CHUKA **UNIVERSITY**

UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATION FOR THE DEGREE OF …

(MAIN CAMPUS - REGULAR BASED)

MATH 443: DESIGN AND ANALYSIS OF EXPERIMENT

JAN - APRIL 2021

STREAMS:

TIME: 2HRS

DAY/DATE: ……. ……..

INSTRUCTIONS:

- Answer question **ONE** and **TWO** other questions
- Sketch maps and diagrams may be used whenever they help to illustrate your answer
- Do not write on the question paper
- This is a **closed book exam**, No reference materials are allowed in the examination room
- There will be **No** use of mobile phones or any other unauthorized materials
- Write your answers legibly and use your time wisely

Question One (30mks)

a) (i) Briefly explain the three basic principles used in experimental designs. (5mks)

(ii) Which of these principles is not applicable in a completely randomized design? Explain. (3mks)

b) The table below shows the lifetime in hours of samples of 3 different types of television tubes manufactured by a company.

	Replications				
Sample 1	407	411	409		
Sample 2	404	406	408	405	402

Sample 3	410	408	406	408	

Analyse the data at 5% level of significance to determine whether there is a difference between 3 types. (6mks)

c) An experimenter wishes to compare 5 treatments, and has resources to take a total of 25 observations, 5 for each treatment. How many residuals (error) degrees of freedom are there if she uses

(i) A completely randomised design (2mks)

(ii) A randomised block design. (2mks)

(iii) A Latin square design (2mks)

(iv) Give a reason for not using the design with the least number of residual degrees of freedom. (2mks)

d) Explain why a B.I.B design is preferred in analysis of variance compared to an R.B.D. (3mks)

e) (i) Define a latin square of size (5 × 5) (2mks)

(ii) When are two Latin squares said to be orthogonal? (3mks)

Question Two (20mks)

a) (i) Explain clearly what is meant by a randomised block design. (5mks)

(ii) Give the model used in the analysis of such design clearly defining each symbol. (5mks)

b) A study was conducted to determine the effects of sleep deprivation on hand-steadiness. The four levels of sleep deprivation of interest are 12, 18, 24, and 30 hours. 32 subjects were randomly selected and assigned to the four levels of sleep deprivation such that 8 subjects were randomly assigned to each level. The response is the reaction time to the onset of a light cue. The results (in hundredths of a second) are contained in the following table:

Treatment (in hours)			
12	18	24	30
20	21	25	26
20	20	23	27
17	21	22	24
19	22	23	27
20	20	21	25
19	20	22	28
21	23	22	26
19	19	23	27

a) Write the model appropriate for this analysis clearly explaining each symbol used.

b) Perform the analysis of variance at 5% level of significance.

(10mrks)

Question Three (20mks)

a) Consider a randomised complete block design with model $y_{i_j} = \mu + t_i + \beta_j + \epsilon_{ij}$ (usual meaning of symbols) $i = 1,2,\dots,v;\quad j = 1,2,\dots,b.$ Suppose that the observation in j^{th} block belonging to i^{th} treatment is missing. Obtain an estimator of the missing observation. (10mks)

b) Consider the B.I.B.D shown below, with observation belonging to the 2nd treatment in the 2nd block missing. Evaluate the missing observation. (5mks)

		Treatments			
		1	2	3	4
Blocks	1	9.3	9.4	9.6	10.0
	2	9.4	-	9.3	9.9
	3	9.2	9.4	9.5	9.7
	4	9.7	9.6	10.0	10.2

c) Give the model for a split plot design explaining clearly the meaning of each symbol used (5mrks)

Question Four (20 mks)

a) The following table gives fields of wheat per plot in a manurial experiment. The 4 manurial treatments denoted by A, B, C & D

		Column		
Row	1	2	3	4
1	B42	C44	D54	A34
2	D38	A51	B49	C41
3	C51	D51	A54	B60
4	A45	B57	C50	D35

(i) Prepare an ANOVA table for the data. (6mks)

(ii) Test whether effects of treatment differ significantly from one another at 5% level of significance. (4mks)

b) The following data represents a split plot with varieties as whole plot treatments in a randomized complete block design. Row spacing was applied to subplots. The yield in bags per acre for 4 blocks is given in the table below.

		Blocks			
Row spacing	Variety	1	2	3	4
18″	A	33.6	37.1	34.6	35.4
	B	28.0	25.5	29.4	27.3
24″	A	31.1	34.5	32.7	30.7
	B	23.7	26.2	25.8	26.8
30″	A	33.0	29.5	30.7	30.7
	B	23.5	26.8	23.3	21.4
36″	A	28.4	29.9	32.3	28.1
	B	25.0	25.3	26.4	24.6

Perform the main plot analysis (10mrks)

Question Five

a) Briefly explain the following terms used in factorial designs.

(i) Simple effect (2mks)

(ii) Main effect. (2mks)

(iii) Interaction effect between factors. (2mks)

b) The following are results of a 2^3 factorial experiment run in a randomised complete block design.

	Blocks		
Treatment	1	2	Total
1	2	3	5
a	6	14	20
b	10	15	25
ab	6	9	15
c	4	6	10
ac	15	25	40
bc	18	22	40
abc	8	12	20
Total	69	106	175

(i) Obtain the design matrix x of this design (3mks)

(ii) Obtain the estimates of factorial effects. (4mks)

(iii) Give a complete analysis of the experiment and check which factorial effects are significant at 5% level of significance. (7mks)