

[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 9101

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Unique Paper Code : 2373010016

Name of the Paper : DSE 5b - Advanced Design of Experiments

Name of the Course : B.Sc. (Hons.) Statistics under NEP-UGCF

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All questions carry equal marks.
3. Attempt any five questions.
4. Use of a non-programmable calculator is allowed.

1. Derive the analysis of variance for one-way classified data per cell under a random effects model, stating clearly the mathematical model, the hypothesis to be tested, and the underlying assumptions. Also, draw the ANOVA table. (18)

2. An engineer is studying the mileage performance characteristics of five types of gasoline additives. In the road test, he wishes to use cars as blocks. However, because of a time constraint, he must use an incomplete block design. He runs the balance design with the five blocks that follow. Identify the parameters of the design used to obtain the following data. Carry out the complete intra-block analysis of the data from this experiment (use $\alpha = 0.05$) and draw conclusions.

Cars						
Additives		1	2	3	4	5
	1		17	14	13	12
	2	14	14		13	10
	3	12		13	12	9
	4	13	11	11	12	
	5	11	12	10		8

(18)

3. (a) Define the term MOLS. Generate the elements of GF(7) and construct the complete set of MOLS of order 7.

- (b) Use orthogonal Latin squares of size 4 to construct the BIBD with

$$v = b = s^2 + s + 1, \quad r = k = s + 1, \quad \lambda = 1 \quad (9,9)$$

4. (a) Let $v = b = 7$, $r = k = 3$. Construct a BIBD with these parameters using the method of differences. Derive a residual BIBD for the resultant BIBD and write its parameters.

- (b) Construct a BIBD by taking (1, 3, 4, 5, 9) as the initial block under modulo 11. What are the parameters of the resultant design? Write its incidence matrix. (9,9)

5. (a) Define a response surface design. Obtain the estimates of the unknown parameters of a first-order model, using the principle of least squares. Obtain their variances and covariances.

- (b) Construct a rotatable CCD in two variables with $N = 12$ runs, such that the design can be blocked orthogonally into two blocks. (9,9)

6. (a) What is meant by Mixture experiments? Define the $q - 1$ -dimensional factor space for $q = 3$. List the 20 blends that comprise a {4,3} simplex-lattice and plot them on the appropriate factor space. Suggest the appropriate model for the design.

- (b) Define a simplex-centroid design. How is it different from a simplex-lattice design? For a three-component simplex-centroid design, express the $2^q - 1$ parameters in the associated polynomial as linear functions of the expected responses η_i, η_{ij} and η_{ijk} . (9,9)