MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF APPLIED SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

FOURTH YEAR **FIRST** SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE

SMA 2430 – DESIGN AND ANALYSIS OF EXPERIMENT

DURATION: 2 HOURS

DATE: 4TH DECEMBER, 2017

TIME: 2.00 – 4.00 P.M.

Instructions to Candidates:

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION ONE - COMPULSORY

QUESTION ONE

(a) State the meaning of the following terms as used in designs of experiments

i) Scientific research

ii) Experiment

iii) Blocking factors

iv) Randomization (4 marks)

(b) i) State the three basic principles of an experimental design and briefly explain the meaning of each principle (6 marks)

ii) Which of this principle is not used in a completely randomized design (1 mark)

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

i) A completely randomized design

ii) A randomized block design

iii) A Latin square design (3 marks)

In this case which is the best design to use and why (1 mark)

(d) Three brands of batteries are under study. It is suspected that the lives (in weeks) of the three brands are different. Five batteries of each brand are tested with the following results

Brand 1	100	96	92	96	92
Brand 2	76	80	75	84	82
Brand 3	108	100	96	98	100

Taking brands effects as treatment effects $\forall_1, \forall_2$ and $\forall_3$ test Ho: $\forall_1 = \forall_2 = \forall_3$ Vs Hi: Anything different at 5% level of significance (5 marks)

(e) For a balanced incomplete block design (B.I.B.D), with parameters *v*, *b*, *r*, *k* and λ (usual notation) explain why

i) $bk = vr$

ii) $\lambda(v-1) = r(k-1)$ (2 marks)

(f) i) Consider a randomized block design with the model $yij = \mu + ti + bj + eij$ (with usual meaning of symbols) $i = 1, 2 - -v, j = 1,2 \ldots t$ suppose that the observation in *jth* block, belonging to *ith* treatment is missing obtain as estimator of the missing observation (5 marks)

ii) Consider the randomized block design shown below with the observation belonging to the 3rd treatment in block 3 missing. Estimate the missing observation.

	Treatments				
Block 1	1	2	3	4	5
Block 2	73	68	74	71	67
Block 3	73	67	75	72	70
Block 4	75	68	-	73	68
	73	71	75	75	69

(3 marks)

SECTION TWO – ANSWER ANY TWO

QUESTION TWO

(a) i) Define a Latin square design (s x s)

ii) When are two Latin squares each (s x s) said to be mutually orthogonal (4 marks)

(b) A 4 x 4 Latin square design produced the following data:

c=10	d=14	a=7	b=8
d=10	a=10	b=12	c=14
b=7	c=18	d=11	a=8
a=5	b=10	c=11	d=9

Analyse the data using $\propto = 0.05$ level of significance (10 marks)

(c) An experiment was conducted to determine the effect of a certain air pollutant on the cardio-pulmonary function of mongrel dogs. The measurements used for this test was pulmonary arterial pressure in Pascal's, which should increase under toxins. A total of 19 dogs were randomly chosen, five were injected with 2mg of sodium chloride as a control, six were

injected with 1mg sodium chloride, 1mg sodium sulphate and eight were injected with 2mg of sodium sulphate. Sodium sulphate is a constituent of the air pollution. The data obtained from this experiment were as follows:-

	Pulmonary		Arteria	Pressure		(Pascal)	
2mg Sodium Chloride	12.3	11.7	12.2	12.1	12.0		
1mg each	12.8	13.2	11.9	12.9	13.1	13.5	
2mg Sodium Sulphate	13.3	12.7	13.2	12.8	12.0	13.1	12.8

Using $\propto = 5\%$ level of significance is there difference in the readings for the three treatments? (6 marks)

QUESTION THREE

(a) Define the following terms as used in factorial experiments

i) Simple effect of a factor

ii) Main effect of a factor

iii) Interaction effect between two factors (3 marks)

(b) The following are results for a 2^3 factorial experiment run in a randomized block design

	Blocks		
Treatments	1	2	Total
(1)	22	31	53
a	43	29	72
b	35	50	85
ab	55	47	102
c	44	38	82
ac	37	40	77
bc	50	54	104
abc	39	47	86
Total	325	336	661

Obtain the design and the x matrix (4 marks)

Obtain the estimates of the treatments effects (7 marks)

Given a complete analysis of the experiment and check which treatment effects are significant at 5% level of significance (6 marks)

You may use

Total s.s = 1,281.4375

Block s.s = 7.5625

Error s.s = 337.9375

QUESTION FOUR

The density of cakes prepared from different mixes A,B,C and D were compared after baking. Unfortunately the spectral temperature in controlled oven could only accommodate three cakes at a time and consequently required an incomplete block design to remove baking to baking variability. The density measurements made on 12 cakes are shown below in a B.I.B.D. the blocks correspond to a single baking or overheat.

D 13.1	C 11.7	B 10.6	D 14.9
A 13.5	B 10.0	D 13.0	C 13.7
C 12.2	A 13.0	A 12.7	B 10.8

Analyse the data completely using $\propto = 0.05$ level of significance. (20 marks)

QUESTION FIVE

(a) State three advantages for a completely randomized design (3 marks)

(b) Consider the linear additive model of the randomized block design with interactions i.e.

$y_{ijr} = \mu + t_{i+} h_j + \delta_{ij} + e_{ij}$ for $i = 1,2 \ldots v, j = 1,2 \ldots b, r = 1,2 \ldots k$ and $y_{ijr} \sim N(o, \delta^2 e)$

obtain the least square estimators of μ, ti, bj and δij (8 marks)

(c) Draw the ANOVA table for the above design (4 marks)

(d) The ANOVA output from the computer print out was as shown below

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	Fratio
Treatment	4	1020.56	-	-
Blocks	-	-	64.765	
Error	20	169.33	-	
Total	29	1513.71		

Fill in the blanks (5 marks)