UNIVERSITI TEKNOLOGI PETRONAS

# FINAL EXAMINATION
# MAY 2024 SEMESTER

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| **COURSE** | **:** | **FEM1013/FFM1013 - ENGINEERING MATHEMATICS I** |
| **DATE** | **:** | **5 AUGUST 2024 (MONDAY)** |
| **TIME** | **:** | **9:00 AM - 12:00 NOON (3 HOURS)** |

## INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

**Note** :

i. There are **SIX (6)** pages in this Question Booklet including the cover page .

ii. **DOUBLE-SIDED** Question Booklet.

1. a. Find the partial derivatives $f_x$ and $f_y$ for the function

$$f(x, y) = \frac{2x - 2y}{x + y}.$$

[6 marks]

b. Use Chain Rule to find the derivatives $\partial z/\partial s$ and $\partial z/\partial t$.

$$z = 2x^2 + 2xy + 1, \qquad x = 2t + s, \qquad y = t + s\,.$$

[6 marks]

c. Find the implicit differentiation $\partial w/\partial x$, $\partial w/\partial y$ and $\partial w/\partial z$ for the function

$$\ln(2x^2 + y - z + w) = \sqrt{2xy}\,.$$

[8 marks]

2. a. Find the area of parallelogram whose vertices are given by the points A(0, 0, 1), B(3, 2, 4), C(5, 1, 4) and D(2, -1, 1).

[8 marks]

b. Given

$$f(x, y, z) = \sin(xyz),$$

find the directional derivative at the point (1, 2, 3) in the direction of $\vec{v} = < 3, 2, 1 >$.

[6 marks]

c. Given $\vec{u} = \langle 1,2 \rangle$ and $\vec{v} = \langle 3,4 \rangle$. Find dot and cross product between $\vec{u}$ and $\vec{v}$.

[6 marks]

3. a. Compute the curl and divergence for

$$\vec{F}(x,y,z) = (e^x y)\hat{\imath} + 2(e^y z)\hat{\jmath} + 3(xye^z)\hat{k}.$$

[6 marks]

b. Find the volume of the solids that lies below the surface

$$z(x,y) = x^2 + y + 3$$

and above the rectangle $R = \{(x,y)|0 \leq x \leq 2, 0 \leq y \leq 3\}$.

[6 marks]

c. Use polar coordinates to evaluate

$$\int_0^5 \int_{2x}^{\sqrt{25-x^2}} (x^2 + y^2)\, dydx.$$

[8 marks]

4. a. Solve

$$\iiint 8xy \, dV$$

where the region lies under the plane $z = x + y$ and above the region in the $xy$-plane bounded by the curves $y = 0$, $x = 1$, and $y = \sqrt{x}$.

[8 marks]

b. Find the parametric equation for the line that passes through the point (0,3) and is parallel to the line $x = -5 + t$, $y = 1 + 2t$.

[4 marks]

c. Let $C$ be the curve represented by the equation

$$x = t,\ y = 3t^2 \text{ and } z = 6t^3\ ;\ 0 \leq t \leq 1.$$

Evaluate $\int_C (2x + 4y + 6z^2)\,ds$.

[8 marks]

5. a. Use Gauss-Seidel method to solve the system

$$3x_1 + x_2 + x_3 = 15$$

$$x_1 + 6x_2 + x_3 = 9$$

$$x_1 + x_2 + 9x_3 = 12$$

until the percent error falls below $\varepsilon = 5\%$. Compute the answer in **SIX (6)** decimal places with initial conditions $x_1 = 0$, $x_2 = 0$ and $x_3 = 3$.

[10 marks]

b. Use Lagrange interpolation polynomial of the first and second order to evaluate $\ln 2$ in **SIX (6)** decimal places

$$x_0 = 1, f(x_0) = 0,$$

$$x_1 = 4, f(x_1) = 1.386294,$$

$$x_2 = 6, f(x_2) = 1.791760.$$

[10 marks]

- END OF PAPER -