



GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENTS OF MINING AND METALLURGY

ENGINEERING MATHEMATICS IV

EMN/EMG 2201

Examination Paper

APRIL 2024

This examination paper consists of 6 printed pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Mr. R. G. Moyo

INSTRUCTIONS

Candidates should answer **ALL** questions in Section A and any **THREE** questions in Section B.

ADDITIONAL REQUIREMENTS

Scientific calculator
Statistical tables

SECTION A (40 marks)

Answer ALL questions from this section.

A1. Define the following terms as they are used in statistics.

- (i) Replication [2]
- (ii) Statistics [2]
- (iii) Analysis of Variance (ANOVA) [2]
- (iv) Variance [2]

A2. Angela is a student who finished her advanced level in December 2023. This lady has a passion for Mining Engineering. After doing her research, she discovered that there are only three Universities in Zimbabwe offering Mining Engineering for the August 2024 intake. These universities are GSU, UZ, and MSU and she can't apply to more than 1 university. The probability that she applies at GSU is 0.5 and the probabilities that she will apply at UZ and MSU are 0.3 and 0.2 respectively. If she applies at GSU, the probability that she will be accepted is 0.68, and the probabilities that she will be accepted at MSU and UZ are 0.73 and 0.51 respectively.

- (i) Present this scenario using a tree diagram. [3]
- (ii) Find the probability that she applied at GSU given that she was accepted [5]

A3. The diameters of steel shafts produced by a certain manufacturing process should have a mean diameter of 0.255 inches. The diameter is known to have a standard deviation of 0.0001 inch. A random sample of 10 shafts has an average diameter of 0.2545 inch. Can we conclude, at 5% level of significance, that the mean diameter of steel shafts has changed? [7]

A4. An insurance company receives on average 3 claims per week. Assuming that the claims can be modeled by a Poisson distribution, find the probability that it receives

- (i) 4 claims in a given week [2]
- (ii) more than 4 claims in a given week [4]
- (iii) no claims on a given day given that the company closes every Friday [3]

A5. Part 1 Geomatics and Surveying class consist of 8 block and 7 conventional students. 5 students from this class were chosen to do a particular task.

- (i) From the five selected students, find the probability that exactly four were block students [3]
- (ii) Find the expected number of conventional students to chosen for this particular task [2]
- (iii) Calculate the variance for the block students [3]

SECTION B (60 marks)**Answer ANY THREE questions from this section.**

- B6.** An experiment was carried out to determine the effect of 5 different formulations of rocket propellant used in aircrew escape system on the observed burning rate. Each formulation is mixed from a batch of raw materials that is only large enough for five formulations to be tested. The formulations are also prepared by several operators and there may be substantial differences in the skills and experiences of the operators. The results of this experiment are summarised below

Batches of Raw materials	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5
1	P=24	Q=20	R=19	S=24	T=24
2	Q=17	R=24	S=30	T=27	P=36
3	R=18	S=38	T=26	P=27	Q=21
4	S=26	T=31	P=26	Q=23	R=22
5	T=22	P=30	Q=20	R=29	S=31

Test for the significant differences between the 5 formulations using $\alpha = 5\%$. Was using different batches of raw materials and having different operators necessary? [20]

- B7.** (i) The Dean of students at Gwanda state university claims that there is an association between students' performance in Statistics and Department. Students from the departments of Geography, Mining and Metallurgical Engineering were given an examination to write. The results of the students are summarized in the table below

Students' symbol	Department of Geography	Department of Mining	Department of Metallurgy
Distinction	12	15	3
Credit	8	8	8
Pass	5	7	9

Formulate a null and hypothesis and use a Chi-square test to test, at 1% level of significance, whether there is an association between students' performance and department. [9]

- (ii) Use **APPENDIX A** to answer the following questions
- APPENDIX A is an SPSS output for a regression analysis of 2 variables. The researcher was analyzing the relationship that exist between the price of a car and its age.
- Of the two variables, state the dependent and the independent variable. [2]
 - Write down the equation of the regression line of the price of a car on age [2]
 - Write down the 95% confidence interval for the regression line constant [2]
 - State the co-efficient of determination and comment on the relationship that exist between the price and age of a car. [2]

- (e) Do an appropriate tests to determine the significance of the age of the car in determining the price of a car. [4]

B8. A polymer is a large molecule, or macromolecule, composed of many repeated sub-units. These sub-units, known as monomers, are covalently bonded to form a long chain. An Engineer was interested in the effect of two factors on the strength of sheet castings of polymer. One factor was time in a polymerization bath with 1% catalyst. The other factor was the temperature of the polymerization bath. The engineer tried two times (20 minutes and 60 minutes) and two temperatures (100° and 120°). He treated samples of polymer under each of the four sets of conditions and then he measured flexural strength (in pounds per square inch or psi) on samples of sheet castings of the polymer. The results of this experiment are summarized in the table below

The corrosion fatigue data, expressed in thousands of cycles to failure, were recorded as follows

Time in bath with 1% catalyst	Temperature of polymerization bath 100°	Temperature of polymerization bath 120°
20 minutes	9.5	11.3
	10.65	11.75
	9.7	11.6
	9.95	11.65
	10.1	11.7
60 minutes	11.5	10.9
	11.65	11.5
	11.25	11.85
	11.25	11.7
	11.9	11.65

Perform an Analysis of Variance (ANOVA) using $\alpha = 0.05$ to test for significant main and interaction effects. Also test for the significant differences between the 4 treatments. Hence compute the standard errors for comparing treatment means. [20]

- B9.** (a) If $X \sim N(5.2; \frac{0.042^2}{5})$. Calculate the 95% confidence interval for μ [3]
- (b) An experiment was performed to compare the abrasive wear of two different laminated materials. 12 pieces of material one were tested by exposing each piece to a machine measuring wear. 10 pieces of material two similarly tested. In each case, the depth of wear was observed. The samples of material one gave an average wear of 85 units with a sample standard deviation of 4 while the samples of material 2 gave an average of 81 with a sample standard deviation of 5. Can we conclude at the 5% level of significance that the abrasive wear of material 1 exceeds that of material 2 by more than 2 units?. Assume the population to be normal with equal variances. [8]

- (c) If X is a continuous random variable with a probability density function given by

$$f(x) = \begin{cases} \frac{x}{3}, & \text{if } 0 \leq x \leq 2 \\ -\frac{2}{3}x + 2, & \text{if } 2 \leq x \leq 3 \\ 0, & \text{otherwise} \end{cases}$$

I. Find $P(1.5 \leq X \leq 2.6)$

[4]

II. Calculate $Var(x)$

[5]

END OF QUESTION PAPER

APPENDIX A

Regression

[DataSet0]

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	age ^b	.	Enter

a. Dependent Variable: price

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.924 ^a	.853	.837	1.25766

a. Predictors: (Constant), age

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	82.850	1	82.850	52.380	.000 ^b
	Residual	14.235	9	1.582		
	Total	97.085	10			

a. Dependent Variable: price

b. Predictors: (Constant), age

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	19.547	1.524		12.826	.000
	age	-2.026	.280	-.924	-7.237	.000

a. Dependent Variable: price