FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2019**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**MAT1123 : Engineering Mathematics 3**
Date of Examination	:	August 1, 2019 (Thursday)
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)	:	**Dr Chan Kah Yein** and Chan Ah Wah
Moderator	:	Mr Foo Kim Eng

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

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
MAT1123 : ENGINEERING MATHEMATICS 3
FINAL EXAMINATION : APRIL 2019 SESSION

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Question 1

(a) Given the following system of linear equations:

$$\mathbf{2x + y - 5z = 6}$$
$$\mathbf{x - 3y + 2z = 9}$$
$$\mathbf{3x - y + 4z = 5}$$

(i) Solve the linear system using Gauss-Jordan method. (8 marks)

(ii) Verify your answer for y in part (i) using Cramer's rule. (4 marks)

(b) Given a 2×2 matrix $\mathbf{A} = \begin{bmatrix} 5 & 4 \\ 3 & 1 \end{bmatrix}$.

(i) Find the eigenvalues of **A**. (3 marks)

(ii) Find an eigenvector corresponding to each of the eigenvalues. (6 marks)

(c) Suppose **A** and **B** are both 3×3 matrices such that $\det(\mathbf{A}) = 2$ and $\det(\mathbf{B}) = 4$. Find $\det(3\mathbf{AB}^{-1})$.

(4 marks)

Question 2

(a) Let the points A(2, 1, –1), B(0, 1, 3) and C(1, –2, 0). Find the following:

(i) vectors $\overrightarrow{\mathbf{AB}}$ and $\overrightarrow{\mathbf{AC}}$. (2 marks)

(ii) a vector orthogonal to $\overrightarrow{\mathbf{AB}}$ and $\overrightarrow{\mathbf{AC}}$. (4 marks)

(iii) the equation of the plane consisting of the points A, B and C. (5 marks)

(iv) the parametric equations of the straight line passing through B which is parallel to $\overrightarrow{\mathbf{AC}}$. (4 marks)

(b) Sketch the regions and set up double integrals with correct limits to evaluate the following. Do not integrate.

(i) The area of the region, expressed in polar coordinates, bounded by the circle $x^2 + y^2 = 10$ and the lines $y = x$ and $y = \sqrt{3}x$ in the first quadrant. (5 marks)

(ii) The area of the region, expressed in Cartesian coordinates, bounded by the lines $y = 2x$, $4x + y = 6$ and $x = 0$ in the first quadrant. (5 marks)

Question 3

(a) Evaluate $\oint_C \vec{\mathbf{F}} \bullet d\vec{\mathbf{r}}$ where $\vec{\mathbf{F}} = (-y)\,\hat{\mathbf{i}} + (2xz)\,\hat{\mathbf{j}} + \hat{\mathbf{k}}$ and C is the boundary of the circle $x^2 + y^2 = 3$ on the xy-plane in a counter clockwise direction, using

(i) line integration, (10 marks)

(ii) Stokes' Theorem. (8 marks)

(b) Evaluate the double integral $\iint_R x\,dydx$ where R is the region bounded by the straight line $y = x$ and the curve $y = \sqrt{x}$. (7 marks)

Question 4

(a) Use Green's theorem to evaluate $\oint_C [(x + 3y)\,dx + (x^2 + xy)\,dy]$ where C is the boundary of the region R bounded by $y = x$, $y = 1$ and $x = 0$ in the counterclockwise direction. (15 marks)

(b) Given a scalar field $\phi = x^2y + yz^3 - 3xz$ and a vector $\vec{\mathbf{A}} = 2\hat{\mathbf{i}} - \hat{\mathbf{j}} + 2\hat{\mathbf{k}}$. Find, at the point $(1, 1, -2)$,

(i) the gradient of ϕ. (5 marks)

(ii) the unit vector in the direction of $\vec{\mathbf{A}}$. (2 marks)

(iii) the directional derivative of ϕ in the direction of $\vec{\mathbf{A}}$. (3 marks)

Question 5

(a) Use Gauss' divergence theorem to evaluate $\oiint_S \vec{\mathbf{F}} \bullet d\vec{\mathbf{S}}$, where

$\vec{\mathbf{F}} = (xz)\,\hat{\mathbf{i}} + (x^2)\,\hat{\mathbf{j}} + (z^2)\,\hat{\mathbf{k}}$ and and S is the closed surface consisting of the

hemisphere $x^2 + y^2 + z^2 = 9$, $z \geq 0$ and the plane $z = 0$. (16 marks)

(b) The position vector of a particle is $\vec{\mathbf{r}}\,(t) = (4t)\,\hat{\mathbf{i}} + (2t^2)\,\hat{\mathbf{j}} + (t^3)\,\hat{\mathbf{k}}$, where $t \geq 0$ is time. Let Q be the point (8, 8, 8).

(i) Find the value of t at point Q. (2 marks)

(ii) Find the velocity vector $\vec{\mathbf{v}}$ and acceleration vector $\vec{\mathbf{a}}$ at point Q. (7 marks)

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