SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI II : 2024/2025

DEE40113: SIGNAL AND SYSTEM

TARIKH : 23 MEI 2025
MASA : 3.00 PTG – 5.00 PTG (2 JAM)

Kertas soalan ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A: Subjektif (3 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Appendix

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A : 60 MARKS

BAHAGIAN A : 60 MARKAH

INSTRUCTION:

This section consists of **THREE (3)** structured questions. Answer **ALL** questions.

ARAHAN :

Bahagian ini mengandungi ***TIGA (3)*** *soalan berstruktur. Jawab* ***SEMUA*** *soalan.*

QUESTION 1

SOALAN 1

CLO1 (a) Visualize the graph using the given equation

$$f(t) = u(t+1) - u(t)$$

Lakarkan graf melalui persamaan yang diberi

$$f(t) = u(t+1) - u(t)$$

[4 marks]

[*4 markah*]

CLO1 (b) Sketch the even and odd signal for the continuous time-domain signal shown in Figure A1(b)(i) and the discrete-time signal shown in Figure A1(b)(ii).

Lakarkan isyarat genap dan ganjil bagi isyarat masa berterusan yang ditunjukkan dalam Rajah A1(b)(i) dan isyarat masa diskrit Rajah A1(b)(ii).

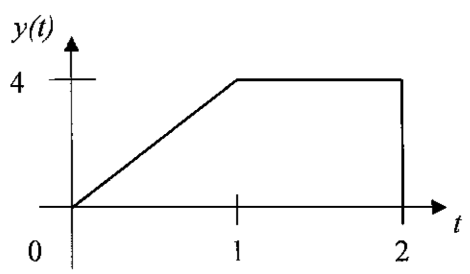

Figure A1(b)(i) / *Rajah A1(b)(i)*

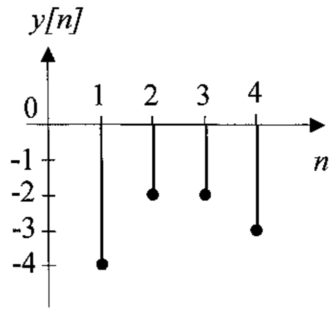

Figure A1(b)(ii) / *Rajah A1(b)(ii)*

[8 marks]

[*8 markah*]

CLO1 (c) A discrete-time signal is as shown in the Figure A1(c) below. Sketch the following signals:

i. $x[n-3]$

ii. $x[2n]$

iii. $x[n+2]$

iv. $x[-n]$

Isyarat masa diskret adalah seperti yang ditunjukkan dalam Rajah A1(c) di bawah. Lakarkan isyarat berikut:

i. $x[n-3]$

ii. $x[2n]$

iii. $x[n+2]$

iv. $x[-n]$

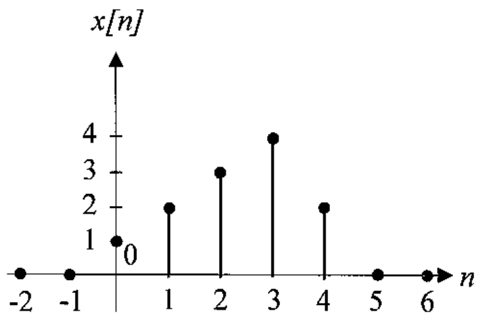

Figure A1(c) / *Rajah A1(c)*

[8 marks]

[*8 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Explain convolution of continuous-Time Liner Time-Invariant (LTI) system.

Terangkan konvolusi sistem Masa-Berterusan Linear Varian-Bukan Pemasa.

[4 marks]

[*4 markah*]

CLO1 (b) Consider LTI system with the impulse signal $x[n] = \{2\ 5\ \underset{\uparrow}{0}\ 4\}$ and input $h[n] = \{4\ \underset{\uparrow}{1}\ 3\}$

If an output $y[n]$ is the response of the discrete convolution sum LTI system derive its expression using discrete convolution sum.

Pertimbangkan LTI *sistem dengan isyarat* $x[n] = \{2\ 5\ \underset{\uparrow}{0}\ 4\}$ *dan* $h[n] = \{4\ \underset{\uparrow}{1}\ 3\}$.

Jika keluaran $y[n]$ *adalah tindak balas sistem LTI isyarat masa berjujukan, dapatkan ungkapan dengan menggunakan isyarat masa berjujukan konvolusi jumlah.*

[8 marks]

[*8 markah*]

CLO1 (c) Consider the signal $x(t)$ and $h(t)$ shown in Diagram A2(c)(i) and Diagram A2(c)(ii). If an output $y(t)$ is the response of the continuous time LTI system determine its expression using convolution integral.

Pertimbangkan isyarat x(t) dan h(t) ditunjukkan dalam Rajah A2(c)(i) dan Rajah A2(c)(ii). Jika keluaran y(t)adalah tindak balas sistem LTI masa yang berterusan, tentukan ungkapan dengan menggunakan konvolusi kamiran.

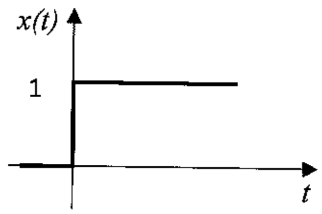

Figure A2(c)(i) / *Rajah A2(c)(i)*

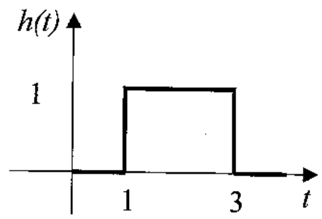

Figure A2(c)(ii) / *Rajah A2(c)(ii)*

[8 marks]
[*8 markah*]

QUESTION 3

SOALAN 3

CLO1 (a) Convert the Laplace transform of the following signal:

Tukarkan penjelmaan Laplace bagi isyarat berikut:

i) $g(t) = 3e^{-2t}u(t)$

ii) $h(t) = 5\cos 2tu(t)$

[4 marks]

[*4 markah*]

CLO1 (b) Show the following Inverse Laplace Transform by using partial fraction expansion method.

Tunjukkan Jelmaan Laplace Songsang berikut dengan menggunakan kaedah pengembangan pecahan separa :

$$G(s) = \frac{s^2 + 4s + 5}{(s+3)(s^2 + 2s + 2)}$$

[8 marks]

[*8 markah*]

CLO1 (c) Compute y[n] = x[n] * h[n] of a discrete-time LTI systems given by using analytical A.

*Kirakan y[n] = x[n] * h[n] bagi system LTI masa diskrit yang diberi dengan menggunakan kaedah analytical A.*

$$x[n] = 2\delta[n-2] + 3\delta[n+1]$$
$$h[n] = \delta[n]n + \delta[n-1] + \delta[n-2]$$

[8 marks]

[*8 markah*]

SECTION B : 40 MARKS

BAHAGIAN B :40 MARKAH

INSTRUCTION:

This section consists of **TWO (2)** essay questions. Answer the question.

ARAHAN:

*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab soalan tersebut.*

QUESTION 1

SOALAN 1

CLO1 Given a continuous-time Linear Time-Invariant (LTI) system, determine the Laplace Transform to derive the second-order differential equation in the time domain.

$$\frac{d^2v(t)}{dt^2}+5\frac{dv(t)}{dt}+6v(t)=10e^{-2t}$$

Diberikan satu sistem LTI (Linear Time-Invariant) dalam bentuk masa berterusan. Tentukan Transformasi Laplace untuk mendapatkan persamaan pembezaan bagi sistem ini yang melibatkan terbitan kedua :

$$\frac{d^2v(t)}{dt^2}+5\frac{dv(t)}{dt}+6v(t)=10e^{-2t}$$

[20 marks]

[*20 markah*]

QUESTION 2

SOALAN 2

CLO1 A periodic rectangular signal f(t) is shown in Figure B2, with a fundamental period of T=2. Evaluate its representation using the Trigonometric Fourier Series with expansion up to the 8th harmonic.

Diberikan satu isyarat segi empat berkala f(t) seperti dalam Rajah B2, dengan tempoh asas T=2. Nilaikan perwakilan isyarat ini menggunakan Siri Fourier Trigonometri dan nyatakan pengembangannya secara jelas sehingga ke harmonik ke-8.

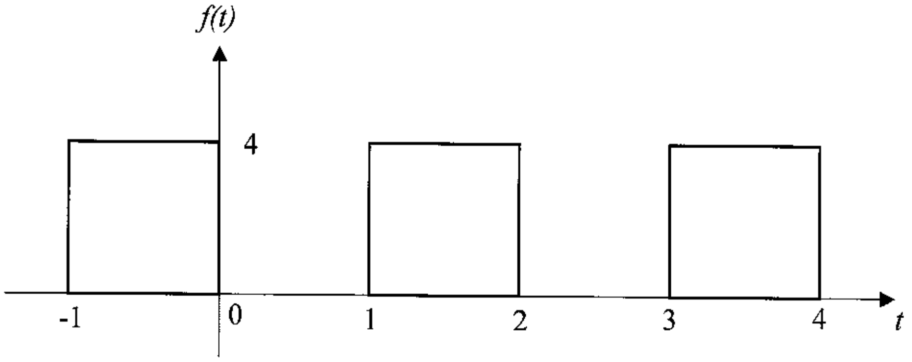

Figure B2 / *Rajah B2*

[20 marks]

[*20 markah*]

SOALAN TAMAT

Laplace Transform Pairs

$x(t)$	$X(s)$	ROC
$\delta(t)$	1	All s
$u(t)$	$\frac{1}{s}$	$\text{Re}(s) > 0$
$-u(-t)$	$\frac{1}{s}$	$\text{Re}(s) < 0$
$tu(t)$	$\frac{1}{s^2}$	$\text{Re}(s) > 0$
$t^k u(t)$	$\frac{k!}{s^{k+1}}$	$\text{Re}(s) > 0$
$e^{-at} u(t)$	$\frac{1}{s+a}$	$\text{Re}(s) > -\text{Re}(a)$
$-e^{-at} u(-t)$	$\frac{1}{s+a}$	$\text{Re}(s) < -\text{Re}(a)$
$te^{-at} u(t)$	$\frac{1}{(s+a)^2}$	$\text{Re}(s) > -\text{Re}(a)$
$-te^{-at}u(-t)$	$\frac{1}{(s+a)^2}$	$\text{Re}(s) < -\text{Re}(a)$
$\cos \omega_0 tu(t)$	$\frac{s}{s^2+\omega_0^2}$	$\text{Re}(s) > 0$
$\sin \omega_0 tu(t)$	$\frac{\omega_0}{s^2+\omega_0^2}$	$\text{Re}(s) > 0$
$e^{-at} \cos \omega_0 tu(t)$	$\frac{s+a}{(s+a)^2+\omega_0^2}$	$\text{Re}(s) > -\text{Re}(a)$
$e^{-at} \sin \omega_0 tu(t)$	$\frac{\omega_0}{(s+a)^2+\omega_0^2}$	$\text{Re}(s) > -\text{Re}(a)$

Z-Transform Pairs

$x[n]$	$X(z)$	ROC
$\delta[n]$	1	All z
$u[n]$	$\dfrac{1}{1-z^{-1}}, \dfrac{z}{z-1}$	$\|z\| > 1$
$-u[-n-1]$	$\dfrac{1}{1-z^{-1}}, \dfrac{z}{z-1}$	$\|z\| < 1$
$\delta[n-m]$	z^{-m}	All z except 0 if $(m > 0)$ or ∞ if $(m < 0)$
$a^n u[n]$	$\dfrac{1}{1-az^{-1}}, \dfrac{z}{z-a}$	$\|z\| > \|a\|$
$-a^n u[-n-1]$	$\dfrac{1}{1-az^{-1}}, \dfrac{z}{z-a}$	$\|z\| < \|a\|$
$na^n u[n]$	$\dfrac{az^{-1}}{(1-az^{-1})^2}, \dfrac{az}{(z-a)^2}$	$\|z\| > \|a\|$
$-na^n u[-n-1]$	$\dfrac{az^{-1}}{(1-az^{-1})^2}, \dfrac{az}{(z-a)^2}$	$\|z\| < \|a\|$
$(n+1)a^n u[n]$	$\dfrac{1}{(1-az^{-1})^2}, \left[\dfrac{z}{z-a}\right]^2$	$\|z\| > \|a\|$
$(\cos \Omega_0 n)u[n]$	$\dfrac{z^2-(\cos \Omega_0)z}{z^2-(2\cos \Omega_0)z+1}$	$\|z\| > 1$
$(\sin \Omega_0 n)u[n]$	$\dfrac{(\sin \Omega_0)z}{z^2-(2\cos \Omega_0)z+1}$	$\|z\| > 1$
$(r^n \cos \Omega_0 n)u[n]$	$\dfrac{z^2-(r\cos \Omega_0)z}{z^2-(2r\cos \Omega_0)z+r^2}$	$\|z\| > r$
$(r^n \sin \Omega_0 n)u[n]$	$\dfrac{(r\sin \Omega_0)z}{z^2-(2r\cos \Omega_0)z+r^2}$	$\|z\| > r$
$\begin{cases} a^n & 0 \le n \le N-1 \\ 0 & \text{otherwise} \end{cases}$	$\dfrac{1-a^N z^{-N}}{1-az^{-1}}$	$\|z\| > 0$

Fourier Transform Pair

$x(t)$	$X(\omega)$
$\delta(t)$	1
$\delta(t-t_0)$	$e^{-j\omega t_0}$
1	$2\pi\delta(\omega)$
$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$
$\cos\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$
$\sin\omega_0 t$	$-j\pi[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]$
$u(t)$	$\pi\delta(\omega)+\frac{1}{j\omega}$
$u(-t)$	$\pi\delta(\omega)-\frac{1}{j\omega}$
$e^{-at}u(t), a>0$	$\frac{1}{j\omega+a}$
$te^{-at}u(t), a>0$	$\frac{1}{(j\omega+a)^2}$
$e^{-a\|t\|}, a>0$	$\frac{2a}{a^2+\omega^2}$
$\frac{1}{a^2+t^2}$	$e^{-a\|\omega\|}$
$e^{-at^2}, a>0$	$\sqrt{\frac{\pi}{a}}\, e^{-\omega^2/4a}$
$p_a(t)=\begin{cases}1 & \|t\|<a \\ 0 & \|t\|>a\end{cases}$	$2a\frac{\sin\omega a}{\omega a}$
$\frac{\sin at}{\pi t}$	$p_a(\omega)=\begin{cases}1 & \|\omega\|<a \\ 0 & \|\omega\|>a\end{cases}$
$\operatorname{sgn} t$	$\frac{2}{j\omega}$
$\sum_{k=-\infty}^{\infty}\delta(t-kT)$	$\omega_0\sum_{k=-\infty}^{\infty}\delta(\omega-k\omega_0), \omega_0=\frac{2\pi}{T}$

Properties of the Fourier Transform

PROPERTY	SIGNAL	FOURIER TRANSFORM
	$x(t)$	$X(\omega)$
	$x_1(t)$	$X_1(\omega)$
	$x_2(t)$	$X_2(\omega)$
Linearity	$a_1x_1(t) + a_2x_2(t)$	$a_1X_1(\omega) + a_2X_2(\omega)$
Time shifting	$x(t - t_0)$	$e^{-j\omega t_0} X(\omega)$
Frequency shifting	$e^{j\omega_0 t} x(t)$	$X(\omega - \omega_0)$
Time scaling	$x(at)$	$\frac{1}{\lvert a\rvert} X\left(\frac{\omega}{a}\right)$
Time reversal	$x(-t)$	$X(-\omega)$
Duality	$X(t)$	$2\pi x(-\omega)$
Time differentiation	$\frac{dx(t)}{dt}$	$j\omega X(\omega)$
Frequency differentiation	$(-jt)x(t)$	$\frac{dX(\omega)}{d\omega}$
Integration	$\int_{-\infty}^{t} x(\tau)\, d\tau$	$\pi X(0)\,\delta(\omega) + \frac{1}{j\omega} X(\omega)$
Convolution	$x_1(t) * x_2(t)$	$X_1(\omega)X_2(\omega)$
Multiplication	$x_1(t)x_2(t)$	$\frac{1}{2\pi} X_1(\omega) * X_2(\omega)$
Real signal	$x(t) = x_e(t) + x_o(t)$	$X(\omega) = A(\omega) + jB(\omega)$
		$X(-\omega) = X^*(\omega)$
Even component	$x_e(t)$	$\text{Re}\{X(\omega)\} = A(\omega)$
Odd component	$x_o(t)$	$j\,\text{Im}\{X(\omega)\} = jB(\omega)$
Parseval's relations		

$$\int_{-\infty}^{\infty} x_1(\lambda)X_2(\lambda)\, d\lambda = \int_{-\infty}^{\infty} X_1(\lambda)x_2(\lambda)\, d\lambda$$

$$\int_{-\infty}^{\infty} x_1(t)x_2(t)\, dt = \frac{1}{2\pi}\int_{-\infty}^{\infty} X_1(\omega)X_2(-\omega)\, d\omega$$

$$\int_{-\infty}^{\infty} |x(t)|^2\, dt = \frac{1}{2\pi}\int_{-\infty}^{\infty} |X(\omega)|^2\, d\omega$$

Appendix 5

TABLE 3.1(a): COMMON LAPLACE TRANSFORM PAIRS

	f(t) = L⁻¹{F(s)}	F(s) = L{f(t)}		f(t) = L⁻¹{F(s)}	F(s) = L{f(t)}
1	$\delta(t)$	1	2	$-u(-t)$	$\frac{1}{s}$
			4	$u(t)$	$\frac{1}{s}$
3	$t^k u(t)$	$\frac{k!}{s^{k+1}}$	6	$tu(t)$	$\frac{1}{s^2}$
5	$-e^{-at}u(-t)$	$\frac{1}{s+a}$	8	$e^{at}u(t)$	$\frac{1}{s-a}$
7	$-te^{-at}u(-t)$	$\frac{1}{(s+a)^2}$	10	$te^{-at}u(t)$	$\frac{1}{(s+a)^2}$
9	$u(t)\sin(at)$	$\frac{a}{s^2+a^2}$	12	$u(t)\cos(at)$	$\frac{s}{s^2+a^2}$
11	$e^{at}u(t)\sin(bt)$	$\frac{b}{(s-a)^2+b^2}$	14	$e^{at}u(t)\cos(bt)$	$\frac{s-a}{(s-a)^2+b^2}$
13	$f'(t)$	$sF(s)-f(0)$		$f''(t)$	$s^2F(s)-sf(0)-f'(0)$
15	$\int_0^t f(v)dv$	$\frac{F(s)}{s}$	16	$\int_{-\infty}^t f(v)dv$	$\frac{F(s)}{s}+\frac{1}{s}\int_{-\infty}^{0-} f(v)d$

TABLE 3.1(b): LAPLACE TRANSFORM PROPERTIES

		Laplace Tansform X(s)={f(t)}	
1	Linearity	$ax_1(t)+bx_2(t)$	$aX_1(z)+bX_2(z)$
2	Time shifting	$x(t-t_0)$	$e^{-st_0}X(s)$
3	Shifting in s	$e^{-st_0}x(t)$	$X(s-s_0)$
4	Time scaling	$x(at)$	$\frac{1}{\lvert a\rvert}X(s)$
5	Time reversal	$x(-t)$	$X(-s)$
6	Differentiation in t	$\frac{dx(t)}{dt}$	$sX(s)$
8	Convolution	$x_1(t)*x_2(t)$	$X[s]X_2[s]$
9	Integration	$\int_{-\infty}^t x(\tau)d\tau$	$\frac{1}{s}X(s)$