JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL, PHYSICAL, MATHEMATICS AND ACTUARIAL SCIENCE

UNIVERSITY EXAMINATION FOR DIPLOMA IN APPLIED STATISTICS

2ND YEAR 1ST SEMESTER 2024/2025 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: WAB 2217

COURSE TITLE: Designing Research Experiments I

EXAM VENUE: **STREAM:**

DATE: **EXAM SESSION:**

TIME: 2.00 HOURS

Instructions:

1. **Answer question one (compulsory) and any other three questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Section A

Question 1 [40 marks]

a) Define the following terms as used in factorial designs. (4 Marks)
   i. A factor
   ii. A level
   iii. An Experimental Treatment
   iv. Yield

b) In an experimental design, the total variation in a set of observations is attributed to two main causes. Identify and explain these two causes. (4 Marks)
c) There are important techniques for avoiding systematic errors and increasing precision. State four of these techniques. (4 Marks)
d) What is SMART objective (4 Marks)
e) State four assumptions used in ANOVA (4 Marks)
f) The mass of a certain object is required to be at least 150g. Past experience has indicated that the standard deviation of mass is $\sigma = 3$ g. A random sample of four specimens is tested. The results are y1=145, y2=153, y3=150 and y4=147.
   i. State the hypotheses that you think should be tested in this experiment (2 Marks)
   ii. Test these hypotheses using $\alpha = 0.05$. What are your conclusions? (3 Marks)
   iii. Construct a 95% confidence interval on the mean mass of the object. (4 Marks)
g) Define hypothesis and give the types (3 Marks)
h) What is the difference between observational studies and experimental studies in research? (2 Marks)
i) Define the term "response variable" and explain its role in experimental design. (2 Marks)
j) Describe the difference between primary data and secondary data in research. How does experimental design rely on these? (4 Marks)

Question 2 [20 marks]

An investigator wishes to study the effect of four different drugs on pain alleviation. He administered each drug at random to 12 patients with similar complaints and of the same age bracket. Each drug was randomly given to 3 of the twelve patients and the response to pain alleviation recorded as shown in minutes. By stating the hypothesis clearly, analyze the effect of drug pain alleviation at 5% level of significance.

Drug		Observation	
A	30	25	20
B	28	26	31
C	35	32	30
D	29	26	25

Question 3 [20 marks]

a) Describe any 3 tools used in collecting primary data. (6 Marks)
b) Describe the two types of errors that are associated with the hypothesis testing. (4 Marks)
c) Describe the sources of variations as used in ANOVA (10 Marks)

Question 4 [20 marks]

a) A manufacturer of television sets is interested in the effect of tube conductivity of four different types of coating for colour picture tubes. The following conductivity data are obtained:

Coating type	conductivity			
1	143	141	150	146
2	152	149	137	143
3	134	136	132	127
4	129	127	132	129

Is there a difference in conductivity due to coating type? Use $\alpha = 0.05$ (10 Marks)

b) The principles of experimental design help researchers minimize bias, control variables, and draw meaningful conclusions from their experiments. Describe with examples the following principles of experimental designs.

i. Randomization (4 Marks)
ii. Replication (3 Marks)
iii. Blocking (3 Marks)

Question 5 (20marks)

a) The data provided represents grain yields (in kilograms per hectare) from different agricultural treatments.

treatment	Grains yield, kg/ha				Treatment total	Treatment mean
Dol- Mix (1kg)	2537	2609	2104	1797	8507	2127
Dol- mix (2kg)	3366	2591	2211	2544	10712	2678
DDT+ BHC	2536	2459	2827	2385	10207	2552
Azodrin	2387	2453	1556	2116	8512	2128
Dimecro-boom	1796	1704	1904	1320	6724	1681
Dimecro – knap	1796	1704	1904	1320	6274	1681
control	1401	1516	1270	1077	5264	1316

Is there any significance difference in the output (yield) at 95% confidence level? (10 Marks)

b) A company selling coffee appoints four salesmen A, B, C and D and observes their sales in three seasons, summer, winter and monsoon. The figures in kilograms are given below in Randomized Complete Block Design.

Salesman / **Season**	A	B	C	D
Summer	30	25	33	20
Winter	28	26	31	35
monsoon	32	30	32	32

i. Describe briefly two important properties of the experimental design that has been used in the summary of this survey. (2 Marks)

ii. Carry out an analysis of variance and comment on your results (8 Marks)

Question 6 [20 Marks]

a) Consider a randomized complete block design modeled as
$y_{ij} = \mu + t_i + b_j + e_{ij}$

i. Briefly describe characteristics of this design. (3 Marks)

ii. Stating all necessary assumptions, derive the estimates of the model parameters hence show clearly how one may partition the sum of squares due to total variation into desired component sum of squares. (7 Marks)

b) An investigator carried out an experiment using a randomized complete block design with V treatments $i = 1,2,3, \dots, V$ and B blocks = $1,2,3, \dots, b$. Before he could conclude his study, one subject disappeared and no observation could be made on him. Let the missing observation be X. Derive an equation from which X may be estimated. (10 Marks)