MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.
Tel: 020-2069349, 061-2309217. 064-30320 Cell phone: +254 712524293, +254 789151411
Fax: 064-30321
Website: www.must.ac.ke Email: info@must.ac.ke

University Examinations 2013/2014

FIRSTYEAR, FIRST SEMESTER EXAMINATIONS FOR MASTER OF SCIENCE IN STATISTICS

STA 3104: DESIGN AND ANALYSIS OF EXPERIMENTS

DATE: APRIL 2014 **TIME: 3 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions.*

QUESTION ONE – (30 MARKS)

(a) Define the following terminologies (if possible, with illustration)
- (i) Latin Square Design
- (ii) Greaco-Latin Square Design
- (iii) D-Optimality and A-Optimality of design (6 Marks)

(b) The following data is not a perfect Latin Square design data

A 10	C 15	B 5	D 4
C 12	B 10	A 3	D 4
B 20	D 10	A 5	C 10
D 10	A 4	B 12	C 25

- (i) Construct a perfect Latin Square design. (2 Marks)
- (ii) Compute the following sum of squares for the Latin square obtained in (i).
  $SS(treatment),\ SS(rows),\ SS(columns)$ (8 Marks)

(c) (i) Complete the ANOVA Table below for a completely Randomized Block Design (CRBD).

Source of variation	df	SS	MSS	F
Treatments	3	21.7	7.23	-
Blocks	2	32.2	-	-
Errors	-	-	-	
total	11	57.7		

(6 Marks)

(ii) Test at $\propto = 0.05$ if the treatments and blocks are statistically significant.

(4 Marks)

(iii) Compute the relative efficiency of the RCBD above over a CRD for the same experiment. What is the gain in efficiency? (4 Marks)

QUESTION TWO – (20 MARKS)

(a) Consider the Randomized Complete Bloc Design (RCBD). For a fixed effects model, with V-treatments and B-blocks, and $\sum_{i=1}^{v} t_i = \sum_{j=1}^{b} B_j = 0$ where t_i = treatment effects and B_j = block effects, show that

(i) $E\left(MSS\left(treatments\right)\right) = \sigma_e^{\,2} + \frac{b}{v-1}\sum_{i=1}^{v} t_i^{\,2}$ (5 Marks)

(ii) $E\left(MSS\left(Blocks\right)\right) = \sigma_e^{\,2} + \frac{v}{b-1}\sum_{j=1}^{b} b_j^{\,2}$ (5 Marks)

(iii)Under $H_0{:}t_i = 0;\ B_j = 0$ comment if $MSS(t)\ and\ MSS(B)$ are unbiased for the error variance. (2 Marks)

(b) The data below is an experiment in which four treatments are laid out in 3 blocks.

		Treatments			
		1	2	3	4
Block	1	6	8	7	11
	2	5	6	6	9
	3	9	9	11	12

At $\propto = 0.01$, test the hypothesis $H_0: t_1 = t_2 = t_3 = t_4 = 0;\ B_1 = B_2 = B_3 = 0$

Versus H_1 : at least one treatment or block effect differs from zero. (8 Marks)

QUESTION THREE – (20 MARKS)

Four fertilizers are applied to a farm, each with five replications. The following yield of maize in bags is recorded.

A	55	49	42	21	52
B	61	112	30	89	63
C	42	97	81	95	92
D	169	137	169	85	154

(a) Identify the type of design used in this experiment. (2 Marks)

(b) Derive the formulae for computation of sums of squares necessary for the ANOVA analysis. Hint: split the formula for total sums of squares. (3 Marks)

(c) At $\alpha = 0.01$, test the hypothesis
$H_0: t_A = t_B = t_C = t_D = 0$ versus
H_1 : at least one effect differs from zero. (7 Marks)

(d) For any two pairs of means and a balance design, we reject

$$H_0: t_i = t_i^{/} \quad for\, H_i: t_i \neq t_i^{/} \text{ if } \quad \frac{\hat{t}_i - \hat{t}_i^{/}}{\hat{\sigma}_e \sqrt{\frac{1}{n_i} + \frac{1}{n_i^{/}}}} > t_{\left(\alpha/2,\ df = n - v\right)}$$

Based on this judgment, compare all the possible pairs of means. (7 Marks)

(e) Recommend one fertilizer to the farmers. (1 Mark)

QUESTION FOUR – (20 MARKS)

(a) Suppose the Yij-th observation in the jth block receiving treatment i is missing, derive the formula for estimating the missing observation in a Randomized Complete Block Design. $(i = 1,2, \ldots v; \;\; j = 1,2, \ldots, b)$ (10 Marks)

(b) Hence set up an ANOVA at $\propto = 0.05$ for the cow feeds data below.

COW FEDS

	HERDS 1	2	3	4
A	19	-	23	26
B	26	28	27	33
C	20	29	22	26

Note that sums of squares due to treatment is over-estimated by a factor

$$p = \frac{\left(B_J^{\,/} + VT_i^{\,/} - G\right)^2}{V(V-1)(b-1)^2}$$ (10 Marks)