(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2017/2018 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF MASTER OF SCIENCE IN STATISTICS

COURSE CODE: **STA 801**

COURSE TITLE: **EXPERIMENTAL DESIGN I**

DATE: 05/10/18 **TIME:** 8 AM -11 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 3 Hours

QUESTION ONE(30 mks)

(a) Explain the following terms as used in experimental designs.

(i) Experiment (1 mark)

(ii) Treatment . (1 mark)

(iii) Analysis of variance. (ANOVA) (2 marks)
(iv) Principles of experimentations. (3 marks)
(v) Components of experimental design. (3 marks)

(b) Decompose the total sum of squares $\sum_{j=1}^{k}\sum_{j=1}^{n_j}\left(y_{ij}-\bar{y}_{oo}\right)^2$ into the error sum of squares and treatment sum of squares. (5 marks)

c) state and prove the two properties of BIBD (7 mks)
d) show whether or not the following BIBDs exists(3mks)
(i) [19,4.1]
(ii) [7,3,2]
(iii) [8,3,1]

e) Below is an ANOVA table extracted by MINITAB to test whether driving experience and road type have effect on steering corrections:

Analysis of variance (balanced design)

Factor	Type	Level	Value		
Experience	Fixed	2	1	2	
Road	Fixed	3	1	2	3

Analysis of variance for corrects

Source	D.f	S.S	M.SS	F	P
Experience	-	228.77	288.17	-	0.008
Road	-	308.33	-	5.78	0.010
Error	20	533033	26.67		
Total	23	-			

(i) Complete the ANOVA (1 mark)

(ii) Determine the linear additive model (1 mark)

(iii) Sketch how the raw data was arranged before analysis. (1 mark)

(iv) Make statistical conclusion from the ANOVA. (2 marks)

Question two (15 mks)

(a) as an engineer for general motors, you suspect that the four machines producing parts for a wind screen wiper assembly are manufacturing parts with different mean diameters. Design a test to conform or disapprove this suspicion.

(b) Derive the formula of estimating one missing observation in a randomized block design.

(c) Hence or otherwise analyze the following RBD after estimating the missing value

Treatments	Blocks			
	B1	B2	B3	B4
T1				
	19	—	23	26
T2	26	28	27	33
T3	20	29	22	26

X

Question three(15 mks)

For (9, 3, 1)-BIBDs

(a) represent the design diagrammatically

(b) construct the incidence matrix of this design

(c) Find an isomorphism π of the two (9, 3, 1)-BIBDs (X,A) and (Y, B), and give a complete verification that the two BIBDs are isomorphic.

$X = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$

$A = \{123, 147, 159, 168, 258, 267, 249, 369, 348, 357, 456, 789\}$

$Y = \{a, b, c, d, e, f, g, h, i\}$

$B = \{abe, acd, afi, agh, bcf, bdg, bhi, ceh, cgi, dfh, dei, efg\}$.

Hint: Observe that if $\pi(x) = \alpha$, $\pi(y) = \beta$, $\{x, y, z\} \in A$, and $\{\alpha, \beta, \gamma\} \in$

B, then it must be the case that $\pi(z) = \gamma$.

Question four (15 mks)

(a) Describe type of confounding in factorial and fractional designs
(b) Construct a 2^5 factorial in 2^3 blocks confounding interactions ABD,ACE,BCDE

Question five (15 mks)

An agricultural statistician conducted an experiment to determine whether there was a different in the yield of 5 varieties of maize. The design adopted was randomized block of 5 plots each. The yield in hectares obtained in the experiment were.

	Variances				
Blocks	V_1	V_2	V_3	V_4	V_5
1	30	23	34	35	20
2	39	22	28	25	28
3	56	43	43	31	49
4	38	45	36	35	32
5	44	51	23	58	40

(a) Analysis the designs and comment on your findings, take $\alpha = 0.05$ or $F_{(1,6)} = 3.0$ (10 marks)

(b) Obtain the efficiency of this design relative to its layout as CRD.

(5 marks)

Question six(15 mks)

A soft drink bottler is interested in obtaining more uniform fill heights in bottles produced by his manufacturing process. The filling machine theoretically fills each bottle to the correct target height, but in practices, there is variation around this target, and bottler would like to understand better the sources of this variability and eventually reduce it.

The process engineer can control three variables during the filling process: The percent carbonation (A), the operating pressure in the filler (B) and bottlers produced per minute on the line speed (C). The pressure and speed are easy to control but the percent carbonation is more difficult to control during actual manufacturing because it varies with product temperature. However, for purposes of experiment, the engineer can control carbonation at three levels 10, 12, and 14 percent. She chooses two levels of pressure (25 and 30 psi) and two levels for the line

speed (200 and 250 bpm). She decides to run two replicates of factorial design in these three factors, with all 24 mins taken in random order. The response variable observed is the average deviation from the target full height observed in a production run of bottles at each set of condition. The data that resulted from this experiment is shown in the table below. Positive deviations are full heights above the target whereas negative are full height below the target.

	Operating Pressure (B)			
	25 PSI		**30 PSI**	
	Line Speed C		**Line speed C**	
Percent Carbonation A	200	250	200	250
10	-3 -1	-1 0	-1 0	1 1
12	0 1	2 1	2 3	6 5
14	5 4	7 6	7 9	10 11

Analyse the data and draw conclusions at $\alpha = 0.05$.