(i) What are the block compositions in each replicate in the two experiments?

(ii) Give the table showing the breakdown of df in the combined analysis of experiment I and experiment II. (6,9)

7. (a) What is meant by fractional factorial designs? Explain the utility of such designs.

(b) Obtain the treatment combinations of a 2^{5-2} design using I = ACD and I = –ABDE as design generators. Verify that each main effect is aliased with at least one two- factor interaction effect. What is the resolution of this design? How many alternate fractions can you generate for this design? Also, give their generating relationships. (6,9)

[This question paper contains 6 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1118 **A**

Unique Paper Code : 32371601

Name of the Paper : Design of Experiments

Name of the Course : **B.Sc. (H), Statistics**

Semester : VI

Duration : 3 + (additional ½ hour) Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in all.
3. Question no. **1** is compulsory.
4. Attempt **four** questions from the remaining questions.
5. The use of simple calculators is allowed.

1. Attempt any **five** parts from the following :

(a) The entries in the following table were determined from some data collected according to a randomized block design with three blocks. The

treatment averages were 45, 58, 46, 45, and 56 for the five groups. Complete the ANOVA table. Show the computation for determination of all the missing values. Are some of the entries impossible to determine with the given information? Give reason.

Sources of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Block		520		
Treatment				
Error		40		
Total				

(b) In a randomized block design there are only two blocks. Let k be the number of treatments and $\overline{y_1}$ and $\overline{y_2}$ be the average yields of two blocks show that the between blocks sum of squares can be expressed as $\frac{k}{2}(\overline{y_1}-\overline{y_2})^2$.

(c) Can there exist a BIBD with the following parameters :

(i) $b = v = 88,\ r = k = 30,\ \lambda = 10$

(ii) $v = 31,\ k = 4,\ \lambda = 1$

Give reasons for your answer.

(b) Five factors each at two levels are required to be tested. To control heterogeneit, it is desired that each block should contain 8 plots only. A balanced arrangement in 5 replications is planned so that the main effect and first-order interactions remain unconfounded while $1/5^{th}$ of the information on each of the 2^{nd} and 3^{rd} order interactions is lost. List the system of effect/s confounded in each replicate.

(c) An experiment for 5 treatment factors, each with two levels, is designed such that only a single replicate of the 32 treatment combinations is run. Suggest a suitable method for analyzing such a design. (6,3,6)

6. (a) Describe Yates' algorithm for computing the total effects and the sum of squares due to various effects for a 2^3 factorial experiment laid out in r randomized blocks.

(b) A 2^3-factorial experiment with factors A, B, and C is to be conducted in 4 replicates consisting of two blocks of 4 plots each. Two experimenters conduct such 4 replicate experiments on two different farms. In experiment I, ABC is totally confounded, and in experiment II, AB, AC, BC, and ABC are partially confounded.

(d) A 2^5-factorial experiment is arranged in four blocks of 8 plots each. If four elements of one block are (1), ab, cd, and e, then find the confounded factorial effects.

(e) The following is a block of a layout plan before randomization for a 3^3-factorial experiment with factors A, B, and C: 001, 102, 012, 110, 121, 200, 020, 222, 211. Identify all the confounded effects.

(f) Obtain the treatment combinations of a 2^{5-2} design using I = ABE and I = –BCE as design generators. (3,3,3,3,3)

2. (a) Name the three principles of experimental design. How are these principles used in CRD?

(b) Prove that in a randomized block design, the mean sum of squares due to error is always an unbiased estimator of the error variance while the mean sum of squares due to treatments and blocks are biased.

(c) Let D_1 and D_2 be designs with error variances σ_1^2 and σ_2^2 and replications r_1 and r_2 respectively. Define the efficiency of D_1 w.r.t. D_2? Determine the efficiency of LSD relative to CRD. State the assumptions used in the derivation. (5,6,4)

P.T.O.

3. Describe the complete statistical analysis of an LSD with one missing observation. Calculate the expression for the standard error of the difference between two estimated treatment means when one of them involves the missing observation. (15)

4. (a) Derive a necessary condition for the existence of a symmetric BIBD with an even number of treatments.

   (b) Show that the following system of blocks (within parenthesis) is a BIB design and evaluate its parameters.

   (1, 4, 5, 9, 3), (2, 5, 6, 10, 4), (3 , 6, 7, 11, 5), (4, 7, 8, 1, 6), (5, 8, 9, 2, 7), (6, 9, 10, 3, 8), (7, 10, 11, 4, 9), (8, 11, 1, 5, 10), (9, 1, 2, 6, 11), (10, 2, 3, 7,1), (11,3,4, 8,2).

   Write the incidence matrix of the complement of this design. Further, define the dual of a design and obtain the dual of the given design along with its parameters. Is the resultant design a BIBD? (6,9)

5. (a) Define the term treatment contrast? When is contrast said to represent (i) a zero-order interaction effect, (ii) a first-order interaction effect, and (iii) a $(k-1)^{th}$ order interaction effect?