TEVETA
Technical Education, Vocational and Entrepreneurship Training Authority

DIPLOMA IN BIOMEDICAL ENGINEERING

LEVEL 6 YEAR I EXAMINATIONS

FINAL INTEGRATED SUMMATIVE EXAMINATIONS

SITTING: NOVEMBER / DECEMBER 2025

SUBJECT: ENGINEERING MATHEMATICS

TIME: THREE (3) HOURS **TOTAL MARKS: 100**

PASS MARK: 50

INSTRUCTIONS TO CANDIDATE

1. Write your examination number and National Registration Card Number on the answer booklet provided. Ensure to append your signature in the spaces provided on the answer booklet.
2. Write your answer script serial number on the examination register provided and the entry slip.
3. There are Eight (8) questions in this paper. Answer Five (5) questions.
4. Diagrams may be used were necessary to clarify your answer.
5. Cell phones and programmable calculators are not allowed in the examination room.

DO NOT TURN THIS PAPER UNTIL YOU ARE TOLD TO DO SO

QUESTION 1

a) Factorize completely: $2x^2 - 3x - 5 + (4x^2 + x - 1) - (3x^2 - 4x)$ **[7 marks]**

b) The formula for the frequency of a vibrating string is: $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$ Make T the subject of the formula. **[5 marks]**

c) Solve for x: $3^{2x-1} = 27$ **[5 marks]**

d) A radioactive substance decays as: $A(t) = 100e^{-0.025t}$ Determine how long it takes for the amount to decay to 40 grams. **[3 marks]**

[TOTAL: 20 MARKS]

QUESTION 2

a) Determine the equation of the line passing through the points A (4, -3) and B (−2, 5). **[5 marks]**

b) Determine whether the lines; $2x - 3y = 6$ and $3x + 2y = 4$ are perpendicular. **[6 marks]**

c) Given two lines: Line 1: $y = \frac{1}{2x} + 4$ and Line 2: $y = -2x + k$, Determine the value of k such that the two lines intersect at the point (2,5). **[9 marks]**

[TOTAL: 20 MARKS]

QUESTION 3

a) Convert the binary number 110101.101_2 to both **octal** and **hexadecimal** **[6 marks]**

b) Perform the binary addition $11101_2 + 1011_2$ **[4 marks]**

c) Use the **2's complement** method to compute the binary subtraction $101101_2 - 010111_2$ **[5 marks]**

d) Repeat part (c) using the **1's complement** method **[5 marks]**

[TOTAL: 20 MARKS]

QUESTION 4

a) Evaluate: $\begin{vmatrix} 2 & 3 & 1 \\ 0 & -1 & 4 \\ -2 & 5 & 0 \end{vmatrix}$ **[9 marks]**

b) The matrix B = $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ represents a transformation applied to a vector in two dimensional space.

(i) Determine whether matrix B is invertible **[2 marks]**

(ii) If it is, find the inverse of the matrix. **[3 marks]**

c) Solve the system using matrix inverse: $2x + 3y = 8 \; and \; x - y = 4$ **[6 marks]**

[TOTAL: 20 MARKS]

QUESTION 5

a) A power interlock safety feature has logic given by: $Y = \overline{(A + \bar{B}).C}$

(i) Apply **De Morgan's Theorem** to simplify the expression. **[5 marks]**

(ii) Draw the logic circuit diagram **[5 marks]**

b) A simplified digital circuit produces an output Y based on inputs A and B, defined by the Boolean expression: $Y = A\bar{B} + AB$

(i) Construct the **truth table** for the expression. **[2 marks]**

(ii) Draw the logic circuit diagram **[4 marks]**

(iii) Use the Karnaugh map to simplify the Boolean expression. **[4 marks]**

[TOTAL: 20 MARKS]

QUESTION 6

a) A force vector acting on a biomedical sensor is given by $\bar{F} = 6i - 8j$

(i). Calculate the magnitude of the vector $\bar{F}$. **[2 marks]**

(ii). Determine the **unit vector** in the direction of $\bar{F}$. **[4 marks]**

b) Given the vectors

$\vec{a} = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ $\vec{b} = \begin{bmatrix} 4 \\ -1 \\ 2 \end{bmatrix}$ Compute the vector projection of $\vec{a}$ *onto* $\vec{b}$ **[7 marks]**

c) Two alternating currents in a biomedical imaging device are represented as phasors: $I_1 = 4\angle 0^0$, $I_2 = 6\angle 90^0$

(i) Represent both phasors on the Argand diagram. **[4 marks]**

(ii) Compute the resultant phasor in rectangular form. **[3 marks]**

[TOTAL: 20 MARKS]

QUESTION 7

a) Given a function $v(t) = t^2 - 5t + 6$. Solve by **factorization**. **[3 marks]**

b) Another function $Q(t)$ is given by $Q(t) = t^2 + 4t + 1$ solve by **completing the square method**. **[3 marks]**

c) A device output signal is described by the quadratic function: $y = -2t^2 + 8t + 3$

(i). Find the **time t** at which the maximum occurs **[2 marks]**

(ii). Determine the **maximum value** of the function. **[2 marks]**

(iii). Sketch the graph and indicate the roots and the turning point. **[10 marks]**

[TOTAL: 20 MARKS]

QUESTION 8

a) A waveform component is expressed as $\sin(45^0 + 30^0)$

(i). Use the compound angle identity to simplify the expression. **[4 marks]**

(ii). A signal amplifier shifts the waveform by an additional 15^0. Express $Sin(75^0 + 15^0)$ the new signal in exact form. **[4 marks]**

b) In modelling a cardiac oscillation waveform, the following double angle identity is applied: $cos(2\theta) = 1 - 2sin^2(\theta)$.Given that $sin\theta = \frac{3}{5}$, determine the value of $cos2\theta$ **[6 marks]**

c) A composite waveform in a biomedical sensor is given by: $f(\theta) = 6sin\theta + 8cos\theta$, Express this signal in the form: $Rsin(\theta + \alpha)$ **[6 marks]**

[TOTAL: 20 MARKS]