FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2019**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**MAT1122 : Engineering Mathematics 2**
Date of Examination	:	July 28, 2019 (Sunday)
Time	:	11:00 am – 1:00 pm Reading Time: Nil
Duration	:	2 Hours
Special Instructions	:	

This paper consists of **FIVE (5)** questions. Answer any **FOUR (4)** out of **FIVE (5)** questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided :

Formula Booklet 1

Examiner (s)	:	**Chan Ah Wah** and Dr Chan Kah Yein
Moderator	:	Assoc Prof Chan Kait Loon

This paper consists of 4 printed pages, including the cover page.

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
MAT1122 : ENGINEERING MATHEMATICS 2
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Question 1

(a) If $z_1 = 1 + i$ and $z_2 = 2 - 3i$, compute the following and leave your answers in Cartesian form.

(i) $3z_1 - 4z_2$ (2 marks)

(ii) $z_1 z_2$ (3 marks)

(iii) $\frac{z_1}{z_1+z_2}$ (5 marks)

(b) Given that $z = \sqrt{3} + i$.

(i) Express z in polar form with argument in degree. (4 marks)

(ii) Find the two square roots of z. Leave your answers in polar form. (6 marks)

(c) Use De Moivre's Theorem to express $\left(\frac{1}{2} - \frac{1}{2}i\right)^8$ in the form of $a + ib$. (5 marks)

Question 2

(a) Solve the following by the indicated substitutions:

(i) $\int \frac{\sec^2 x}{\sqrt{1 - \tan^2 x}}\, dx$; $u = \tan x$ (4 marks)

(ii) $\int \frac{\ln x}{x}\, dx$; $u = \ln x$ (4 marks)

(iii) $\int \frac{x + 1}{\sqrt{x^2+2x+3}}\, dx$; $u = x^2 + 2x + 3$ (4 marks)

(b) Solve the following by any method deemed appropriate:

(i) $\int x \sin^2 x\, dx$ (6 marks)

(ii) $\int \frac{dx}{x^3+9x}$ (7 marks)

Question 3

(a) Given $z = e^{x+y}\sin(x^2y^3)$, find $\dfrac{\partial z}{\partial x}$ and $\dfrac{\partial z}{\partial y}$. (6 marks)

(b) Given the expression $G = \dfrac{AL}{M^4}$ where A is a constant. If L and M increase by 0.25% and decrease by 1% respectively, determine the percentage change in the calculated value of G.

(3 marks)

(c) Solve the following homogeneous second-order differential equation:

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 9y = 0$$

(4 marks)

(d) Use the series

$$\ln(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \cdots$$

to expand $\ln\left(\frac{1-2x}{1+2x}\right)$ as a series of ascending powers of x up to and including the term in x^5.

(6 marks)

(e) (i) Derive the binomial series for $(1+x^2)^{-1}$ up to and including the fourth term.
(2 marks)

(ii) Use the result in (i) to evaluate the integral

$$\int_0^{0.4} \frac{x}{1+x^2}\,dx$$

Let your answer be correct to **four (4)** decimal places. (4 marks)

Question 4

(a) The power P dissipated in a resistor is given by $P = \frac{E^2}{R}$. If E = 220V and R = 5Ω, find the change in P resulting from a drop of 5V in E and an increase of 0.2Ω in R.

(5 marks)

(b) Solve the following differential equations:

(i) $(1 + x^2)\frac{dy}{dx} + 3xy = 5x$ (6 marks)

(ii) $\frac{dy}{dx} + (\tan x)y = \sin x$ (5 marks)

(iii) $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 2x^2$ (9 marks)

Question 5

(a) Use Laplace transform to solve the differential equation

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 3y = \sin 2t$$

given that $y(0) = 0$ and $y'(0) = 0$. (10 marks)

(b) Find the determinant of the following matrix by co-factor expansion along the second column:

$$\mathbf{A} = \begin{bmatrix} a & b & c \\ 1 & 2 & 1 \\ 3 & -1 & 4 \end{bmatrix}$$

where a, b and c are constants. (5 marks)

(c) Use elementary row operations to find the inverse of the matrix below:

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 4 & 9 \end{bmatrix}$$

Then, using the result, solve the following system of equations:

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 4 & 9 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 3 \\ 4 \\ 6 \end{bmatrix}$$

(10 marks)

-THE END-