CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

MATH 444: DESIGNS AND ANALYSIS OF EXPERIMENTS

STREAMS: BSC **TIME: 2 HOURS**

DAY/DATE: WEDNESDAY 19/04/2023 **2.30 P.M. – 4.30 P.M.**

INSTRUCTIONS:

QUESTION ONE (30 MARKS)

a) Define the following terms as used in Designs of experiments.

(i) Balanced incomplete block designs (BIBD) [3 Marks]

(ii) Response surface methodology [3 Marks]

(iii) Partially balanced incomplete designs (PBIBD) [3 Marks]

(iv) Youden squares [3 Marks]

b) Draw a general ANOVA of a partially Balanced incomplete block design, with two association classes. [4 Marks]

c) State and explain briefly two uses of response surface designs. [2 Marks]

d) Analyze the following Youden square design at 5% level of significance. Is position significant? [12 marks]

	Position		
Blocks	1	2	3
1	A=2	B=9	C=14
2	B=6	A =8	D =5
3	C=2	D=9	A=0
4	D =8	C =11	B = 10

QUESTION TWO [20 MARKS]

a) Outline the first six steps of analyzing a lattice design. [6 Marks]

b) An Engineer uses a balanced incomplete block design to test performance of Buses on 5 diesel additives, due to time constraint.

	Bus				
Additive	1	2	3	4	5
1	-	18	15	14	13
2	15	15	-	14	11
3	13	-	14	13	10
4	14	12	12	13	-
5	12	13	11	-	9

Analyze the data at 5% level of significance and draw conclusions. [14 Marks]

QUESTION THREE (20 MARKS]

a) Perform the intrablock analysis for the following partially balanced incomplete block design at 5% level of significance. [15 marks]

b) Find the association matrices for the data given below. [5 marks]

	Block					
Treatment	1	2	3	4	5	6
1	14	-	-	10	-	16
2	10	-	12	15	-	-
3	20	24	-	-	19	-
4	-	16	-	11	10	-
5	-	13	17	-	-	12
6	-	-	9	-	10	8

QUESTION FOUR [20 MARKS]

a) Consider the BIBD given below

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
1 2	3 4	1 3	2 4	1 4	2 3

Replace treatment 1 by 1,2,3, 2 by 4,5,6, 3 by 7,8,9 and 4 by 10,11,12.

i) Make new design and draw an associate scheme. [4 Marks]

ii) Obtain the associate matrices. [4 Marks]

b) The data below shows the factors used in an agricultural experiment and the yield.

X (Nitrogen kg /ha)	10	20	30	40	50
Y (Yield kg/ha)	875	1450	1575	1180	1400

(i) Find the Coded values table [4 Marks]

(ii) Determine the quadratic normal equations [6 Marks]

(iii) Find the Optimum level of nitrogen (coded) [1 Marks]

(iv) Hence the optimum according to original units. [1 Mark]

QUESTION FIVE [20 MARKS]

An experiment involving 9 paddy varieties conducted in a 3x3 balanced lattice design. Analyze the data at 5% level of significance. (the numbers in parentheses are treatments). [20 marks]

Block	Replication I			Block	Replication III		
1	(7)6.31	(5)5.22	(3)4.79	7	(1)3.52	(9)5.50	(5)5.33
2	(6)4.69	(8)5.72	(1)4.45	8	(4)3.58	(8)5.03	(3)4.21
3	(2)4.72	(4)4.20	(9)5.87	9	(7)4.83	(2)4.51	(6)4.30

Block	Replication II			Block	Replication IV		
4	(9)5.14	(3)4.75	(6)3.30	10	(5)5.34	(4)3.59	(6)4.50
5	(8)5.55	(5)5.30	(2)4.20	11	(3)4.30	(2)4.83	(1)4.14
6	(7)4.67	(1)4.19	(4)3.08	12	(9)5.33	(8)5.31	(7)5.50