KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER

SPECIAL/SUPPLIMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

COURSE CODE: STA 312/STA 345

COURSE TITLE: EXPERIMENTAL DESIGN I

DATE: 12/01/2022   **TIME**: 11 AM -1:00 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

QUESTION 1 (30 MARKS)

a) Define the following terms:
   i) Treatment (1 mark)
   ii) Experimental unit (1 mark)
   iii) Hypothesis (1 mark)
   iv) Conjecture (1 mark)
b) Briefly discuss three principles of experimentation (6 marks)
c) State the assumptions of any statistical experimental design model (3 marks)
d) A production manager has designed three types of man – machine sequences, sequence 1, sequence 2 and sequence 3. Each sequence was observed for 8 days for the time in hours it takes to produce a product and results recorded as follows

Day	1	2	3	4	5	6	7	8
Sequence 1	15	14	11	15	11	13	14	12
Sequence 2	10	12	9	7	11	8	12	9
Sequence 3	11	5	9	10	6	8	8	7

For the 24 entries, use an F – test to analyse the differences in days and sequences. Take $\alpha = 0.0$
(17marks)

QUESTION 2 (20 MARKS)

Starting with a linear additive model of the form
$Y_{ij} = \mu + t_i + e_{ij}$ where
μ is the grand mean yield
t_i is the ith treatment effect and e_{ij} is the random error effect
Show that $S^2_T = S^2_e + S^2_t$,
where S^2_T is the total sum of squares, S^2_e is sum of squares due to random error and S^2_t is sum of squares due to treatment

And hence show that the mean sum of squares due to random error $\left(\frac{S^2_e}{N-K}\right)$ is an unbiased estimator of the error variance, δ^2_e

QUESTION 3 (20 MARKS)

a) A manufacturer of paper used for making grocery bags is interested in improving the tensile strength of the product. Product engineers thinks that tensile strength is a function of the hardwood concentration in the pulp and that the range of hardwood concentrations of practical interest is between 5% and 20%. A team of engineers responsible for the study decide to investigate four levels of hardwood concentration: 5%, 10%, 15% and 20%. They decide to make up six test specimens at each concentration level, using a pilot plant. All 24 specimens are tested on a laboratory tensile tester in a random order. The data from this experiment are shown in the table below

Hardwood concentration (%)	Observations					
	1	2	3	4	5	6
5	7	8	15	11	9	10
10	12	17	13	18	19	15
15	14	18	19	17	16	18
20	19	25	22	23	18	20

Test at 5% significance level whether or not the hardwood concentration causes a significance difference in the tensile strength. (10 marks)

b) Analyze the following randomized block design after estimating the missing value at 5% significance level. (10 marks)

Treatment	Blocks			
	1	2	3	4
T_1	19	-	23	26
T_2	26	28	27	33
T_3	20	29	22	26

QUESTION 4 (20 MARKS)

a) Highlight the main features of a balanced incomplete block design (5 marks)

b) Set up an analysis of variance for the following results in a Latin square design, taking $\alpha = 5\%$ (15 marks)

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

QUESTION 5 (20 MARKS)

In an agricultural station an experiment was performed to determine whether there was any difference in the yield of five varieties of maize. The design adopted was five randomized blocks of five plots each. The yield in kgs per plot obtained in the experiment are given below

Blocks	Varieties					
	V_1	V_2	V_3	V_4	V_5	Total
1	30	23	34	25	20	132
2	39	22	28	25	28	142
3	56	43	43	31	49	222
4	38	45	36	35	32	186
5	44	51	23	58	40	216
Total	207	184	164	174	169	898

i) Analyze the design and comment on your findings (15 marks)

ii) Obtain the efficiency of this design relative to its layout as CRD (5 marks)