



GWANDA STATE UNIVERSITY

EMI/EMR: 2201

FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENTS OF MINING AND METALLURGY

ENGINEERING MATHEMATICS IV

EPOCH MINE CAMPUS

MR R.G. MOYO

SECOND SEMESTER EXAMINATIONS: 2022

Time : 3 hours

Candidates should attempt **ALL** questions from SECTION A and **ANY THREE** questions from SECTION B.

**Instruments and Materials**

- Graph paper
- Statistical Tables
- Scientific Calculator

## SECTION A (40 marks)

Answer ALL questions from this section.

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

- (a) Probability [1]
- (b) Treatment [2]
- (c) Replication [2]
- (d) Null Hypothesis [2]

A2. Part 2 Mining class consist of 11 male and 23 female students. Mr Ndlovu, the departmental chairperson selected 10 students from this class for a departmental photo shoot. Calculate

- (a) the probability that, from the 10 students selected, exactly 5 were male. [3]
- (b) the expected number of female students to be selected. [2]
- (c) the variance for male students. [3]

A3. Early this semester, Gwanda state university's water pump broke down. The university management saw it fit to surply water using a 1000 litre jojo tank. This initiative was welcomed by both students and members of staff. The probability that the jojo truck delivered water on any particular day was 0,5. Since the winter season had started, many students took advantage of water shortages and skipped bathing. The probability that student 'X' bathed on any particular day when the water was delivered and not delivered was 0.25 and 0.027 respectively.

- (a) Represent the above scenario by a means of a tree diagram. [4]
- (b) Find the probability that student 'X' did not bath on any given day. [3]
- (c) Find the probability that the water was not delivered and student 'X' did bath. [3]

A4. Let X be a continuous random variable with a probability density function given by

$$f(x) = \begin{cases} \frac{x}{3} & 0 \leq x \leq 2 \\ \frac{-2}{3}x + 2 & 2 \leq x \leq 3 \\ 0 & otherwise \end{cases} \quad (1)$$

- (a) Sketch  $f(x)$  [2]
- (b) Calculate  $P(1.33 \leq x \leq 2.8)$  [3]
- (c) Calculate  $E(2x)$  [4]
- (d) Calculate  $\text{Var}(2x)$  [6]

## SECTION B (60 marks)

Answer ANY THREE questions from this section.

- A5. (a) Mr Nkomo, the chairperson for the department of Metallurgical Engineering at Gwanda State university claims that his students perform much better than Mining students. The students from the 2 departments were then given a test to write and the results from the test are summarized in the table below.

Department	Number of students	Mean mark	Standard Deviation
Metallurgy	12	46.31	6.44
Mining	10	2.79	7.52

Test Mr Nkomo's claim. Use  $\alpha = 0.05$  [7]

- (b) The Dean of studies at Gwanda state university believes that there is a connection between students results symbols in Statistics and department. Students from Geomatics, Mining and Metallurgy departments were given an examination and their symbols were recorded. The table below shows students' symbols and their respective departments.

Students' symbols	Geomatics	Mining	Metallurgy
Distinction (D)	12	15	3
Credit (C)	8	8	8
Fail (F)	5	7	9

Formulate the null and alternative hypothesis and use a chi-square test to test at 1% level of significance, whether there is an association between students' symbols and departments. [13]

- A6. (a) GSU Admission department receive an average of 6 applicants for undergraduate admissions per week. Assuming that the number of applicants follow a poisson distribution, calculate
- (i) the probability that the department will receive exactly four applications on any given week. [2]
  - (ii) the probability that the Admissions department will receive exactly 5 applications in a given hour given that the university opens from Monday to Friday, 8 hours a day. [3]

- (b) An experiment was carried out to determine the effect of 4 different chemicals on the strength of fabric. These chemicals are used as part of the permanent press finishing process. 5 Fabric samples were selected and a randomized complete block design was run by testing each chemical type once in a random order on each fabric sample. The data are shown in the table below.

Chemical Type (Treatment)	Fabric Sample 1	Fabric Sample 2	Fabric Sample 3	Fabric Sample 4	Fabric Sample 5
A	1.3	1.6	0.5	1.2	1.1
B	2.2	2.4	0.4	2.0	1.8
C	1.8	1.7	0.6	1.5	1.3
D	3.9	4.4	2.0	4.1	3.4

Test for the significant differences in means using ANOVA with  $\alpha = 0.05$ . Was blocking necessary? [15]

- A7. (a) If X follows  $N(5.34, \frac{0.042^2}{5})$ . Calculate the 99% confidence interval for the population mean. [3]
- (b) An experiment involving a storage battery used in the launching mechanism of a shoulder-fired ground-to-air missile was carried out. Three material types can be used to make the battery plates. The objective is to design a battery that is relatively un-affected by the ambient temperature. The output response from the battery is effective life in hours. Three temperature levels are selected and a factorial experiment with four replicates is run. The data are as follows:

Material	Temperature $^{\circ}F$ (Low)	Temperature $^{\circ}F$ (Medium)	Temperature $^{\circ}F$ (High)
1	130 155 74 180	34 40 80 75	20 70 82 58
2	150 188 159 126	136 122 106 115	25 70 5 45
3	138 110 168 160	174 120 150 139	96 104 82 60

Carry out a complete analysis of variance to test for the significance of main and interaction effects. Use  $\alpha = 0.05$ . Also compute the standard errors for comparing any 4 temperature means. [17]

- A8.** (a) Differentiate between Type 1 and Type 2 error. [4]
- (b) Use **APPENDIX A** to answer the following questions  
APPENDIX A is an SPSS output for a regression analysis of 2 variables. The researcher wanted to compare the linear relationship that exist between the price of a car and its age.
- (i) Of the 2 variables, state the dependent and the independent variable. [2]
- (ii) Write down the equation of the regression line of the price of a car on age. [3]
- (iii) Use the regression line to estimate the price of a 6.5 year old car. [3]
- (iv) Write down the 95% confidence interval for the regression line constant. [2]
- (v) Write down the coefficient of determination and comment on the linear relationship that exist between the price and age of a car. [2]
- (vi) Comment on the significance of the age of the car in determining the price of a car. [4]

**END OF QUESTION PAPER**

*“Mathematics may not teach us how to add love or subtract hate  
But it gives us hope that every problem has a solution”* Anonymus

## APPENDIX A

### Regression

[DataSet0]

Variables Entered/Removed<sup>a</sup>

Model	Variables Entered	Variables Removed	Method
1	Age <sup>b</sup>	.	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	.834 <sup>a</sup>	.696	.658	2.4416

a. Predictors: (Constant), Age

ANOVA<sup>a</sup>

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	109.277	1	109.277	18.331	.003 <sup>b</sup>
	Residual	47.692	8	5.961		
	Total	156.969	9			

a. Dependent Variable: Price

b. Predictors: (Constant), Age

Coefficients<sup>a</sup>

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	20.468	2.970		6.892	.000	13.620	27.317
	Age	-2.361	.552	-.834	-4.281	.003	-3.633	-1.089

a. Dependent Variable: Price