FINAL ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2021**
Programme	:	Diploma In Mechanical Engineering (DMEN) Diploma In Electrical And Electronic Engineering (DEEI)
Course	:	**MAT1123 / MAT1136: Engineering Mathematics 3**
Date of Examination	:	July 29, 2021 (Thursday)
Time	:	8.00am – 10.30am Reading Time : Nil
Duration	:	2 Hours : 30 Minutes

Note: 30 minutes is added into the duration of the examination to factor in any connectivity matters and for you to scan and upload your scripts.

Special Instructions :

Answer **ALL** the questions

Materials permitted :

Nil

Materials provided :

Nil

Examiner(s) : **Teow Hsien Loong** and Dr. Nurulanati Othman

Moderator : Phua Chin Lai

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

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
MAT1123/MAT1136: ENGINEERING MATHEMATICS 3
FINAL ALTERNATIVE EXAMINATION: APRIL 2021 SESSION

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

Question 1

(a) Given that the planes $P_1: x + 5y - 3z = 0$ and $P_2: x + 5y = 2$, and the line L: $x = 3t + 4,\ y = 5 - 2t,\ z = 7t + 1$,

(i) apply vector algebra to obtain the angle between planes P_1 and P_2. Give your answer correct to 2 decimal places.

(7 marks)

(ii) show the parametric equations of the line that passes through the point $R(2, 4, 3)$ and is parallel to L.

(4 marks)

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

(4 marks)

(b) Let $\vec{\boldsymbol{r}} = (4\sin t)\hat{\boldsymbol{\imath}} + (2\cos 4t)\hat{\boldsymbol{\jmath}} + (\sin 2t)\hat{\boldsymbol{k}}$ be the position vector of a moving particle, where $0 \leq t \leq 2\pi$ is time. Use vector differentiation to obtain the velocity and acceleration vectors at the point $Q(-4, 2, 0)$.

(10 marks)
(Total: 25 marks)

Question 2

(a) Given a scalar field $\phi = x^2y + yz^3 - 2xz$ and a vector $\vec{\mathbf{v}} = 2\hat{\mathbf{i}} - \hat{\mathbf{j}} + 4\hat{\mathbf{k}}$, use vector differentiation at the point $P(1, 1, -2)$, to obtain the directional derivative of ϕ in the direction of $\vec{\mathbf{v}}$. Hence, state with reason whether there will be an increase, decrease or no change in ϕ.

(10 marks)

(b)

(i) Sketch and shade, in the same diagram, the region bounded by the limits of integration for the following integral:

$$\int_0^5 \int_0^y dx\, dy + \int_0^{5\sqrt{2}} \int_0^{\sqrt{50-y^2}} dx\, dy$$

Label all the boundaries and intersection points.

(4 marks)

(ii) Change the order of the integration in part(b)(i) and write the expression as one double integral.

(5 marks)

(iii) Hence, solve the double integral in part(b)(ii) using polar coordinates.

(6 marks)

(Totol: 25 marks)

Question 3

(a) Use line integration to evaluate $\oint_C \vec{\mathbf{F}} \bullet \mathrm{d}\vec{\mathbf{r}}$ where $\vec{\mathbf{F}} = \langle 2z,\ x,\ y^2 \rangle$ and C is the cross section of the paraboloid $z = 16 - x^2 - y^2$ with the xy-plane in a counter-clockwise orientation as viewed from above.

(10 marks)

(b) Given that $\vec{\mathbf{F}} = xy^2\hat{\mathbf{i}} + yz^2\hat{\mathbf{j}} + zx^2\hat{\mathbf{k}}$, find the divergence of $\vec{\mathbf{F}}$. Hence, use the Divergence Theorem to compute $\iint_S \vec{\mathbf{F}}.\mathrm{d}S$ where S is the surface enclosed by cylinder $x^2 + y^2 = 4$ and the planes $z = 0$ and $z = 3$.

(15 marks)

(Total: 25 marks)

Question 4

(a) A periodic function whose period is 2π is defined by $g(x) = x\cos x,\ -\pi < x < \pi$. Assess whether $g(x)$ is an odd or even function (or neither) and explain your answer.

(4 marks)

(b) Show the Fourier Series up to the fourth harmonic for $f(x)$, where

$$f(x) = x^2, \qquad -\pi < x < \pi,$$
$$f(x) = f(x + 2\pi).$$

(21 marks)

(Total: 25 marks)

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