

071306T4EEN

Electrical Engineering level 6 (power option)

ENG/OS/PO/CC/01/6

Apply Engineering Mathematics

July/August 2023

Time: 3 Hours



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3 HOURS

INSTRUCTIONS TO CANDIDATE

*This paper consists of **TWO** sections: **A**, and **C**.*

*Answer **ALL** questions in sections **A** and **B** in the answer booklet provided.*

Marks for each question are indicated in brackets.

Do not write on this question paper.

*Answer the questions in **English**.*

This paper consists of THREE (3) printed pages.

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

SECTION A: (40 Marks)*Answer all questions in this section*

1. Simplify the expression: (3Marks)

$$\frac{\log 125 - \frac{1}{2} \log 25}{\log 625 + \frac{1}{2} \log 25}$$

2. Solve the equations (5marks)

$$10 \cos \theta + 4 \sin \theta = 7$$

For values of θ between 0° and 90° inclusive.

3. Determine the values of the constants P and Q equations,

$$Pe^{2x} - Qe^{-2x} = 6 \cosh 2x + 4 \sinh 2x. \quad (3 \text{ marks})$$

4. Given the vector $p = -3i + 6j + 4k$ and $q = 2i + 5j - 3k$ determine the:

- a) Angle between p and q (5 marks)
b) Area of the triangle spanned

5. The probability of getting a defective resistor was 0.04 in a sample of 10 resistors selected. Determine the probability of getting. (5 marks)

- a) 2 defective resistor
b) less than 8 non defective resistor

6. The height of a ceiling rose lamp holder in the shape of a cone is increasing at 0.4 cm/s and its radius is decreasing at 0.3 cm/s . Determine, correct to 3 significant figures, the rate at which the volume is changing ($\text{in cm}^3/\text{s}$) when the height is 3.4 cm and the radius is 1.4 cm (5marks)

7. Use De Moivre's theorem to prove that: (3marks)

$$\sin 4\theta = 4 \cos^3 \theta \sin \theta - 4 \cos \theta \sin^3 \theta$$

8. Express the equation of the parabola $y^2 = 3 - 5x$ in the polar form. (3marks)

9. Find, from first principles, the Laplace transform of $f(t) = te^{-3t}$ (3mark)

10. Find the determinant of the matrix. (2marks)

$$A = \begin{bmatrix} 1 & -2 & 3 \\ -2 & 1 & 2 \\ 1 & 1 & -1 \end{bmatrix}$$

11. Evaluate the integrals: (3marks)

$$\int_1^4 \left(\frac{1}{x-1} + \frac{1}{x^2} + \frac{1}{x^3} \right) dx$$

SECTION B: (60 Marks)

Answer any **THREE** Questions from this section

12. (a). A 2×2 symmetric matrix A has eigenvalues $\lambda_1 = 4$ and $\lambda_2 = -1$. Given the eigenvectors corresponding to λ_1 is $\begin{bmatrix} 2 & 1 \end{bmatrix}^T$ determine the: (12marks)

- Eigenvector corresponding to λ_2
- Matrix A.

- (b). Determine the Fourier sine series of the periodic function (8marks)

$$f(x) = 4x, 0 \leq x \leq \pi.$$

13. (a) Use Laplace transforms to solve the differentiation equation (10marks)

$$\frac{d^2x}{dt^2} + 3\frac{dy}{dx} + 2x = 2e^{-t}, \text{ given that when } t = 0, x = 0 \text{ and } \frac{dy}{dx} = 1$$

- (b) Use the method of undetermined coefficients to solve the differential equation

$$\frac{d^2x}{dt^2} - 5\frac{dx}{dt} + 6x = e^{-4t} \quad (10\text{marks})$$

14. (a) Show that a better root of $f(x)$ $5X + 1$ is given by $X_n + 1 = \frac{2x_n^3 - 1}{3x_n^2 - 5}$ n $n = 0, 1, 2, \dots$ by taking $x_0 = 0$. tion to 6 decimal places (10 marks)

- (b). Table 1 represent a cubic poly

Table 1

X	-2	-1	0	1	2	3	4	5	6
F(x)	3	1	1	9	31	73	141	241	379

Use the Newton-Gregory forward difference interpolation formula to determine $f(x)$. (10marks)

15. (a) Use Maclaurin's theorem to expand $\tan\left(\frac{\pi}{4} + h\right)$ as far the term in x^3 . Hence determine the value of $\tan 46^\circ$. (11marks)

- (b). Expand $1 - x + x^2 - x^3$ in Taylor series about point $x = -1$. Hence evaluate the

$$\text{Integral of } \int_0^1 \frac{1-x+x^2-x^3}{(x+1)^2} dx \quad (9\text{marks})$$

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