INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**January 2018**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**MAT1123: Engineering Mathematics 3**
Date of Examination	:	March 5, 2018 (Monday)
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** & Bark Chee Beg
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 : JANUARY 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 solve the system below. Leave your solution in vector form.

$$\begin{aligned} x_1 + 3x_2 - 4x_3 + 4x_4 &= 4 \\ x_1 + 4x_2 - 7x_3 + 6x_4 &= 3 \end{aligned}$$

(8 marks)

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

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

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

(c) Consider the following system of linear equations:

$$\begin{aligned} 2x - 11y - z &= 36 \\ 8x - y + 2z &= 21 \\ x - y + 9z &= 14 \end{aligned}$$

(i) Set up a Gauss-Seidel scheme for the system. (3 marks)

(ii) Compute one (1) iteration, starting with initial guess $x = y = z = 1$. Keep 3 decimal places in all calculations. (3 marks)

Question 2

(a) Let the points A(1, –1, 4), 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. (5 marks)

(b) Let the line integral $\mathbf{I} = \int_C [(12x^2 + 3y^2 + 5y)dx + (6xy - 3y^2 + 5x)dy]$.

(i) Show that **I** is independent of path. (5 marks)

(ii) Find the scalar potential and hence, evaluate **I** if C is a simple path joining the points (0, 0) and (2, 1) in the xy-plane. (9 marks)

Question 3

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

(i) Green's theorem, (8 marks)

(ii) line integration. (11 marks)

(b) Given that $f = x^2 + 2xy^2 + 2yz^3$ and $\vec{\mathbf{v}} = 4\hat{\mathbf{i}} - 2\hat{\mathbf{j}} - 2\hat{\mathbf{k}}$, find the directional derivative of f in the direction of $\vec{\mathbf{v}}$ at the point (2, 1, –1). (6 marks)

Question 4

(a) Use Stokes' theorem to evaluate $\oint_C \vec{F} \bullet d\vec{r}$ where $\vec{F} = (y)\,\hat{i} + (xz)\,\hat{j} + \hat{k}$ and C is the boundary of the circle $x^2 + y^2 = 1$ in a counter-clockwise orientation. (10 marks)

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

(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)

(c) Let the vectors $\vec{u} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{w} = 2\hat{i} + 3\hat{j} - 6\hat{k}$. Find the angle between the two vectors. Leave your answer in 1 decimal place. (5 marks)

Question 5

(a) Use Gauss' divergence theorem to evaluate $\oiint_S \vec{F} \bullet d\vec{S}$, where $\vec{F} = (2x)\,\hat{i} + (y^2)\,\hat{j} + (z)\,\hat{k}$ and and S is the surface of the solid completely enclosed by the cylinder $x^2 + y^2 = 9$ and the planes $z = 0$ and $z = 5$. (16 marks)

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

(i) The region bounded by the circle $x^2 + y^2 = 7$ and the lines $y = x$ and $y = \sqrt{3}x$ in the first quadrant. (4 marks)

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

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