THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

MAIN EXAMINATION

P.O. Box 62157

00200 Nairobi - KENYA

Telephone: 891601-6

Ext 1022/23/25

SEPTEMBER –DECEMBER 2021

FACULTY OF SCIENCE

DEPARTMENT OF MATHEMATICS

REGULAR PROGRAMME

MAT 363: DESIGN AND ANALYSIS OF EXPERIMENTS

Date: DECEMBER 2021	Duration: 2 Hours
INSTRUCTIONS: Answer Question ONE and any TWO Questions	

Q1.

a. Describe 3 factors that influence sample representativeness   **(3 marks)**

b. When might you sample the entire population?   **(3marks)**

c. Describe how the following terms are used in experimental designs
   (i)   Treatments
   (ii)   Experimental units
   (iii) Randomization
   (iv)   Experimental Error
   (v)   Experimental design   **(10 marks)**

d. (i) Fertilizer is applied to a plot of land containing corn plants, some of which will be harvested and measured. Identify the experimental unit and the measurement units.   **(2 marks)**
   (ii) Ingots of steel are given different heat treatments, and each ingot is punched in four locations to measure its hardness. Identify the experimental units and the measurement units.   **(2 marks)**

ISO 9001:2015 Certified by the Kenya Bureau of Standards

(iii) Mice are caged together, with different cages receiving different nutritional supplements. Identify the experimental unit, and the measurement units.

(2 marks)

e.
(i) Describe using a real life situation example how to set up and analyse an experiment using completely randomized design **(2 marks)**

(ii) A cosmetic company wants to produce silver nitrate for use in its cosmetics. It is interested in knowing the most productive procedure for producing the silver nitrate from dissolved silver. It is believed that stiring of the mixture of silvger and nitric acid during the dissolving process has an effect on the yield of silver nitrate crystals produced. To determine the optimal number of revolutions while stiring, the company has set up an experiment involving 15 identical samples randomly assigned to one of the three stiring scenarios. The yields of the three stiring options are shown below:-

Stiring Experiment Results

10 revolutions per minute	20 revolutions per minute	30 revolutions per minute
3.9	3.2	3.5
3.6	3.1	3.3
3.7	3.3	3.2
3.3	3.3	3.4
3.8	3.4	3.4

Analyze the variance into ANOVA table and test at 5% level of significance test the claim that the number of revolutions while starring has no effect on silver nitrate yield?

(6 marks)

Q2.

a. Describe with examples how to set up and analyze the following experimental designs
   (i)   A randomized block design.   **(3 marks)**
   (ii)   Latin square design   **(3marks)**
   (iii) Graeco Latin Design   **(3 marks)**

ISO 9001:2015 Certified by the Kenya Bureau of Standards

(iv)   Factorial Design   **(3 marks)**

b. Consider the experiment result for a randomized block design with three treatments A;B;C and blocking effects 1;2;3;4. The experimental results are as shown in the table below:-

Treatment/Blocks	A	B	C
1	10	9	9
2	13	6	6
3	18	15	14
4	21	19	19
5	8	8	9

(i)   Make the calculations necessary and setup the analysis of variance table

(6marks)

(ii)   Test for significant differences for both treatment and block effects at $\alpha=0.05$ level of significance.

(2marks)

Q3(a) Randomization methods can be either physical or numerical. Describe two physical and two numerical randomization methods used in assigning experimental units to different treatments using practical examples   **(4marks)**

(b) ANOVA computations are summarized in a table with columns for source of variation, degrees of freedom, sum of squares, mean squares, and Fstatistics. There is a row in the table for every source of variation in the full ANOVA table model. In the CRD, the sources of variation are treatments and errors, sometimes called between and within-groups variation. Fill in and describe each of the entry for a generic ANOVA table for a Completely Randomized Design(CRD).   **(6marks)**

(c) A research firm tests miles per gallon characteristics of three brands of gasoline. Because of different gasoline performance characteristics in different brands of automobiles five brands of automobiles are selected and treated as blocks in the

ISO 9001:2015 Certified by the Kenya Bureau of Standards

experiments where each brand of automobile is tested with each type of gasoline. The results of the experiment (in miles per gallon) is as shown in table below: -

Gasolines/ Automobiles	I	II	III
A	18	21	20
B	24	26	27
C	30	29	34
D	22	25	24
E	20	23	24

(i)Analyze the experimental data using appropriate ANOVA procedure.   **(6marks)**

(ii) Test at α=0.05 level of significance the difference in the mean miles per gallon characteristics of the three brands of gasoline.   **(4marks)**

Q4.

   (a) Describe each of the following steps followed in setting up an experimental design:-

   i.   Problem definition(step 1)

   ii.   Goals and objectives formulation(step 2)

   iii.   Experimental design development/methodology (step 3)

   iv.   Data analysis and interpretation (step 4)

   v.   Results and discussions (step 5)   **(15 marks)**

   (b) Describe and differentiate between a cross-sectional and a longitudinal research design?   **(5marks)**

Q5(a Mechanical parts such as computer disk drives, light bulbs, and glue bonds eventually fail. Buyers of these parts want to know how long they are likely to last, so manufacturers perform tests to determine average lifetime, sometimes expressed as mean time to failure, or mean time between failures for repairable items.

   (a) Carry out Preliminary Exploratory and graphical Analysis   **(8marks)**

(b) Conduct ANOVA and test for treatment effect of Temperature on lifetime
(12marks)

Temperature (°C)				
175	194	213	231	250
2.04 1.85	1.66 1.66	1.53 1.35	1.15 1.21	1.26 1.02
1.91 1.96	1.71 1.61	1.54 1.27	1.22 1.28	0.83 1.09
2.00 1.88	1.42 1.55	1.38 1.26	1.17 1.17	1.08 1.06
1.92 1.90	1.76 1.66	1.31 1.38	1.16	

END

ISO 9001:2015 Certified by the Kenya Bureau of Standards