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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ENGINEERING MATHEMATICS I
COURSE CODE	:	DAC 11403
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS IN SECTION A AND ANSWER **THREE (3)** QUESTIONS IN SECTION B

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THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

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SECTION A

Q1 (a) Solve the following integrals.

(i) $\int \sqrt{x}\left(\frac{3}{\sqrt{x}}+2\sqrt{x}\right)dx$.

(3 marks)

(ii) $\int_0^{\pi}\left(\sin\frac{\theta}{2}+\cos 2\theta\right)d\theta$.

(3 marks)

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

(7 marks)

(c) Find $\int \frac{2x-6}{x^3+2x^2}\,dx$ by using partial fraction.

(7 marks)

Q2 (a) Given a region on a graph is enclosed by the curve $y=\sqrt{x-2}$, the y - axis and the lines $y=0$ and $y=2$.

(i) Sketch the bounded region.

(3 marks)

(ii) Find the enclosed area.

(4 marks)

(b) The region bounded by the curve $x=(y-2)^2$, x - axis and y - axis is rotated about the x - axis .

(i) Sketch the bounded region.

(3 marks)

(ii) Find the volume of the solid generated using cylindrical shell method.

(5 marks)

(c) Find the arc length of the curve $y=1-2x^{\frac{3}{2}}$ between interval $x=0$ and $x=1$.

(5 marks)

SECTION B

Q3 (a) The function $f(x)$ is given by

$$f(x)=\begin{cases}4 & x<2\\ (x-4)^2 & 2\le x<4\\ 4-x & x\ge 4\end{cases}$$

(i) Sketch the graph of $f(x)$.

(3 marks)

(ii) Write the domain and range for $f(x)$.

(2 marks)

(iii) Calculate the value of $f(x)$ when $x=-1$, $x=3$ and $x=6$.

(3 marks)

(b) Given the function $f(x)=\sqrt{3+x}$, $g(x)=\dfrac{3}{x}$, and $h(x)=x^2-4$. Find

(i) $(g\circ f)(x)$.

(2 marks)

(ii) $(h\circ f\circ g)(x)$.

(4 marks)

(iii) $(f^{-1}\circ h^{-1})(x)$.

(6 marks)

Q4 (a) Given a piecewise function

$$g(x)=\begin{cases}\cos\pi x & x\le 1\\ x^2+1 & x>1\end{cases}$$

(i) Find $\lim_{x\to 1^-} g(x)$.

(3 marks)

(ii) Find $\lim_{x\to 2} g(x)$.

(3 marks)

(b) Based on graph of $f(x)$ in **Figure Q4(b)**, find $\lim_{x\to -2} f(x)$ and determine $f(x)$ is continuous or not when $x = -2$. Give a reason.

(4 marks)

(c) Evaluate the following limits.

(i) $\lim_{t\to 5}\left(\dfrac{t^2-25}{t-5}-7t\right)$.

(5 marks)

(ii) $\lim_{z\to 0}\dfrac{z}{4-\sqrt{z+16}}$.

(5 marks)

Q5 (a) Differentiate the following functions.

(i) $y=\dfrac{3}{2x^6}-7\sqrt[3]{x}$.

(2 marks)

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

(3 marks)

(iii) $y=\sin\sqrt{e^{\theta}+3\theta}$.

(3 marks)

(b) Find $\dfrac{dy}{dx}$ for the given $x=7te^{2t}$ and $y=\dfrac{3t}{t^2-6}$ by using parametric differentiation.

(6 marks)

(c) Find the implicit differentiation for $\tan^2 y-4e^{8x}=y\sec x$.

(6 marks)

Q6 (a) By using L'Hospital's Rule, calculate

(i) $\lim_{x\to 2}\dfrac{x^3-7x^2+10x}{x^2+x-6}$.

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(4 marks)

(ii) $\lim_{t\to 0}\dfrac{\sin(6t)}{\sin(11t)}$.

(4 marks)

(b) Given a function $g(z) = 3z^4 + 8z^3 - 174z^2 - 360z$.

(i) Find $g'(z)$ and $g''(z)$.

(4 marks)

(ii) Find the stationary points.

(3 marks)

(iii) Determine the minimum and maximum points of the function.

(5 marks)

Q7 (a) Find the approximate value (to three decimal places) of the following integral

(i) $\int_0^3 3x - x^2 dx$ using trapezoidal rule by taking $n = 6$ subintervals.

(8 marks)

(ii) $\int_1^3 \frac{3x}{x+5} dx$ using Simpson's Rule by taking steps size, $h = 0.25$.

(8 marks)

(b) Find improper integral equation, $\int_2^\infty \frac{9}{(1-3z)^4} dz$. Then, state either the integral converges or diverges.

(4 marks)

- END OF QUESTIONS -

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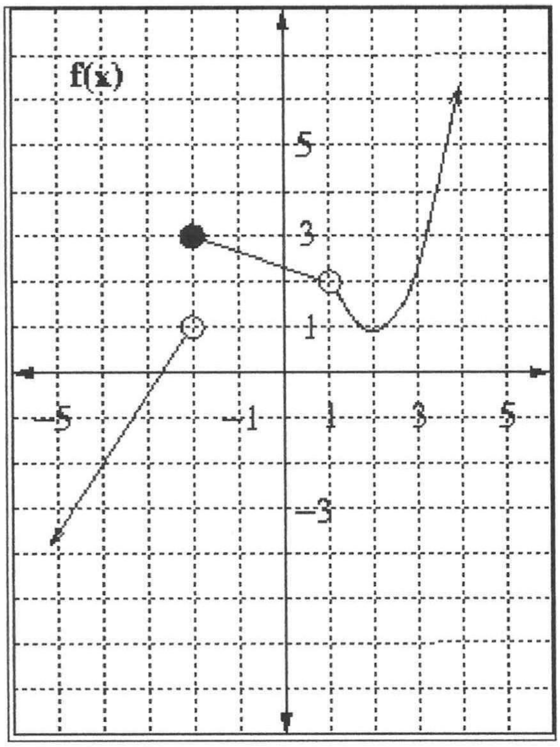

Figure Q4(b)

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Formula

Table 1: Differentiation

$\frac{d}{dx}[c]=0$	$\frac{d}{dx}[\sin u]=\cos u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[x^n]=nx^{n-1}$	$\frac{d}{dx}[\cos u]=-\sin u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[cu]=c\frac{du}{dx}$	$\frac{d}{dx}[\ln\|u\|]=\frac{1}{u}\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[u\pm v]=\frac{du}{dx}\pm\frac{dv}{dx}$	$\frac{d}{dx}\left[e^u\right]=e^u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[uv]=u\frac{dv}{dx}+v\frac{du}{dx}$	$\frac{d}{dx}[a^u]=a^u\ln a\left(\frac{du}{dx}\right)$
$\frac{d}{dx}\left[\frac{u}{v}\right]=\frac{v\frac{du}{dx}-u\frac{dv}{dx}}{v^2}$	$\frac{d}{dx}[\tan u]=\sec^2 u\left(\frac{du}{dx}\right)$
$\frac{d}{dx}[\log_a u]=\frac{1}{u}\log_b e\left(\frac{du}{dx}\right)$	$\frac{d}{dx}[\sec u]=\sec u\tan u\left(\frac{du}{dx}\right)$
Chain Rule: $\frac{dy}{dx}=\frac{dy}{du}.\frac{du}{dx}$	Parametric Differentiation: $\frac{dy}{dx}=\left(\frac{dy}{dt}\Big/\frac{dx}{dt}\right)=\frac{dy}{dt}.\frac{dt}{dx}$

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Table 2: Integration

$\int a\,dx = ax + C$	$\int \sin nx\,dx = -\frac{1}{n}(\cos nx) + C$
$\int x^n\,dx = \frac{x^{n+1}}{n+1} + C, (n \neq -1)$	$\int \cos nx\,dx = \frac{1}{n}(\sin nx) + C$
$\int \frac{1}{nx+b}\,dx = \frac{1}{n}\ln\lvert nx+b\rvert + C$	$\int \tan x\,dx = \ln\lvert \sec x \rvert + C$
$\int \frac{1}{b-nx}\,dx = -\frac{1}{n}\ln\lvert b-nx\rvert + C$	$\int \sec^2 x\,dx = \tan x + C$
$\int e^{nx}\,dx = \frac{1}{n}\left(e^{nx}\right) + C$	$\int \csc^2 x\,dx = -\cot x + C$
$\int e^{nx+b}\,dx = \frac{1}{n}e^{nx+b} + C$	$\int \sec x\,dx = \ln\lvert \sec x + \tan x\rvert + C$
Integration part by part: $\int udv = uv - \int vdu$	
Improper Integral: $\int_a^{\infty} f(x)dx = \lim_{b\to\infty}\int_a^b f(x)dx$	
Identity: $1 + \tan^2 x = \sec^2 x$	

Area of Region

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

Volume Cylindrical Shells

$$V = \int_a^b 2\pi x\, f(x)\,dx \quad \text{or} \quad V = \int_c^d 2\pi y\, f(y)\,dy$$

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Arc Length

$$L=\int_a^b \sqrt{1+\left(\frac{dy}{dx}\right)^2}\,dx \quad \text{or} \quad L=\int_c^d \sqrt{1+\left(\frac{dx}{dy}\right)^2}\,dy$$

Partial Fraction

$$\frac{P(x)}{(x+a)(x+b)}=\frac{A}{x+a}+\frac{B}{x+b}$$

$$\frac{P(x)}{x^2(x+a)}=\frac{A}{x}+\frac{B}{x^2}+\frac{C}{x+a}$$

Simpson's Rule

$$\int_a^b f(x)\,dx \approx \frac{h}{3}\left[(f(a)+f(b))+4\sum_{\substack{i=1\\ i\text{ odd}}}^{n-1} f(a+ih)+2\sum_{\substack{i=2\\ i\text{ even}}}^{n-2} f(a+ih)\right]; \quad n=\frac{b-a}{h}$$

Trapezoidal Rule

$$\int_a^b f(x)\,dx \approx \frac{h}{2}\left[f(a)+f(b)+2\sum_{i=1}^{n-1} f(a+ih)\right]; \quad n=\frac{b-a}{h}$$