



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY  
SCHOOL OF BIOLOGICAL, PHYSICAL, MATHEMATICS AND ACTUARIAL  
SCIENCES  
UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF SCIENCE IN  
ACTUARIAL SCIENCE**

**3<sup>rd</sup> Year 2<sup>nd</sup> SEMESTER 2021/2022 ACADEMIC YEAR  
MAIN REGULAR**

---

**COURSE CODE: WAB 2314**

**COURSE TITLE: DESIGN AND ANALYSIS OF EXPERIMENTS**

**EXAM VENUE: STREAM: (BSc Actuarial Science)**

**DATE: EXAM SESSION: May-August 2022**

**TIME: 2.00 HOURS**

---

**Instructions:**

- i. Answer questions one and any other two.
- ii. Candidates are advised not to write on the question paper.
- iii. Candidates must hand in their answer booklets to the invigilator while in the examination room.
- iv. Computations and data analysis may be done with any statistical software.

### QUESTION ONE

a. Ten candidates sat for two aptitude tests A and B, and the results were as follows.

candidate	1	2	3	4	5	6	7	8	9	10
Test A	20	15	13	10	14	15	18	19	14	12
Test B	6	8	8	4	5	7	3	6	8	9

It is thought that there is some association between the two tests. By clearly stating the null and alternative hypothesis, test for the statistical association at 5% level of significance using appropriate method.

(4 marks)

b. The following output was obtained from a computer program that performed a two-factor ANOVA on a factorial experiment. Use  $\alpha = 0.05$ .

Two-way ANOVA: y versus, A, B					
Source	DF	SS	MS	F	P
A	1	0.523			
B		80.554	40.2771	4.59	
Interaction					
Error	12	105.327	8.7773		
Total	17	231.752			

- Fill in the blanks in the ANOVA table. You can use bounds on the P-values. (5 marks)
  - How many levels were used for factor B? (2 mark)
  - How many replicates of the experiment were performed? (2 mark)
  - What conclusions would one draw about this experiment? (2 mark)
- c. Four catalysts that may affect the concentration of one component in a three-component liquid mixture are being investigated. The following concentrations are obtained from a completely randomized experiment:

Catalyst			
1	2	3	4
58.2	56.3	50.1	52.9
57.2	54.5	54.2	49.9
58.4	57.0	55.4	50.0
55.8	55.4		51.7
55.2			

- Do the four catalysts have the same effect on the concentration (2 mark)
  - Analyze the residuals from the experiment and discuss normality assumption of the error terms (2 mark)
  - Construct a 99% confidence interval estimate of the mean response for catalyst 1. (3 mark)
- d. Consider the hardness testing experiment in the table below. Suppose that the experiment and that C-sale data (coded by subtracting 40 units) obtained and provided as below. Use  $\alpha = 0.05$ .

		Coupon		
Tip	1	2	3	4

1	9.3	9.4	9.8	10.0
2	9.4	9.3	9.8	9.9
3	9.2	9.4	9.5	9.7
4	9.7	9.6	10.0	10.2

- i. Analyze the data from this experiment and test significance of the treatments (2 mark)
- ii. Use the Fisher LSD method to make comparisons among the four tips (2 mark)
- iii. Determine specifically which tips would be most recommended based on the posthoc test (2 mark)
- iv. Analyze the residuals from this experiment and assess normality assumptions (2 mark)

## QUESTION TWO

a) Iron intake of antenatal mothers in different periods of pregnancy in 10 villages is provided below.

Antenatal period (Trimester)	Villages										Total of each trimester
	1	2	3	4	5	6	7	8	9	10	
I	11.5	19.5	18.5	12.5	18.5	16.5	26.5	18.5	16.5	24.5	182.5
II	27.0	28.0	22.0	21.0	15.0	19.5	20.0	26.0	30.0	28.5	237.0
III	28.0	30.0	26.0	30.0	24.5	28.5	26.0	30.0	27.0	25.5	275.5
Total of village	66.5	77.5	66.5	63.5	58.0	64.5	72.5	74.5	73.0	78.5	695.0

Test the hypothesis that the iron intake in the different periods is significantly not different at 95% confidence level. (10 marks)

b. Use **corndata2021** provided here

<https://drive.google.com/drive/folders/1EAe1chgNhwqEsi9Cvu7FohnpCc3N3FD?usp=sharing> to answer the following questions. Develop a simple linear regression model of **corn**(y) on **soybean**(x) and at 95% level and answer the following questions

- i. Provide mean and standard deviations of corn and soybean (1 marks)
- ii. Provide intercept and slope parameters and interpret accordingly (1 marks)
- iii. Write down model connecting the two variables including the estimated parameters (2 marks)
- iv. Give confidence interval for the two regression parameters (2 marks)
- v. Provide coefficient of determination and interpret (1 marks)
- vi. Develop an ANOVA table for the model and use it to test the hypothesis that  $\beta_1=0$  (2 marks)
- vii. Use the confidence interval to test the hypothesis on the slope parameter  $\beta_1$ . Compare (v) and (vi) (1 marks)

### QUESTION THREE

A company studied the effect of 3 different types of promotions on sales of its craters. Fifteen (n=15) stores were selected at random for the study with five stores assigned to each promotional type. Data on the number of cases of product sold during a previous promotional period (x) and on the current period (y) given below.

Promotion type	1		2		3		4		5	
	y <sub>i1</sub>	x <sub>i1</sub>	y <sub>i2</sub>	x <sub>i2</sub>	y <sub>i3</sub>	x <sub>i3</sub>	y <sub>i4</sub>	x <sub>i4</sub>	y <sub>i5</sub>	x <sub>i5</sub>
1	38	21	39	26	26	22	45	28	33	19
2	43	34	38	26	38	29	27	18	34	25
3	24	23	32	39	31	30	21	16	28	29

Fit an ANACOCA model to these data and assess whether there was promotional type effect on the sales after adjusting for the previous sales (use alpha=0.05) (20 marks)

### QUESTION FOUR

- a. The following table gives the retail prices of a farm input sold in agrovets selected at random from four towns. Due to government policies, it is assumed that the shops should on average operate at the same retail price. Carry out ANOVA to test the significance of the difference between the prices of the commodity in the four towns at 5% level. State clearly the test hypothesis. (10 Marks)

TOWN	PRICES OF COMMODITY			
<b>A</b>	22	24	26	23
<b>B</b>	20	19	23	18
<b>C</b>	16	14	19	17
<b>D</b>	29	27	26	24

- b. Use **sweetpotato** dataset provided here (<https://drive.google.com/drive/folders/1EAe1chgNhwqEsi9Cvu7FohnpCc3N3FD?usp=sharing>) to answer the following questions. The data correspond to an experiment with costanero sweetpotato made at the locality of the Tacna department, southern Peru. The effect of two viruses (Spmv and Spcsv) was studied. The treatments were the following: CC (Spcsv) = Sweetpotato chlorotic dwarf, FF (Spmv) = Feathery mottle, FC (Spmv y Spcsv) = Viral complex and OO (witness) healthy plants. In each plot, 50 sweetpotato plants were sown and 12 plots were employed. Each treatment was made with 3 repetitions and at the end of the experiment the total weight in kilograms was evaluated. The virus transmission was made in the cuttings and these were sown in the field.
- State and explain when one way analysis is used in design and analysis of experiments? (2 marks)
  - Test whether or not sweet potato yields variability had anything to do with the type of virus. (2 marks)
  - Use an appropriate posthoc test and interpret your results (2 marks)

- iv. Suggest an alternative statistical test for the problem (2 marks)
- v. Use the proposed alternative test to carry out statistical analysis of the effect of viruses on the amount of sweet potato yields (2 marks)

**QUESTION FIVE**

Johnson and Leone (Statistics and experimental Design in Engineering and the Physical Sciences, Wiley, 1977) describe an experiment to investigate warping of copper plates. The two factors studied were temperature and the copper content of the plates. The two factors studied were a measure of the amount of warping. The data were as follows:

	Copper content (%)			
Temperature (deg celsius)	40	60	80	100
50	17,20	16,21	24,22	28,27
75	12,9	18,13	17,12	27,31
100	16,12	18,21	25,23	30,23
125	21,17	23,21	23,22	29,31

- i. Is there any indication that either factor affects the amount of warping's? (2 marks)
- ii. Is there any interaction between the factors? Use  $\alpha = 0.05$ . (3 marks)
- iii. Analyze the residuals from this experiment (3 marks)
- iv. Plot the average warping at each level of copper content and compare them to an appropriately scaled t distribution. (4 marks)
- v. Describe the differences in the effects of the different levels of copper content on warping. (3 marks)
- vi. If low warping is desirable, what level of copper content would you specify? (3 mark)
- vii. Suppose that temperature cannot be easily controlled in the environment in which the copper plates are to be used. Does this change the answer in part (iv and v) (4 marks)