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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	ENGINEERING MATHEMATICS I
COURSE CODE	:	DAS 10203
PROGRAMME CODE	:	DAA / DAM
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	SECTION A) ANSWER **ALL** QUESTIONS SECTION B) ANSWER **THREE (3)** QUESTIONS ONLY

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THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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SECTION A

Q1 (a) Evaluate

(i) $\int \left(\frac{3x^2 + 4e^x - 6\sqrt{x}}{2} \right) dx$.

(3 marks)

(ii) $\int_{\pi/2}^{\pi} (\sin 2\theta - \cos\theta) d\theta$.

(3 marks)

(b) By using substitution method, find

$$\int \frac{4x}{(5x+3)^2} dx.$$

(7 marks)

(c) Find $\int 2xe^{3x} dx$ by using integration by parts.

(7 marks)

Q2 (a) **Figure Q2(a)** shows that the region R bounded by the curve $y^2 = 10 - x$ and $x = (y-2)^2$.

(i) Find the coordinate of point A.

(4 marks)

(ii) Find the area of the shaded region.

(4 marks)

(b) **Figure Q2(b)** shows the region R bounded by the curve $y = \sqrt{x}$, the line $y = 3$ and the $y-$axis. By using the cylindrical shells method, find the volume of the solid generated when the region R is rotated about $y-$axis.

(5 marks)

(c) Find the arc length of the curve, $y = \ln(\cos x)$ when $0 \le x \le \frac{\pi}{4}$.

(7 marks)

SECTION B

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

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

(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 $x=-4$, $x=1$ and $x=6$.

(3 marks)

(b) Given $f(x)=e^x+1$, $g(x)=\ln x$, and $h(x)=x-1$. Find the composite function of

(i) $f\circ g(1)$.

(3 marks)

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

(4 marks)

(c) If $h(x)=cx+2$, find

(i) the inverse function, $h^{-1}(x)$.

(3 marks)

(ii) the value of c if $h^{-1}(3)=\frac{1}{5}$.

(2 marks)

Q4 (a) The graph of $f(x)$ is shown in **Figure Q4(a)**. Using the properties of continuity determine whether the function is continuous when

(i) $x = -8$.

(4 marks)

(ii) $x = -2$.

(4 marks)

(iii) $x = 6$.

(4 marks)

(b) Evaluate the following limits.

(i) $\lim_{x \to -2} \frac{x^4 - 16}{x + 2}$.

(4 marks)

(ii) $\lim_{x \to \infty} \frac{e^{-3x} - 2e^{8x}}{9e^{8x} - 7e^{-3x}}$.

(4 marks)

Q5 (a) Differentiate the following functions.

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

(2 marks)

(ii) $y = \frac{1}{\sqrt[3]{x}} + \log_2 7x$.

(2 marks)

(iii) $y = \frac{6^x}{\sin(2x - 3)}$.

(3 marks)

(b) Given $x = 5\cos t + 2te^t$ and $y = -\sin(t + 3) + 4t^{-2}$. Find

(i) $\frac{dx}{dt}$ and $\frac{dy}{dt}$.

(2 marks)

(ii) $\frac{dy}{dx}$ by using the parametric differentiation.

(2 marks)

(c) Find

(i) the value of $\frac{dy}{dx}$ for $y = (x - 2^{x+2})(\sqrt{16 - x^4})$.

(3 marks)

(ii) the implicit differentiation for $8^{x^3} - 5x^{\frac{4}{10}} = 7y^{-3}x^3$.

(6 marks)

Q6 (a) Given the function of $f(x) = \frac{1}{3}x^3 - \frac{5}{2}x^2 + 6x$.

(i) Find the extrema and the inflection point. Hence, complete the **Table Q6(a)** by finding **P**, **Q**, **R**, **S**, **T**, and **U**.

(6 marks)

(ii) Sketch the graph.

(3 marks)

(b) An ice cube is melting so that its edge length x is decreasing at the rate of 0.2 m/sec.

(i) Find the rate of change of the volume of ice cube when $x = 3$.

(4 marks)

(ii) Find the rate of change of the surface area of ice cube when $x = 2$.

(4 marks)

(c) By using L'Hospital's Rule, find $\lim_{x \to 2} f(x) = \frac{x^2 - 4}{x - 2}$.

(3 marks)

Q7 (a) By using Simpson's rule, solve the following integral with $h = 0.2$. Write the answer to 3 decimal places.

$$\int_0^2 \frac{\sqrt[3]{x^2 + 7x}}{e^{2x}}\,dx.$$

(7 marks)

(b) By using Trapezoidal's rule, solve the following integral with $n = 12$. Write the answer to 3 decimal places.

$$\int_1^4 \frac{5x+3}{(2x-9)^2}\,dx.$$

(6 marks)

(c) Solve the following improper integral.

$$\int_5^{\infty} \frac{2x}{x^2 - 4}\,dx.$$

(7 marks)

- END OF QUESTIONS –

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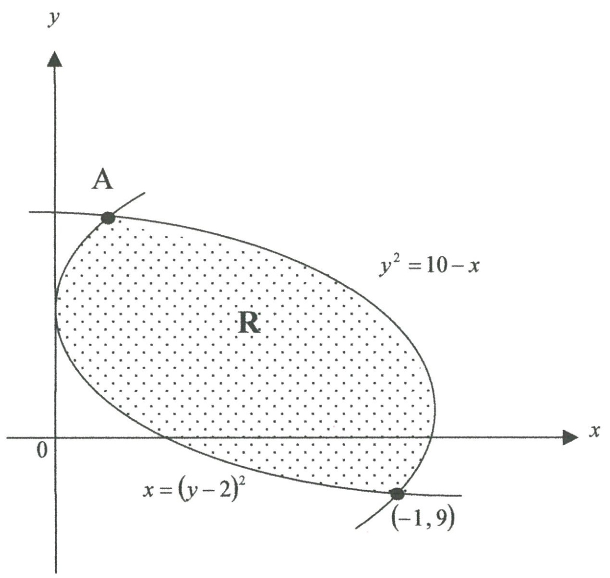

Figure Q2(a)

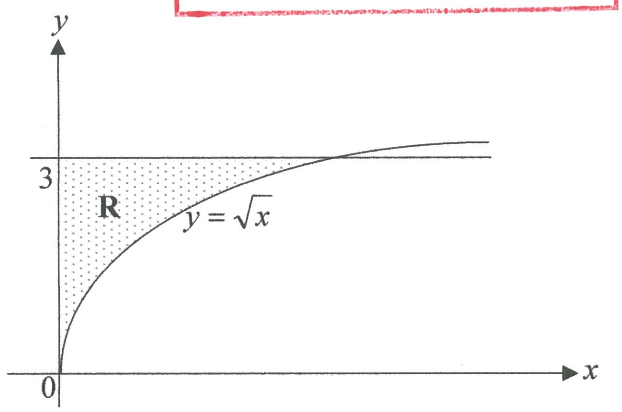

Figure Q2(b)

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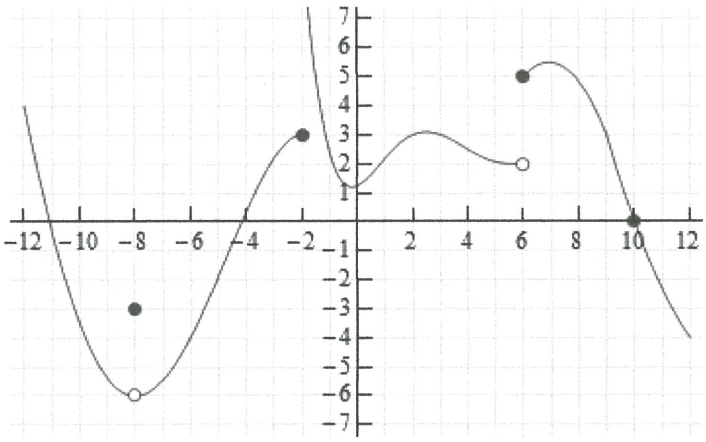

Figure Q4(a)

Table Q6(a)

Value Type	Test Value	Critical Value	Test Value	Inflection Value	Test Value	Critical Value	Test Value
x	1	**P**	2.3	**Q**	2.8	**R**	4
$f(x)$	3.83	4.67	4.63	4.58	4.52	4.5	5.33
Sign of $f'(x)$	+	0	-	-	-	0	+
Sign of $f''(x)$	-	-	-	0	+	+	+
Graph Characteristics	**S**	Relative Minimum	Decreasing Concave down	**T**	Decreasing Concave up	**U**	Increasing Concave up

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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: $\int u\,dv = uv - \int v\,du$	
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

$$\frac{a}{x^2-1}=\frac{A}{x+1}+\frac{B}{x-1}$$

Simpson's Rule

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

Trapezoidal Rule

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

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