CHUKA   **UNIVERSITY**

UNIVERSITY EXAMINATIONS

FOURTH YEAR EXAMINATION FOR THE AWARD OF
DEGREE OF BACHELOR OF SCIENCE

MATH 443: DESIGNS AND ANALYSIS OF EXPERIMENTS

STREAMS: BSC MATHEMATICS, BSC ECON STAT; BA ECON, MATH; BED SCI
TIME: 2 HOURS

DAY/DATE : WEDNESDAY 22 /09/ 2021   **11.30 AM – 1.30 PM**

INSTRUCTIONS TO CANDIDATES:
1. Time 2 Hours
2. Answer **Question ONE (Compulsory)** and any other **TWO** Questions
3. Do not write on the question paper

QUESTION ONE: (30 MARKS)

(a)   (i)   State and explain the three basic principles of experimental designs

(6marks)

(ii)   Why is randomization important   (3marks)

 (b)   Define a Latin square of size $(S \times S)$ (2marks)

         When are two Latin squares said to be orthogonal?   (2marks)

(c)   Define the following terms as used in designs of experiments

        (i)   Orthogonal contrast   (3 marks)

        (ii)   Split plot design   (3 marks)

(d)   Write down the skeleton of an ANOVA table for a Completely Randomized Design
                                                                    (5 marks)

(e) State the two disadvantages of split plot design and Randomized complete block design.
                                                                    (6 marks)

QUESTION 2 (20 MARKS)

A baker is investigating the relationship between the quality of the bread she produces and the flour and the baking time used. She makes three loaves of bread for each treatment combination of flour and baking time. The loaves are graded according to quality/marketability index she has devised for the purpose. The values of the measurement in metric variables are:

Flour	Baking times (mins)			
	25	30	35	40
Exe	3.7	4.2	4.1	4.8
	4.2	3.8	4.3	5.5
	2.9	4.1	4.2	5.4
Chef	4.1	4.4	4.9	5.4
	4.5	4.6	4.4	5.2
	4.6	3.9	4.9	4.9
	4.1	4.4	4.7	4.8
Boma	4.2	4.8	5.0	4.6
	3.8	4.0	5.2	5.1

Perform an analysis of variance to determine whether the various factors differ significantly at 5% level of significance. (20 marks)

QUESTION THREE: (20 MARKS)

a) Define the following terms as used in factorial designs

    i)   Simple effect (2marks)

    ii)   Main effect (2marks)

    iii)   Interaction effect between two factors (2marks)

b) The following are results of a 2^3 factorial experiment run in a randomized 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 and the X matrix for this design   (3marks)

ii) Obtain the main estimates of the factorial design.   (4marks)

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

QUESTION FOUR: (20 MARKS)

The table below shows the effect of N:P:K fertilizer and seed rate (S1,S2,S3) on yield of paddy in a split-plot design experiment. The treatment combinations used were: $f_1 = 75:15:20$, $f_2 = 75:30:20$, $f_3 = 75:45:20$, $f_4 = 75:15:40$, $f_5 = 75:15:60$.

Analyze the data at 5% level of significance.   (20 marks)

Replication I			Replication II			Replication III		
S2	S1	S3	S1	S3	S2	S2	S3	S1
$f_1$13.8	$f_2$11.1	$f_3$11.8	$f_5$12.3	$f_4$13.7	$f_3$11.3	$f_5$13.4	$f_3$14.3	$f_4$10.4
$f_4$13.2	$f_5$9.7	$f_1$14.0	$f_2$10.9	$f_1$14.1	$f_5$14.1	$f_2$14.2	$f_1$13.8	$f_5$11.8
$f_2$11.5	$f_3$10.8	$f_4$13.6	$f_4$10.6	$f_3$13.3	$f_2$13.2	$f_3$13.7	$f_4$11.9	$f_2$9.8
$f_5$14.4	$f_1$11.8	$f_2$14.3	$f_1$10.1	$f_5$14.2	$f_4$14.2	$f_1$14.3	$f_5$14.1	$f_3$7.8
$f_3$12.9	$f_4$10.2	$f_5$13.1	$f_3$11.3	$f_2$13.7	$f_1$13.8	$f_4$13.0	$f_2$13.5	$f_1$11.7

QUESTION 5 (20 MARKS)

The thrusts produced by the rocket engines on five different fuels and five different injection systems were measured

Injection rate (L/s)

Fuel	1.2	1.5	1.6	1.9	2.5
Super	A (4.5)	B (4.7)	C (5.1)	D (4.3)	E (5.1)
Premium	C (5.3)	D (4.8)	E(5.1)	A (4.9)	B (5.2)
Diesel	E (4.4)	A (4.1)	B (4.6)	C (4.5)	D (5.1)
Space gas	D (4.7)	E (4.4)	A (4.3)	B (4.6)	C (5.5)
Airflame	B (4.7)	C (5.2)	D (5.3)	E (4.7)	A (4.9)

The engines are denoted by the letters, A, B, C, D and E. Analyze the data at 5% level of significance to investigate the effects of the fuel, injection rate and the engines.   (20 marks)

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