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

(i) Type 1 error [2]

(ii) Alternative Hypothesis [2]

(iii) Probability [2]

(iv) 2-Factor factorial experiment [2]

A2. 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 [3]

(ii) Find the probability that a person tried by this court is not innocent. [4]

A3. The viscosity of a liquid detergent is supposed to have an average of 800 centistokes at 25^oC. 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]

A4. 10% of the articles from a certain production line are defective. A sample of 10 articles from this production line is taken. Let X represents the number of defective articles. Find

(i) $P(X = 10)$ [3]

(ii) $P(X < 4)$ [4]

(iii) $Var(X)$ [2]

A5. 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.

B6. An industrial engineer is investigating the effect of four assembly methods (A, B, C, D) on the assembly time for a color television component. Four operators are selected for the study. Furthermore, the engineer knows that each assembly method produces such fatigue that the time required for the last assembly may be greater than the time required for the first, regardless of the method. That is, a trend develops in the required assembly time. To account for this source of variability, the engineer uses the Latin square design shown below:

Order of Assembly	**Operator 1**	**Operator 2**	**Operator 3**	**Operator 4**
1	C=10	D=14	A=7	B=8
2	B=7	C=18	D=11	A=8
3	A=5	B=10	C=11	D=9
4	D=10	A=10	B=12	C=14

Are there any significant differences between the four assembly methods. Was using different operators and different assembly orders necessary?. Use $\alpha = 0.05$ [20]

B7. (i) If $X \sim N(5.2; \frac{0.042^2}{5})$. Calculate the 95% confidence interval for μ [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 $\alpha = 0.05$ [7]

(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) Find $P(1.2 \leq X \leq 2.3)$ [4]

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

(c) Find the 65^{th} percentile [4]

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 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 below.

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 $\alpha = 0.05$ [10]

B9. 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: sulphiric 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)**
Uncoated	361 469 466 937 1069 1357	314 522 244 739 261 134	1344 1216 1027 1097 1011 1011
Anodized	114 1032 1236 92 533 211	322 471 306 130 68 398	78 466 387 107 130 327
Conversion	130 1482 841 529 1595 754	252 874 105 755 847 573	586 524 402 751 846 529

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