



**GWANDA STATE UNIVERSITY**  
**FACULTY OF ENGINEERING AND THE ENVIRONMENT**  
**DEPARTMENTS OF MINING AND METALLURGY**

**ENGINEERING MATHEMATICS IV**

**EMN/EMG 2201**

**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  
Statistical Tables

## SECTION A (40 marks)

**Answer ALL questions from this section.**

**A1.** Define the following terms

- (i) Type 1 error [2]
- (ii) Alternative Hypothesis [2]
- (iii) Correlation [2]
- (iv) Treatment [2]

**A2.** Differentiate between descriptive and inferential statistics [4]

**A3.** In a certain court, there are only two verdicts on passing judgment namely 'Convicted' or discharged. Of all the cases that have been tried by this court, 80% of the verdicts were convictions. Suppose that when the court's verdict is 'Convicted' or 'Discharged', the probabilities of the accused being innocent are 0.07 and 0.4 respectively.

- (i) Represent this scenario by a means of a tree diagram [2]
- (ii) Find the probability that a person tried by this court is not innocent. [3]

**A4.** The viscosity of a liquid detergent is supposed to have an average of 800 centistokes at  $25^{\circ}C$ . A random sample of 16 batches of detergent is collected, and the average viscosity is 812. Suppose we know that the standard deviation of viscosity is 25 centistokes. Does this provide evidence that the viscosity of liquid detergent has changed?. Use  $\alpha = 5\%$  [7]

**A5.** Lengths of metal strips produced by a machine are normally distributed with a mean length of 150cm and a standard deviation of 10cm. Find the probability that the length of a randomly selected strip is

- (i) shorter than 165cm [3]
- (ii) within 5cm of the mean [4]

**A6.** The department of Mining Engineering has a total of 101 male and 95 female students. A random sample of 10 students is drawn from this department. Find

- (i) the probability that from this sample, exactly 4 were female [3]
- (ii) the expected number of male students to be included in the sample. [2]
- (iii) the variance for the female students [4]

## SECTION B (60 marks)

Answer ANY THREE questions from this section.

**B7.** (i) If  $X \sim N(5.2; \frac{0.042^2}{5})$ . Find the 95% confidence interval for  $\mu$  [3]

(ii) According to Chemical Engineering, an important property of fiber is its water absorbency. The average percent absorbency of 25 randomly selected pieces of cotton fiber was found to be 20 with a standard deviation of 1,5. A random sample of 23 pieces of acetate yielded an average percent of 12 with a standard deviation of 1,25. Is there strong evidence that the population mean percent absorbency is significantly higher for cotton fiber than for acetate?. Assume that the percent absorbency is normally distributed and that the population variances in percent absorbency for the two fibers are the same, Use  $\alpha = 0.05$  [6]

(iii) If  $X$  is a continuous random variable with a probability density function given by

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

(a) Sketch  $f(x)$  [2]

(b) Find the mode [1]

(c) Find  $P(1.2 \leq X \leq 2.3)$  [3]

(d) Find the 85<sup>th</sup> percentile [5]

**B8.** (i) The dataset for known locations can be used to contract a simple linear regression model to express drain currency  $y$  (in milliaperes) as a function of ground-to-source voltage  $x$  (in volts). The data are as follows:

y	x	y	x
0.734	1.1	1.50	1.6
0.886	1.2	1.66	1.7
1.04	1.3	1.81	1.8
1.19	1.4	1.97	1.9
1.35	1.5	2.12	2.0

(a) Fit an equation of a regression line for  $y$  on  $x$  and use it to estimate the value of  $y$  when  $x=1.45$  [5]

(b) Find the product moment correlation co-efficient and the coefficient of determination. Hence comment on the relationship that exist between  $x$  and  $y$  [5]

(ii) Three samples are taken comprising of 120 mining students, 150 metallurgy students and 130 Geography students. Each student is asked to select one of the three categories that best represents their feeling towards the introduction of modular learning. The three categories are 'in favour of the policy'(F), 'against the policy'(A), and 'indifferent towards the policy'(I). The results of the interviews are given in the following table

DEPARTMENT	In Favor (F)	Against (A)	Indifferent (I)
Mining	80	30	10
Metallurgy	70	40	40
Geography	50	50	30

On the basis of this data can it be concluded that the views of Mining, Metallurgy , and Geography students are homogeneous in so far as the introduction of modular learning is concerned. Use  $\alpha = 0.1\%$  [10]

- B9.** (i) Differentiate between a Randomized Complete Block Design (RCBD) and a Latin square. [4]
- (ii) A medical device manufacturer produces vascular grafts(artificial veins). These grafts are produced by extruding billets of polytetrafluoroethylene (PTFE) resin combined with a lubricant into tubes. Frequently, some of the tubes in a production run contain small, hard protrusions on the external surface. These defects are known as flicks. The defect is cause for rejection of the unit. The product developer responsible for the vascular grafts suspects that the extrusion pressure affects the occurrence of flicks and therefore intends to conduct an experiment to investigate this hypothesis. However, the resin is manufactured by an external supplier and is delivered to the medical device manufacturer in batches. The engineer also suspects that there may be significant batch-to-batch variation, because while the material should be consistent with respect to parameters such as molecular weight, mean particle size, retention, and peak height ratio, it probably isnt due to manufacturing variation at the resin supplier and natural variation in the material. Therefore, the product developer decides to investigate the effect of four different levels of extrusion pressure on flicks using a randomized complete block design considering batches of resin as blocks.

The results of this experiment are shown in the following table. Note that there are four levels of extrusion pressure (treatments) and six batches of resin (blocks). Remember that the order in which the extrusion pressures are tested within each block is random. The response variable is yield, or the percentage of tubes in the production run that did not contain any flicks.

Entrusion Pressure(PSI)	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Batch 6
8500	90.3	89.2	98.2	93.9	87.4	97.9
8700	92.5	89.5	90.6	94.7	87.0	95.8
8900	85.5	90.8	89.6	86.2	88.0	93.4
9100	82.5	89.5	85.6	87.4	78.9	90.7

Investigate all the hypothesis in this scenario. Use  $\alpha = 5\%$  [16]

**B10.** Corrosion Fatigue in metals has been defined as the simultaneous action of cyclic stress and chemical attack on a metal structure. A widely used technique for minimizing corrosion fatigue damage in aluminum involves the application of a protective coating. A study conducted by the Departments of Mining and Metallurgical Engineering at Gwanda State University used three different levels of humidity.

**Low:** 20% to 25% relative humidity

**Medium:** 55% to 60% relative humidity

**High:** 86% to 91% relative humidity,  
and three types of coatings

**Uncoated:** no coating

**Anodized:** sulphuric acid anodic oxide coating

**Conversion:** chromate chemical conversion coating.

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

COATING	HUMIDITY LEVEL (Low)	HUMIDITY LEVEL (Medium)	HUMIDITY LEVEL (High)
<b>Uncoated</b>	361 469 466	314 522 244	1344 1216 1027
	937 1069 1357	739 261 134	1097 1011 1011
<b>Anodized</b>	114 1032 1236	322 471 306	78 466 387
	92 533 211	130 68 398	107 130 327
<b>Conversion</b>	130 1482 841	252 874 105	586 524 402
	529 1595 754	755 847 573	751 846 529

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 9 treatments. [20]

**END OF QUESTION PAPER**