Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	ENGINEERING MATHEMATICS
COURSE CODE	:	DAE 12003
PROGRAMME CODE	:	DAE
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS.
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **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 **EIGHT (8)** PAGES

Q1 (a) Solve the following limits:

(i) $\lim_{x \to 8} \frac{\sqrt{x+1}-2}{x-3}$.

(1 mark)

(ii) $\lim_{x \to +\infty} \frac{6x^2+7x}{2x^2-3}$.

(3 marks)

(iii) $\lim_{x \to 4} \frac{x^2-2x-8}{\sqrt{x^2+9}-5}$.

(5 marks)

(b) Determine whether the function, $g(x)$ below is continuous at $x=3$:

$$g(x)=\begin{cases} 4x-1, & x \neq 3 \\ \frac{14+x^2}{x}, & x=3 \end{cases}.$$

(4 marks)

(c) Given the piecewise function below:

$$f(x)=\begin{cases} x^2+4x+r & ; \quad -2 \le x \le 1 \\ s-x & ; \quad 1 \le x \le 4 \\ 3 & ; \quad x \ge 4 \end{cases}.$$

Calculate the values of r and s, so that the function, $f(x)$ is continuous at $x=1$ and $x=4$.

(7 marks)

Q2 (a) Differentiate the following functions:

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

(3 marks)

(ii) $r=\frac{1}{\sqrt{x^2-3\sin x}}$.

(3 marks)

(b) If $3x^2 - e^{-3x}y^3 = y\ln 5$. Determine $\frac{dy}{dx}$ in terms of x and y by using implicit differentiation.

(6 marks)

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

(5 marks)

(d) By using L'Hopital's rule, evaluate $\lim_{x\to 0}\frac{2e^x - x - 2}{\cos x - \frac{x}{2}}$.

(3 marks)

Q3 (a) Evaluate $\int \frac{1}{2}(5x-2)^4\, dx$.

(2 marks)

(b) By using integration by parts, find $\int e^{-3x}\cos 2x\, dx$.

(7 marks)

(c) Solve $\int \frac{5x-3}{x^2+x-2}\, dx$ using partial fraction method.

(6 marks)

(d) Find the volume of the solid generated in **Figure Q3(d)** when ***R*** is revolved about y-axis.

(5 marks)

Q4 (a) Find the Laplace transform of the following functions:

(i) $f(t) = (4-t)(4+t)$.

(3 marks)

(ii) $f(t) = e^{-t}\left(3\cos 4t + 5\sinh\sqrt{5}t\right)$.

(4 marks)

(iii) $f(t) = t\sin 3t$.

(3 marks)

(b) Determine the inverse Laplace transform for these expressions:

(i) $\frac{6}{s^4}-\frac{3s}{s^2+9}+\frac{30}{2s^2-50}$.

(4 marks)

(ii) $\frac{s+6}{s^2+s-12}$.

(6 marks)

Q5 Solve the following differential equations using Laplace transform:

(a) $y''+3y'+2y=-2e^{-\frac{1}{2}t}$; $y(0)=0$ and $y'(0)=0$.

(10 marks)

(b) $y''-9y=3t$; $y(0)=0$ and $y'(0)=1$.

(10 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER / SESSION : SEM II 2022/2023 PROGRAMME CODE : DAE
COURSE NAME : ENGINEERING MATHEMATICS COURSE CODE : DAE 12003

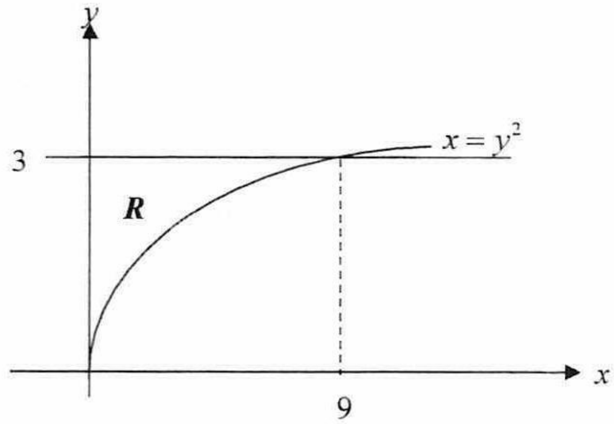

Figure Q3(d)

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II 2022/2023	PROGRAMME CODE	: DAE
COURSE NAME	: ENGINEERING MATHEMATICS	COURSE CODE	: DAE 12003

Formula

Table 1: Integration and Differentiation

Integration	**Differentiation**
$\int x^n dx = \frac{x^{n+1}}{n+1} + C$	$\frac{d}{dx} x^n = nx^{n-1}$
$\int \frac{1}{x} dx = \ln\lvert x\rvert + C$	$\frac{d}{dx} \ln x = \frac{1}{x}$
$\int \frac{1}{a-bx} dx = -\frac{1}{b}\ln\lvert a-bx\rvert + C$	$\frac{d}{dx}\ln(u) = \frac{1}{u}\frac{du}{dx}$ **where** $u = f(x)$
$\int e^{ax+b} dx = \frac{1}{a} e^{ax+b} + C$	$\frac{d}{dx} e^u = e^u \frac{du}{dx}$
$\int \sin(ax+b)\, dx = -\frac{1}{a}\cos(ax+b) + C$	$\frac{d}{dx}\sin u = \cos u \frac{du}{dx}$
$\int \cos(ax+b) dx = \frac{1}{a}\sin(ax+b) + C$	$\frac{d}{dx}\cos u = -\sin u \frac{du}{dx}$
$\int \sec^2(ax+b)\, dx = \tan(ax+b) + C$	$\frac{d}{dx}\tan u = \sec^2 u \frac{du}{dx}$
$\int \csc^2(ax+b)\, dx = -\cot(ax+b) + C$	$\frac{d}{dx}\cot u = -\csc^2 u \frac{du}{dx}$
$\int u\, dv = uv - \int v du$	$\frac{d}{ds}(uv) = u\frac{dv}{ds} + v\frac{du}{ds}$
$\int_a^b f(x) dx = F(b) - F(a)$	$\frac{d}{ds}\left(\frac{u}{v}\right) = \frac{v\frac{du}{ds} - u\frac{dv}{ds}}{v^2}$
Volume of Solid Region $V = 2\pi\int_a^b x[f(x) - g(x)]\, dx$ **or** $V = 2\pi\int_c^d y[w(y) - v(y)]\, dy$	Chain Rule: $\frac{dy}{dx} = \frac{dy}{du}\cdot\frac{du}{dx}$ Parametric Differentiation: $\frac{dy}{dx} = \frac{dy}{dt}\cdot\frac{dt}{dx}$

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FINAL EXAMINATION

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COURSE NAME	: ENGINEERING MATHEMATICS	COURSE CODE	: DAE 12003

Table 2: Partial Fraction

$\dfrac{a}{(s+b)(s-c)} = \dfrac{A}{s+b} + \dfrac{B}{s-c}$
$\dfrac{a}{s(s-b)(s-c)} = \dfrac{A}{s} + \dfrac{B}{s-b} + \dfrac{C}{s-c}$
$\dfrac{a}{(s+b)^2} = \dfrac{A}{s+b} + \dfrac{B}{(s+b)^2}$
$\dfrac{a}{(s+b)(s^2+c)} = \dfrac{A}{(s+b)} + \dfrac{Bs+C}{(s^2+c)}$

FINAL EXAMINATION

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Table 3: Laplace and Inverse Laplace Transforms

$L\{f(t)\} = \int_0^\infty f(t)e^{-st}dt = F(s)$	
$f(t)$	$F(s)$
k	$\frac{k}{s}$
$t^n, n = 1, 2, \ldots$	$\frac{n!}{s^{n+1}}$
e^{at}	$\frac{1}{s-a}$
$\sin at$	$\frac{a}{s^2+a^2}$
$\cos at$	$\frac{s}{s^2+a^2}$
$\sinh at$	$\frac{a}{s^2-a^2}$
$\cosh at$	$\frac{s}{s^2-a^2}$
First Shift Theorem	
$e^{at}f(t)$	$F(s-a)$
Multiply with t^n	
$t^n f(t), n = 1, 2, \ldots$	$(-1)^n \frac{d^n F(s)}{ds^n}$
Initial Value Problem	
$L\{y(t)\} = Y(s)$	
$L\{y'(t)\} = sY(s) - y(0)$	
$L\{y''(t)\} = s^2Y(s) - sy(0) - y'(0)$	

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