INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2018**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**MAT1123: Engineering Mathematics 3**
Date of Examination	:	December 13, 2018 (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 : AUGUST 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.

$$\begin{aligned} x_1 + 3x_2 + x_3 + 5x_4 &= 8 \\ 2x_1 + 7x_2 + 2x_3 + 9x_4 &= 14 \end{aligned}$$

(7 marks)

(b) Use the rank test to check the consistency of the system below.

$$\begin{aligned} 2x_1 - 3x_2 + 4x_3 &= -1 \\ x_1 + x_2 - 3x_3 &= 4 \\ x_1 - 4x_2 + 7x_3 &= -1 \end{aligned}$$

(7 marks)

(c) Let matrix $\mathbf{A} = \begin{pmatrix} 5 & -3 \\ -6 & 2 \end{pmatrix}$.

(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, 3), B(2, 1, 2) and C(1, 1, 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 C which is parallel to $\overrightarrow{AC}$. (4 marks)

(b) 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 $x^2 + y^2 = 16$ and the lines $y = \frac{1}{\sqrt{3}}x$ and $y = \sqrt{3}x$ in the first quadrant. (4 marks)

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

Question 3

Evaluate the line integral $\oint_C [(xy)\,dx + (3x^2 + y^2)\,dy]$ where C is the triangular path OAB defined by O(0,0), A(1,0) and B(1,2) in a counter-clockwise direction, using

(a) Green's theorem, (10 marks)

(b) line integration. (15 marks)

Question 4

(a) Use Stokes' theorem to evaluate $\oint_C \vec{F} \bullet d\vec{r}$ where $\vec{F} = (2x + y^2)\,\hat{\imath} + (-yz^2)\,\hat{\jmath} + (-y^2z)\,\hat{k}$ and C is the boundary of the hemispherical surface $x^2 + y^2 + z^2 = 5$ on the xy-plane, orientated counter-clockwise as viewed from above. (16 marks)

(b) Given that $f = 3xz + 2y^2z + 4xz^2$ and $\vec{v} = \hat{\imath} + 2\hat{\jmath} - 3\hat{k}$, find the directional derivative of f in the direction of $\vec{v}$ at the point (1, 1, 3). (9 marks)

Question 5

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

$\vec{F} = (x^2)\,\hat{\imath} + (y^2)\,\hat{\jmath} + (z^2)\,\hat{k}$ and and S is the surface of the cube bounded by the planes

$x = 0, x = 1, y = 0, y = 1, z = 0$ and $z = 1$. (15 marks)

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

(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-