INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2019**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**MAT1123 : Engineering Mathematics 3**
Date of Examination	:	December 12, 2019 (Thursday)
Time	:	5:00 pm – 7:00 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 Dinash a/l Kandasamy
Moderator	:	Assoc Prof Chan Kait Loon

This paper consists of 3 printed pages, including the cover page.

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

Instructions: This paper consists of **FIVE (5)** questions. Answer only **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks. Working must be shown.

Question 1

(a) Use elementary row operations to find the solution to the system below. Give your answer in vector form.

$$\begin{aligned} x_1 + 2x_2 + 3x_3 &= 4 \\ 5x_1 + 6x_2 + 7x_3 &= 8 \\ 9x_1 + 10x_2 + 11x_3 &= 12 \end{aligned}$$

(8 marks)

(b) Use Cramer's Rule to solve for z in the system below.

$$\begin{aligned} 2x - 4y + z &= 12 \\ x + 3y - 2z &= 1 \\ 3x + y - 4z &= 19 \end{aligned}$$

(6 marks)

(c) Let matrix $\mathbf{A} = \begin{pmatrix} 2 & -4 \\ -3 & 1 \end{pmatrix}$.

(i) Find the eigenvalues of **A**. (4 marks)

(ii) Find a set of linearly independent eigenvectors for **A**. (7 marks)

Question 2

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

(b) Let the vectors $\vec{\mathbf{u}} = 4\hat{\mathbf{i}} - 2\hat{\mathbf{j}} - 3\hat{\mathbf{k}}$ and $\vec{\mathbf{v}} = -\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 3\hat{\mathbf{k}}$. Find the cosine of the angle between the two vectors. Leave your answer in surds. (5 marks)

(c) Set up double integrals with the correct limits to evaluate the area of following regions. Do not integrate.

(i) The region bounded by the circle $x^2 + y^2 = 9$ and the lines y = x and the x-axis in the first quadrant. (4 marks)

(ii) The region bounded by the curve $y = x^2$ and the lines $y = 8 + 2x$ and $x = 0$ in the first quadrant. (5 marks)

Question 3

Find $\oint_C \vec{F} \bullet d\vec{r}$ where $\vec{F} = (-y)\,\hat{\imath} + (x)\,\hat{\jmath} + (z)\,\hat{k}$ and C is the rectangle described by $0 \leq x \leq 4$, $0 \leq y \leq 2$, $z = 0$. Assume a counter-clockwise orientation for the path, as viewed from above. Use

(a) line integration, (15 marks)

(b) Stokes' Theorem. (10 marks)

Question 4

(a) Use Green's Theorem to find the work done by the force $\vec{F} = (e^x - y^3)\,\hat{\imath} + (\sin y + x^3)\,\hat{\jmath}$ on a particle that travels once around the circle $x^2 + y^2 = 4$ in a counterclockwise direction. (15 marks)

(b) Given that $f = x^2y^2 + 3y^2z - 4xz^2$ and vector $\vec{v} = 4\hat{\imath} - 3\hat{\jmath} + 4\hat{k}$, find the directional derivative of f in the direction of $\vec{v}$ at the point A(3, 2, –1). (10 marks)

Question 5

(a) Use Gauss' Divergence Theorem to evaluate $\oiint_S \vec{F} \bullet d\vec{S}$ where $\vec{F} = (xy)\,\vec{\imath} - (\frac{1}{2}y^2)\,\vec{\jmath} + (z^2)\,\vec{k}$ and S is the closed surface of the solid bounded by the cylinder $x^2 + y^2 = 9$ and the planes $z = 0$, $z = 5$. (15 marks)

(b) The position vector of a particle is $\vec{r}\,(t) = (2t^2)\,\hat{\imath} + (\sin 2t)\,\hat{\jmath} + (\cos 3t)\,\hat{k}$, where $t \geq 0$ is time. Let Q be the point $(2\pi^2, 0, 1)$.

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

(ii) Find the velocity vector $\vec{v}$ and acceleration vector $\vec{a}$ at point Q. (8 marks)

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