Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	ENGINEERING MATHEMATICS
COURSE CODE	:	DAM 13303
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Sketch a piece-wise function below:

$$m(x)=\begin{cases} x-3 & ;x\le -1 \\ x^3+0.5 & ;-1<x\le 2. \\ (x-2)^2-2 & ;2<x\le 5 \end{cases}$$

Hence, identify the domain and range of $m(x)$.

(5 marks)

(b) Find the value of b if $f\circ f(2)=5$ and $f(x)=\dfrac{bx}{x-1}$.

(6 marks)

(c) Evaluate $\lim\limits_{k\to 6}\dfrac{\dfrac{1}{\sqrt{30+x}}-\dfrac{1}{6}}{-k+6}$.

(6 marks)

(d) Given the piece-wise function as below:

$$g(t)=\begin{cases} -t^2-4t & ;-5\le t<-2 \\ t+6 & ;-2\le t<0 \\ -2t^3+6 & ;0\le t<2 \\ -10 & ;t\ge 2 \end{cases}.$$

(i) Find $\lim\limits_{t\to 2} g(t)$.

(4 marks)

(ii) Calculate $g(2)$.

(2 marks)

(iii) Determine whether $g(t)$ is continuous at $t=2$. Give your reason.

(2 marks)

Q2 (a) Differentiate the following functions:

(i) $y=\dfrac{2x^4+\sqrt{3x^3}}{\sqrt{x}}$.

(3 marks)

(ii) $y=\left(x-3\ln\left|2x-1\right|\right)^{\frac{3}{2}}$.

(4 marks)

(b) Find $\frac{dy}{dx}$ by implicit differentiation for $5x^2 - x\ln 2 + 3xe^{-2y} = 2y^3$.

(7 marks)

(c) Given the parametric functions, $x = 3\sin\left(\frac{t}{2}\right)$ and $y = -2\cos(2t)$. Find $\frac{dy}{dx}$ when $t = \frac{\pi}{4}$.

(5 marks)

(d) The edges of a cube shaped block of ice are decreasing in length at a rate of $4\,\text{cm/hr}$, determine the rate at which its surface area is decreasing when its volume is $27\ \text{cm}^3$.

(6 marks)

Q3 (a) By using integration by part, solve $\int (e^{3.5x}\cos 3.5x)\,dx$.

(7 marks)

(b) Solve $\int_2^4 \frac{x^2+3x}{x(x^2+6x+3)}\,dx$ by using substitution method.

(8 marks)

(c) The region ***R*** bounded by $y_1 = x+5$ and $y_2 = x^2 - 8x + 10$.

(i) Sketch the region ***R***.

(2 marks)

(ii) Find the area of the region ***R*** bounded by the two curves.

(8 marks)

Q4 (a) Solve the first order differential equation below:

$$\cos x\frac{dy}{dx} + y\sin x = 1, \text{ given that } y(\pi) = 2.$$

(8 marks)

(b) Malaysia has primarily planted a population species of 3290 mangrove trees mostly in coastal saline areas in 2019 to prevent flooding and storm damage. It was found the rate of growth of the population of mangrove trees exponentially increased yearly when there were about 4525 mangrove trees in 2022. Determine the population growth of mangrove trees in 2024 and 2030.

(6 marks)

(c) Given the differential equation:

$$\left(3x^2+12xy+10y^2\right)dx=\left(8xy+8x^2\right)dy.$$

(i) Show that the differential equation above is homogeneous equation.

(3 marks)

(ii) Then, solve the given differential equation.

(8 marks)

- END OF QUESTIONS -

Formula

Table 1: Integration and Differentiation

Integration	Differentiation
$\int x^n dx = \frac{x^{n+1}}{n+1} + C$	$\frac{d}{dx} x^n = nx^{n-1}$
$\int \frac{1}{x} dx = \ln\lvert x\rvert + C$	$\frac{d}{dx}\left[f(x)\right]^n = n\left[f(x)\right]^{n-1} f'(x)$
$\int \frac{1}{a-bx} dx = -\frac{1}{b}\ln\lvert a-bx\rvert + C$	$\frac{d}{dx}\ln(u) = \frac{1}{u}\frac{du}{dx}$
$\int e^{ax} dx = \frac{1}{a} e^{ax} + C$	$\frac{d}{dx} e^u = e^u \frac{du}{dx}$
$\int \sin ax\, dx = -\frac{1}{a}\cos ax + C$	$\frac{d}{dx}\sin u = \cos u \frac{du}{dx}$
$\int \cos ax\, dx = \frac{1}{a}\sin ax + C$	$\frac{d}{dx}\cos u = -\sin u \frac{du}{dx}$
$\int \sec^2 x\, dx = \tan x + C$	$\frac{d}{dx}\tan u = \sec^2 u \frac{du}{dx}$
$\int \csc^2 x\, dx = -\cot x + C$	$\frac{d}{dx}\cot u = -\csc^2 u \frac{du}{dx}$
$\int u\, dv = uv - \int v du$	$\frac{d}{ds}(uv) = u\frac{dv}{ds} + v\frac{du}{ds}$
$\int_a^b f(x) dx = F(b) - F(a)$	$\frac{d}{ds}\left(\frac{u}{v}\right) = \frac{v\frac{du}{ds} - u\frac{dv}{ds}}{v^2}$

Table 2: Area

Area of Region

$$A = \int_a^b \left[f(x) - g(x)\right] dx \quad \text{or} \quad A = \int_c^d \left[w(y) - v(y)\right] dy$$