (08)
　　　(i)　　Derive its C matrix.
　　　(ii)　　Show that RBD is orthogonal.
　　　(iii) Derive the expression for the adjusted block sum of squares and adjusted treatment sum of squares.

(b) Write down the independent treatment combinations in key block of size 2^5 of 2^8 factorial design such that no main effect, two factor interaction and three factor interaction effects are confounded with the blocks using Das method. Also obtain the independent interactions confounded with the blocks and their generalized interaction effects. (07)

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