INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2018**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**MAT1123: Engineering Mathematics 3**
Date of Examination	:	July 31, 2018 (Tuesday)
Time	:	8:00 am – 10:00 am 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 2018 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.

$$\begin{aligned} x_1 + 2x_2 - x_3 + 4x_4 &= 1 \\ x_1 + x_2 + x_3 - 2x_4 &= 2 \end{aligned}$$

(8 marks)

(b) Use Cramer's Rule to solve for y in the system below:

$$\begin{aligned} x + y - 2z &= 3 \\ 2x - y + z &= 0 \\ 3x + y - z &= 8 \end{aligned}$$

(6 marks)

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

(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, 1, 1), B(2, –1, 1) and C(3, 1, 3). 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. (6 marks)

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

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

(i) The region, expressed in polar coordinates, bounded by the circle $x^2 + y^2 = 1$ and the lines $y = x$ and $y = \sqrt{3}x$ in the first quadrant. (4 marks)

(ii) The region, expressed in Cartesian coordinates, bounded by the curve $y = x^2$ and the lines $2x + y = 3$ and $x = 0$ in the first quadrant. (5 marks)

Question 3

(a) Use Green's Theorem to evaluate $\oint_C [(x^3 - x^2y)\,dx + (xy^2)\,dy]$ where C is the counter-clockwise boundary of the region enclosed by the circle $x^2 + y^2 = 16$, $y = x$ and $x = 0$ in the first quadrant. (11 marks)

(b) Let the line integral $\mathbf{I} = \int_C [(x^2 + 3y^2 + 4y)dx + (6xy - 2y^2 + 4x)dy]$. Show that **I** is independent of path. (6 marks)

(c) Given that $f = x^2z + 2xy^2 + yz^2$ and $\vec{\mathbf{v}} = 2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 4\hat{\mathbf{k}}$, find the directional derivative of f in the direction of $\vec{\mathbf{v}}$ at the point (1, 2, –1). (8 marks)

Question 4

Evaluate $\oint_C \vec{\mathbf{F}} \bullet d\vec{\mathbf{r}}$ where $\vec{\mathbf{F}} = (y^2)\,\hat{\mathbf{i}} + (x^2)\,\hat{\mathbf{j}} - (x + z)\,\hat{\mathbf{k}}$ and C is the boundary of the triangle with vertices at 0(0, 0, 0), A(1, 0, 0) and B(1, 2, 0) in a counter-clockwise orientation. Use

(a) Stokes' theorem, (10 marks)

(b) line integration. (15 marks)

Question 5

(a) Use Gauss' divergence theorem to evaluate $\oiint_S \vec{\mathbf{F}} \bullet d\vec{\mathbf{S}}$, where $\vec{\mathbf{F}} = (x^2)\,\hat{\mathbf{i}} + (3y)\,\hat{\mathbf{j}} + (2z)\,\hat{\mathbf{k}}$ and and S is the surface of the solid completely enclosed by the cylinder $x^2 + y^2 = 16$ and the planes $z = 0$ and $z = 3$. (15 marks)

(b) The position vector of a particle is $\vec{\mathbf{r}}\,(t) = (t^2 + 3)\,\hat{\mathbf{i}} + (t^3)\,\hat{\mathbf{j}} + (4t + 1)\,\hat{\mathbf{k}}$, where $t \geq 0$ is time. Let Q be the point (4, 1, 5).

(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. (8 marks)

-THE END-