GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND THE ENVIRONMENT

DEPARTMENT OF GEOMATICS AND SURVEYING

PROBABILITY THEORY AND STATISTICS

ESG 1111

Main Examination Paper

APRIL 2025

This examination paper consists of 5 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
Graph paper

SECTION A (40 marks)

Answer ALL questions from this section.

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

(i) Geostatistics [2]

(ii) Regression [2]

(iii) Analysis of Variance (ANOVA) [2]

A2. 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? [6]

A3. 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) 5 claims in a given week [2]

(ii) more than 4 claims in a given fortnight. [4]

(iii) no claims on a given day given that the company closes every Saturday [3]

A4. Part 1 Geomatics and Surveying class consist of 8 block and 7 conventional students. 5 students from this class were selected to do a surveying task at GSU Gwanda town campus.

(i) From the five selected students, find the probability that exactly three were conventional students [3]

(ii) Find the expected number of block students. [2]

(iii) Calculate the variance for the block students [3]

A5. 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 $Var(7x)$ [7]

SECTION B (60 marks)

Answer ANY THREE questions from this section.

B6. Fit a multiple linear regression for the following data. Use y as the dependent variable depending on x_1 and x_2. [20]

y	1.45	1.93	0.81	0.61	1.55	0.95	0.45	1.14	0.74	0.98	1.41
x_1	0.58	0.86	0.29	0.20	0.5	0.28	0.08	0.41	0.22	0.35	0.59
x_2	0.71	0.13	0.79	0.20	0.56	0.92	0.01	0.60	0.70	0.73	0.13

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 Geomatics, 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 Geomatics**	**Department of Mining**	**Department of Metallurgy**
Distinction (D)	12	15	3
Credit (C)	8	8	8
Pass (P)	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.

(a) Of the two variables, state the dependent and the independent variable. [2]

(b) Write down the equation of the regression line of the price of a car on age [2]

(c) Write down the 95% confidence interval for the regression line constant [2]

(d) 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 its price. [3]

B8. Given the following data

Distance	1	2	3	4	5	6	7	8	9	10
Z(u)	128.3	294.2	405.8	484.4	349.1	442.5	344.4	435.3	424.6	395.6

(i) Calculate $\gamma(1)$ to $\gamma(9)$ [15]

(ii) Sketch the variogram [5]

B9. (i) 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]

(ii) The effective life of insulating fluids at an accelerated load of 35 kV is being studied. Test data have been obtained for four types of fluids. The results from a completely randomized experiment were as follows:

Fluid Type	**Life**	**(in hrs)**	**at 35**	**kV**	**Load**	
1	17.6	18.9	16.3	17.4	20.1	21.6
2	16.9	15.3	18.6	17.1	19.5	20.3
3	21.4	23.6	19.4	18.5	20.5	22.3
4	19.3	21.1	16.9	17.5	18.3	19.8

Is there any indication that the fluids differ? Use $\alpha = 0.05$ [9]

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