



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011**

COURSE NAME : ENGINEERING MATHEMATICS
I

COURSE CODE : DAS 10303

PROGRAMME : 1 DAE / DAL
2 DAE / DAL

EXAMINATION DATE : APRIL/MAY 2011

DURATION : 3 HOURS

INSTRUCTIONS : ANSWER **FIVE (5)** QUESTIONS
ONLY

THIS QUESTION PAPER CONSISTS OF THIRTEEN (13) PAGES

- Q1** (a) Given a function, $f(x) = 7x^4 + (2x - 5)x$ and $g(x) = 4 - \frac{3}{4x^2 - 1}$.

Find

- (i) $12f(0) + g(0)$
- (ii) $2f(1) - g(2)$
- (iii) $f(2a) \cdot g(1)$
- (iv) $\frac{f(-1)}{g(x-1)}$

(10 marks)

- (b) Find the domain and range of the following functions

- (i) $f(x) = 4x^3 + 2x^2 - 3x + 7$
- (ii) $g(x) = \frac{1}{x^2 - 9}$

(5 marks)

- (c) Given $f(x) = x^2 - 3$ and $g(x) = \sqrt{x^2 - 3}$.

Find

- (i) $(f \circ g)(x)$
- (ii) $(g \circ f)(x)$
- (iii) $[f^{-1}(x)]^2 + [g^{-1}(x)]^2$

(5 marks)

- Q2** (a) Find the limits below.

- (i) $\lim_{x \rightarrow 2} \sqrt{x^3 - 2x} - 4$
- (ii) $\lim_{x \rightarrow 0} \frac{\sqrt{x+4} - 2}{3x}$
- (iii) $\lim_{x \rightarrow \infty} \left(\frac{3x^3 - 4x^2 - 3}{7 - 2x + 5x^3} \right)$

(8 marks)

(b) By using L'hospital's Rule, compute:

(i) $\lim_{x \rightarrow 0} \frac{1 - \cos x}{3x^2}$

(ii) $\lim_{x \rightarrow \infty} \left(\frac{8 - 2x}{x^2 - x - 12} \right)$

(6 marks)

(c) Refer to **Figure Q2(c)**, check whether the function $f(x)$ is continuous at $x = -1$ and $x = 0$?

(6 marks)

Q3 (a) Differentiate

(i) $y = 3x^5 - \frac{x^3}{3} + \frac{2}{x^4}$

(ii) $y = \tan(2x - 5)$

(iii) $y = 7e^{x^2+2x-1}$

(9 marks)

(b) By using product and chain rules, find $\frac{dy}{dx}$ for $y = (x^2 - 5)^3 \left(3x - \frac{2}{5} \right)$.

(6 marks)

(c) Given $x = \frac{2-3t}{4t}$ and $y = \frac{5t^2+1}{3t}$. Find the value of $\frac{dy}{dx}$ when $t = 0$.

(5 marks)

Q4 (a) Given a function, $f(x) = x^4 - 8x^3 + 18x^2 + 15$.

- (i) Determine $f'(x)$ and $f''(x)$.
- (ii) Find the critical values when $f'(x) = 0$ and $f''(x) = 0$.
- (iii) Use the table method (sign analysis) below to find the minimum, maximum, inflection points and the shape of the graph.

Domain	$f'(x)$	$f''(x)$	Decreasing or Increasing?	Concavity?	Shape of the graph
$x < a$					
$a < x < b$					
$b < x < c$					
$x > c$					

- (iv) Sketch the graph of $f(x)$.

(13 marks)

- (b) An open box is to be made from a 16-inch by 6-inch piece of cardboard by cutting out squares of equal size from the four corners and bending up the sides. What size should the squares be to obtain a box with the largest volume?

(7 marks)

Q5 (a) Find the Laplace transforms for the functions below.

- (i) $f(t) = t^4 - 3t + 2e^{-5t}$
- (ii) $f(t) = \sin 2t - e^{2t} \cos t$

(10 marks)

(b) Given $g(t) = \begin{cases} t-1, & 0 \leq t < 3, \\ 2t, & 3 \leq t < 5, \\ t+4, & t \geq 5. \end{cases}$

- (i) Sketch the graph for the function $g(t)$.
 (ii) By using The Second Shift Theorem, write the Heaviside Function of $g(t)$.
 (iii) Find the Laplace transforms for $g(t)$.

[Use: $g(t) = g_1 + [g_2 - g_1]H(t-a) + [g_3 - g_2]H(t-b)$]

(10 marks)

Q6 (a) Find the inverse Laplace transforms for the functions below.

(i) $F(s) = \frac{4}{s} - \frac{3}{s-5}$

(ii) $F(s) = \frac{1}{(s+7)(s-7)}$

(iii) $F(s) = \frac{2}{(s-4)^3}$

(iv) $F(s) = \frac{3s}{(s-2)^2}$

(11 marks)

(b) Given $G(s) = \frac{3s+1}{s^2-s-6}$.

- (i) Find the partial fraction for $G(s)$.
 (ii) Determine the inverse Laplace of $G(s)$

(9 marks)

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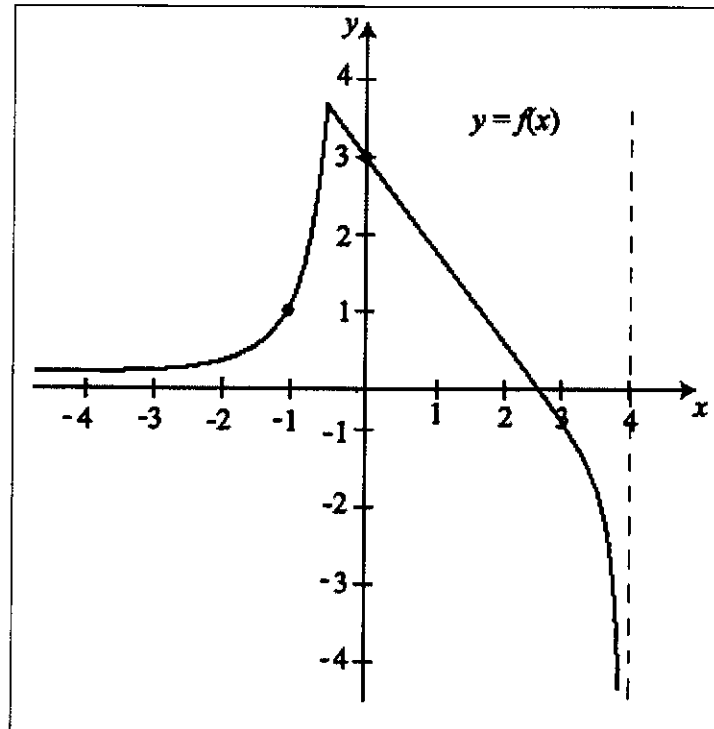


FIGURE Q2(c)

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FORMULAE

Table 1 : Laplace transform.

$\mathcal{L}\{f(t)\} = \int_0^{\infty} f(t)e^{-st} dt = F(s)$	
$f(t)$	$F(s)$
k	$\frac{k}{s}$
$t^n, n = 1, 2, \dots$	$\frac{n!}{s^{n+1}}$
e^{at}	$\frac{1}{s-a}$
$\sin at$	$\frac{a}{s^2 + a^2}$
$\cos at$	$\frac{s}{s^2 + a^2}$
$\sinh at$	$\frac{a}{s^2 - a^2}$
$\cosh at$	$\frac{s}{s^2 - a^2}$
The First Shift Theorem	
$e^{at} f(t)$	$F(s-a)$
Multiply with t^n	
$t^n f(t), n = 1, 2, \dots$	$(-1)^n \frac{d^n F(s)}{ds^n}$
The Unit Step Function	
$H(t-0)$	$\frac{1}{s}$
$H(t-a)$	$\frac{e^{-as}}{s}$
The Second Shift Theorem	
$f(t-a) H(t-a)$	$e^{-as} F(s)$

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Heaviside Function

$$g(t) = g_1 + [g_2 - g_1]H(t-a) + [g_3 - g_2]H(t-b)$$

Table 2: Differentiation

$$\frac{d}{dx} x^n = nx^{n-1}$$

$$\frac{d}{dx} [f(x)g(x)] = f(x)g'(x) + g(x)f'(x)$$

$$\frac{d}{dx} \left[\frac{f(x)}{g(x)} \right] = \frac{g(x)f'(x) - f(x)g'(x)}{(g(x))^2}$$

$$\frac{d^2 y}{dx^2} = \frac{d}{dx} \left(\frac{dy}{dx} \right) = \frac{d}{dt} \left(\frac{dy}{dx} \right) \cdot \left(\frac{dt}{dx} \right)$$

$$\frac{d}{dx} \ln u = \frac{1}{u} \cdot \frac{du}{dx}$$

$$\frac{d}{dx} e^u = e^u \cdot \frac{du}{dx}$$

$$\frac{d}{dx} \sin u = \cos u \cdot \frac{du}{dx}$$

$$\frac{d}{dx} \tan u = \sec^2 u \cdot \frac{du}{dx}$$

$$\frac{d}{dx} \cot u = -\csc^2 u \cdot \frac{du}{dx}$$

$$\frac{d}{dx} \sec u = \sec u \tan u \cdot \frac{du}{dx}$$

$$\frac{d}{dx} \csc u = -\csc u \cot u \cdot \frac{du}{dx}$$

$$\frac{d}{dx} \cos u = -\sin u \cdot \frac{du}{dx}$$

- S1 (a) Diberikan fungsi, $f(x) = 7x^4 + (2x-5)x$ dan $g(x) = 4 - \frac{3}{4x^2 - 1}$.

Dapatkan

- (i) $12f(0) + g(0)$
- (ii) $2f(1) - g(2)$
- (iii) $f(2a) \cdot g(1)$
- (iv) $\frac{f(-1)}{g(x-1)}$

(10 markah)

- (b) Dapatkan domain dan julat bagi fungsi berikut

- (i) $f(x) = 4x^3 + 2x^2 - 3x + 7$
- (ii) $g(x) = \frac{1}{x^2 - 9}$

(5 markah)

- (c) Diberikan $f(x) = x^2 - 3$ and $g(x) = \sqrt{x^2 - 3}$.
Dapatkan

- (i) $(f \circ g)(x)$
- (ii) $(g \circ f)(x)$
- (iii) $[f^{-1}(x)]^2 + [g^{-1}(x)]^2$

(5 markah)

- S2 (a) Dapatkan limit berikut:

- (i) $\lim_{x \rightarrow 2} \sqrt{x^3 - 2x} - 4$
- (ii) $\lim_{x \rightarrow 0} \frac{\sqrt{x+4} - 2}{3x}$
- (iii) $\lim_{x \rightarrow \infty} \left(\frac{3x^3 - 4x^2 - 3}{7 - 2x + 5x^3} \right)$

(8 markah)

(b) Dengan menggunakan Aturan L'hospital, hitung

$$(i) \quad \lim_{x \rightarrow 0} \frac{1 - \cos x}{3x^2}$$

$$(ii) \quad \lim_{x \rightarrow \infty} \left(\frac{8 - 2x}{x^2 - x - 12} \right)$$

(6 markah)

(c) Merujuk kepada **Rajah S2(c)**, semak samada fungsi $f(x)$ kontinu pada $x = -1$ dan $x = 0$?

(6 markah)

S3 (a) Bezakan

$$(i) \quad y = 3x^5 - \frac{x^3}{3} + \frac{2}{x^4}$$

$$(ii) \quad y = \tan(2x - 5)$$

$$(iii) \quad y = 7e^{x^2 + 2x - 1}$$

(9 markah)

(b) Dengan menggunakan hukum hasil darab dan hukum rantai, dapatkan $\frac{dy}{dx}$ bagi

$$y = (x^2 - 5)^3 \left(3x - \frac{2}{5} \right).$$

(6 markah)

(c) Diberikan $x = \frac{2 - 3t}{4t}$ dan $y = \frac{5t^2 + 1}{3t}$. Dapatkan nilai bagi $\frac{dy}{dx}$ apabila $t = 0$.

(5 markah)

S4 (a) Diberikan a fungsi, $f(x) = x^4 - 8x^3 + 18x^2 + 15$.

- (i) Tentukan $f'(x)$ dan $f''(x)$.
- (ii) Dapatkan nilai genting apabila $f'(x) = 0$ dan $f''(x) = 0$.
- (iii) Gunakan kaedah jadual (analisis tanda) di bawah untuk mendapatkan titik minimum, maksimum, titik pertukaran dan bentuk graf.

Domain	$f'(x)$	$f''(x)$	Decreasing or Increasing?	Concavity?	Shape bagi the graf
$x < a$					
$a < x < b$					
$b < x < c$					
$x > c$					

(iv) Lakarkan graf $f(x)$.

(13 markah)

- (b) Sebuah kotak tidak bertutup ingin diperbuat daripada sekeping kadbod berukuran 16in. x 6in. dengan memotong segiempat sama yang sama saiz pada keempat-empat penjuru kadbod berkenaan dan dibengkokkan menjadi sanding kotak. Apakah saiz segiempat yang diperlukan bagi memperolehi kotak yang berisipadu paling besar?

(7 markah)

S5 (a) Dapatkan jelmaan Laplace bagi fungsisi di bawah.

- (i) $f(t) = t^4 - 3t + 2e^{-5t}$
- (ii) $f(t) = \sin 2t - e^{2t} \cos t$

(10 markah)

(b) Diberikan $g(t) = \begin{cases} t-1, & 0 \leq t < 3, \\ 2t, & 3 \leq t < 5, \\ t+4, & t \geq 5. \end{cases}$

- (i) Lakar graf bagi fungsi $g(t)$.
 (ii) Dengan menggunakan Theorem Anjakan Kedua, tuliska Fungsi Heaviside bagi $g(t)$.
 (iii) Dapatkan jelmaan Laplace bagi $g(t)$.

[Gunakan: $g(t) = g_1 + [g_2 - g_1]H(t-a) + [g_3 - g_2]H(t-b)$]

(10 markah)

- S6 (a) Dapatkan jelmaan Laplace songsang bagi fungsis di bawah.

(i) $F(s) = \frac{4}{s} - \frac{3}{s-5}$

(ii) $F(s) = \frac{1}{(s+7)(s-7)}$

(iii) $F(s) = \frac{2}{(s-4)^3}$

(iv) $F(s) = \frac{3s}{(s-2)^2}$

(11 markah)

(b) Diberikan $G(s) = \frac{3s+1}{s^2-s-6}$.

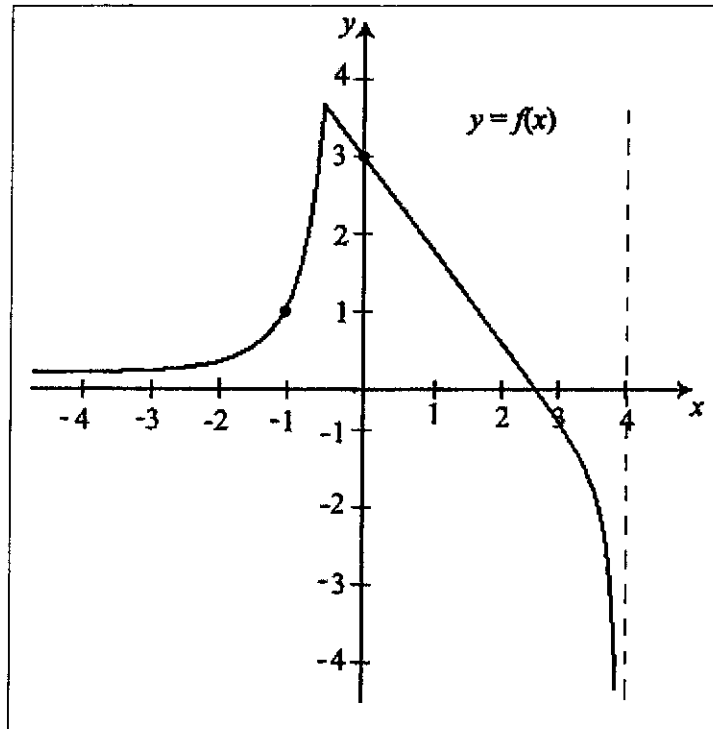
- (i) Dapatkan pecahan separa bagi $G(s)$.
 (ii) Tentukan jelmaan Laplace songsang bagi $G(s)$.

(9 markah)

PEPERIKSAAAN AKHIR

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Rajah S2(c)