FINAL

ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session : **April 2020**

Programme : Diploma In Mechanical Engineering (DMEN)
Diploma In Electrical & Electronic Engineering (DEEI)

Course : **MAT1123/MAT1136 : Engineering Mathematics 3**

Date of Examination : August 6, 2020 (Thursday)

Time : 12:00 pm – 2:15 pm Reading Time : Nil

Duration : 2 hours 15 mins

Special Instructions :

Answer **ALL FOUR (4)** questions.

Material permitted : Non-Programmable Calculator

Materials provided : Nil

Examiner(s) : **Dr Chan Kah Yein** & Dr Nurulanati Binti Othman

Chief Moderator : Dr Chan Kah Yein

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

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING PROGRAMME (DEEI)
MAT1123/MAT1136 : ENGINEERING MATHEMATICS 3
FINAL ALTERNATIVE ASSESSMENT : APRIL 2020 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry equal marks. Working must be shown.

Question 1

(a) Use Cramer's Rule to find w in the system below.
(Do not compute x, y and z.)

$$\begin{aligned} 5x + y - z + w &= 3 \\ 4y + z - w &= 12 \\ 3z + w &= 8 \\ z - 2w &= 5 \end{aligned}$$

(12 marks)

(b) Two of the eigenvalues for matrix $\mathbf{A} = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 2 & 1 \\ 3 & 2 & 3 \end{pmatrix}$ are $\lambda = 5$ and $\lambda = 0$.

(i) Find the third eigenvalue for **A**.

(2 marks)

(ii) Find an eigenvector for **A** corresponding to $\lambda = 0$.

(7 marks)

(iii) Without any computation, find the eigenvalues for the following matrices:

$$\mathbf{B} = \begin{pmatrix} 3 & 3 & 3 \\ 3 & 6 & 3 \\ 9 & 6 & 9 \end{pmatrix}, \quad \mathbf{C} = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 2 & 1 \\ 3 & 2 & 3 \end{pmatrix}^2.$$

(4 marks)

Question 2

(a) Let the planes P_1: $3x - 2y + 7z = 8$ and P_2: $x + 5y = 2$ and the line L: $x = 3t + 4$, $y = 5 - 2t$, $z = 7t + 1$.

(i) Determine the angle between planes P_1 and P_2.

(7 marks)

(ii) Explain, with reason, whether plane P_1 and line L are orthogonal, parallel or neither.

(4 marks)

(b) The position of a moving particle is described by $x = 5t^2 - 4$, $y = 3t - t^2$, $z = 2t + 1$, where $t \geq 0$ is time. The particle is at P(16, 2, 5). Find the velocity vector, speed and acceleration vector at P.

(9 marks)

(c) Set up a double integral with correct limits to evaluate the area of the region bounded by the curve $x = y^2$ and the lines $x = 0$ and $x + y = 2$ in the first quadrant.

(5 marks)

Question 3

(a) Use Green's Theorem to evaluate $\oint_C \vec{\mathbf{F}} \bullet d\vec{\mathbf{r}}$ where $\vec{\mathbf{F}} = (x^2y)\,\hat{\mathbf{i}} + (x)\,\hat{\mathbf{j}}$ along the triangular path defined by the points $(0,0)$, $(1,0)$, $(1,2)$ and back to $(0,0)$ again.

(9 marks)

(b) Use Gauss' Divergence Theorem to evaluate $\oiint_S \vec{\mathbf{F}} \bullet d\vec{\mathbf{S}}$ given that $\vec{\mathbf{F}} = (x^3)\,\vec{\mathbf{i}} + (y^3)\,\vec{\mathbf{j}} + (z^3)\,\vec{\mathbf{k}}$ and S is the surface of the solid completely enclosed by the cylinder $x^2 + y^2 = 25$ and planes $z = 0$ and $z = 2$.

(16 marks)

Question 4

The following periodic function, f(x) has a period of 2π.

$$f(x) = \begin{cases} 0, & -\pi < x < 0 \\ 1, & 0 < x < \pi \end{cases}$$

(a) Sketch the function f(x) for $-3\pi \leq x \leq 3\pi$.

(3 marks)

(b) Determine the Fourier series for the periodic function f(x) up to fifth harmonic.

(22 marks)

If f(x) is defined in the range –L to L (ie. has a period of 2L), its Fourier series is:

$$f(x) = \frac{1}{2}a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi x}{L} + b_n \sin\frac{n\pi x}{L}\right)$$

where $a_0 = \frac{1}{L}\int_{-L}^{L} f(x)\,dx$; $a_n = \frac{1}{L}\int_{-L}^{L} f(x)\cos\frac{n\pi x}{L}\,dx$; $b_n = \frac{1}{L}\int_{-L}^{L} f(x)\sin\frac{n\pi x}{L}\,dx$

-THE END-