

**071606T4IMT**

**Industrial Mechatronics Technology Level 6**

**ENG/OS/IMT/CC/02/6/A**

**Apply Engineering Mathematics**

**July/August 2023**

**Time: 3 Hours**



**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION  
COUNCIL (TVET CDACC)**

**WRITT**

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**INSTRUCTIONS TO CANDIDATE:**

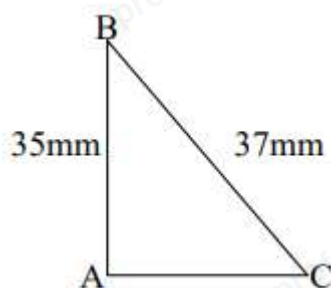
1. *This paper consists of TWO sections: A and B.*
2. *Answer ALL questions in sections A and THREE questions in section B*
3. *Marks for each question are indicated in brackets.*
4. *Do not write on this question paper.*

**This paper consists of FOUR printed pages.**

**Candidates should check the question paper to ascertain that all pages are printed as indicated and that no questions are missing.**

**SECTION A (40 MARKS)**Answer **ALL** questions in this section.

- Using indices only, Solve  $\frac{(3^2)^3}{3 \times 3^9}$ . (3 marks)
- Using factorization, determine the value of  $x$  in the equation:  
 $x^2 + 2x - 8 = 0$ . (3 marks)
- Calculate the length of distance AC of the right-angled triangle ABC shown below. (3 marks)



- Given that  $Z_1 = 2 + j4$  and  $Z_2 = 3$  value of  $Z_1 - Z_2$ . Represent the value obtained on an Argand diagram (4 marks)
- Find the co-ordinate of the point on the curve  $y = x^2 - 7x + 2$  where the gradient is  $-1$ . (3 marks)
- Evaluate:  $\int_0^{\pi/2} 3\sin 2x dx$ . (3 marks)
- Calculate the total surface area of a cylinder of diameter 8 cm and height 15 cm. (3 marks)
- Find out the mean, median and mode for the set.  
2, 3, 7, 5, 5, 13, 1, 7, 4, 8, 3, 4, 3 (3 marks)
- A force of 4 N is inclined at an angle of  $45^\circ$  to a second force of 7 N, both forces acting at a point. Determine the magnitude of the resultant of these two forces. (3 marks)
- Evaluate the determinant: (3 marks)
 
$$\begin{vmatrix} 1 & 4 & -3 \\ -5 & 2 & 6 \\ -1 & -4 & 2 \end{vmatrix}$$
- Solve the equation: (4 marks)
 
$$\log(x - 1) + \log(x + 1) = 2\log(x + 2)$$
- Use the binomial series to determine the expansion of  $(2 + x)^7$ . (5 marks)

**SECTION B (60 MARKS)**

Answer any **THREE** questions from this section.

13.

- a) Use Newton's method to determine the positive root of the quadratic equation

$$5x^2 + 11x - 17 = 0, \text{ correct to 3 significant figures.} \quad (10 \text{ marks})$$

- b) The function given by  $y = f(x) = 2x^3 + 3x^2 - 5$

- i) Show that the curve  $y = f(x)$  has two stationary points and determine the  $(x, y)$  coordinates of these points. (3 Marks)
- ii) Use differentiation to determine the nature of stationary points (whether maxima, minima or inflection). (4 Marks)
- iii) For the equation  $4xy = x^4 + y^3$ , use implicit differentiation to determine the expression for  $\frac{dy}{dx}$  in terms of  $x$  and  $y$ . (3 Marks)

14.

- a) If 3% of the gearwheels produce are defective, determine the  
probabilities that in a sample of 8

- i) Two will be defective; (4 marks)
- ii) More than two will be d (5 marks)

- (b) Solve the following simultaneous equations using Cramer's rule. (11 marks)

$$x + y + z = 4$$

$$2x - 3y + 4z = 33$$

$$3x - 2y - 2z = 2$$

15.

- a) Find  $f(t)$  using Laplace transforms. (12 marks)

$$3f'(t) - 2f(t) = 4e^{-t} + 2 \text{ where } f(0) = 0$$

- b) Given the two complex numbers  $z_1 = 2 - 3i$  and  $z_2 = -3 + 5i$

- i) Find  $z_3 = 2z_1 + 3z_2$  (2 marks)
- ii) Find  $z_4 = z_1 z_2$  and express  $z_4$  in exponential form as  $z_4 = re^{i\theta}$ . (3 marks)
- iii) If  $z = x + iy$ , show that the locus  $|z - z_1| = |z + z_2|$  is a straight line. (3 marks)

16.

- a) Determine the Fourier series for the periodic function defined by: (14 marks)

$$f(x) = \begin{cases} -2. & \text{when } -\pi < x < -\frac{\pi}{2} \\ 2. & \text{when } -\frac{\pi}{2} < x < \frac{\pi}{2} \\ -2 & \text{when } \frac{\pi}{2} < x < \pi \end{cases}$$

- b) Determine the first four terms of Maclaurin's series of  $\cos x$ . (6 Marks)

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