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 I : 2024/2025

DEE40113 : SIGNAL AND SYSTEM

TARIKH : 03 DISEMBER 2024
MASA : 8.30 AM – 10.30 AM (2 JAM)

Kertas soalan ini mengandungi **TUJUH (7)** halaman bercetak.
Bahagian A: Subjektif (3 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Formula

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)** subjective questions. Answer **ALL** questions.

ARAHAN :

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

QUESTION 1

SOALAN 1

CLO1 (a) A signal can be classified according to its behaviour. Explain the classification of the signal, y[n] as shown in Figure A1(a) in terms of continuous or discrete time, even or odd, periodic or nonperiodic and deterministic or non-deterministic.

Suatu isyarat boleh diklasifikasikan mengikut sifat isyarat tersebut. Terangkan klasifikasi isyarat, y[n] yang ditunjukkan dalam Rajah A1(a) sebagai masa selanjar atau diskrit, genap atau ganjil, berkala atau tidak berkala dan deterministik atau tidak deterministik.

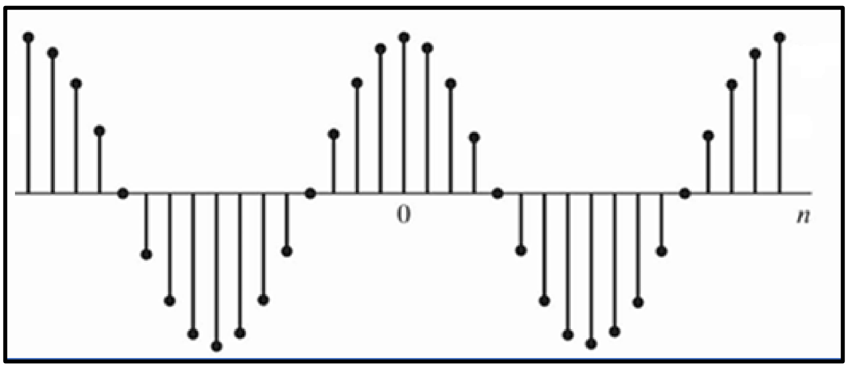

Figure A1(a) / *Rajah A1(a)*

[4 marks]

[*4 markah*]

CLO1 (b) Sketch the odd and even signals of Figure A1(b).

Lakarkan isyarat ganjil dan genap bagi Rajah A1(b).

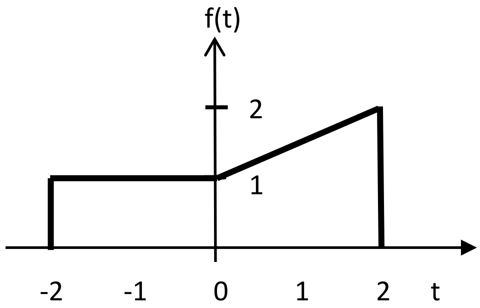

Figure A1(b) / *Rajah A1(b)*

[8 marks]

[*8 markah*]

CLO1 (c) A discrete-time signal x[n] is shown in Figure A1(c). Sketch the graph of $y[n] = x[2n] + 0.5\, x[n-1]$.

Suatu isyarat masa diskrit x[n] ditunjukkan dalam Rajah A1(c). Lakarkan graf $y[n] = x[2n] + 0.5\, x[n-1]$.

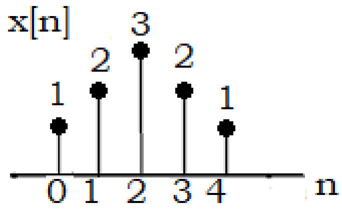

Figure A1(c) / *Rajah A1(c)*

[8 marks]

[*8 markah*]

QUESTION 2
SOALAN 2

CLO1 (a) By referring to Figure A2(a), express the input-output relationship for the block diagram of continuous-time LTI system.
Dengan merujuk kepada Rajah A2(a), dapatkan hubungan masukan-keluaran bagi gambarajah blok sistem LTI masa selanjar.

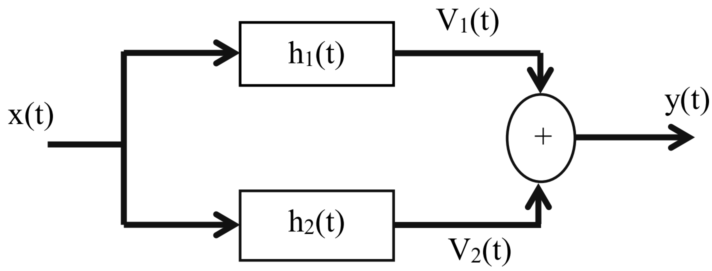

Figure A2(a) / *Rajah A2(a)*

[4 marks]
[*4 markah*]

CLO1 (b) Sketch the output y[n] = x[n] * h[n] by using graphical method where x[n] = [<u>2</u>, 0, -1] and h[n] = [<u>1</u>, 3, 2].
*Lakarkan keluaran y[n] = x[n] * h[n] dengan menggunakan kaedah grafik, dimana x[n] = [<u>2</u>, 0, -1] dan h[n] = [<u>1</u>, 3, 2].*

[8 marks]
[*8 markah*]

CLO1 (c) Use the convolution integral equation to get the output y(t) of the continuous-time LTI system, if the input signal x(t) and impulse response h(t) of the LTI system are shown in Figure A2(c).
Gunakan persamaan kamiran konvolusi untuk mendapatkan keluaran y(t) sebuah sistem LTI masa selanjar, sekiranya isyarat masukan x(t) dan sambutan dedenyut h(t) sistem LTI tersebut adalah seperti yang ditunjukkan pada Rajah A2(c).

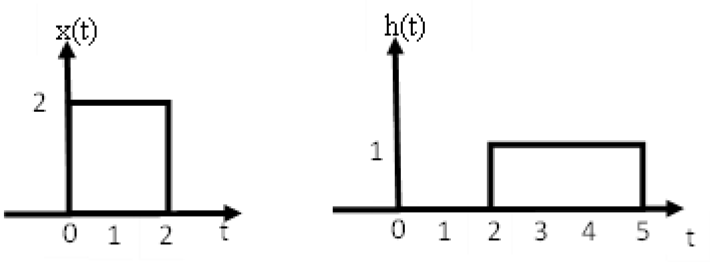

Figure A2(c) / *Rajah A2(c)*

[8 marks]
[*8 markah*]

QUESTION 3
SOALAN 3

CLO1 (a) The causality and the stability of a continuous-time LTI system can be visualized through the zero-pole diagram. Express a stable and non-causal system with the aid of a zero-pole diagram.
Kausaliti dan kestabilan sebuah sistem LTI masa selanjar boleh digambarkan melalui rajah kutub-sifar. Ungkapkan sebuah sistem yang stabil dan tak kausal dengan bantuan gambarajah kutub-sifar.

[4 marks]
[*4 markah*]

CLO1 (b) Solve the inverse Laplace transform to obtain y(t), right-sided function with partial fraction expansion method.
Selesaikan Jelmaan Laplace Songsang untuk mendapatkan y(t), fungsi sebelah kanan dengan kaedah pengembangan pecahan separa.

$$Y(s) = \frac{6}{(s^3 + 3s^2 + 2s)}$$

[8 marks]
[*8 markah*]

CLO1 (c) Use the formula of Convolution Sum to get the output of the LTI discrete-time system, if the impulse response, h[n] and input signal, x[n] are shown in Figure A3(c).

Gunakan persamaan penambahan konvolusi untuk mendapatkan keluaran sistem LTI masa diskrit, sekiranya sambutan dedenyut, h(n) dan isyarat masukan, x(n) adalah seperti yang ditunjukkan pada Rajah A3(c).

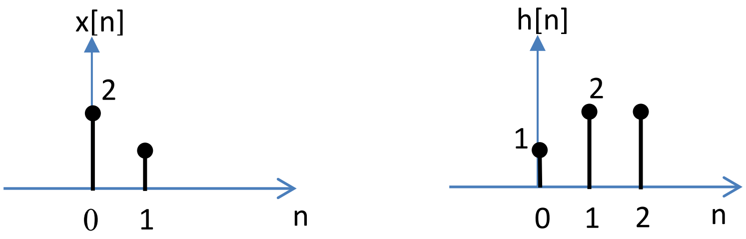

Figure A3(c) / *Rajah A3(c)*

[8 marks]

[*8 markah*]

SECTION B : 40 MARKS

BAHAGIAN B :40 MARKAH

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 The following equation describes a causal system with zero initial conditions:

$$y''(t) + 5y'(t) + 6y(t) = 5x(t)$$

Figure out the transfer function, h(t) and stability of the system with ROC by applying the Laplace transform and Partial Fraction Expansion method.

Persamaan berikut mengambarkan sebuah sistem kausal yang mempunyai nilai keadaan awal 0:

$$y''(t) + 5y'(t) + 6y(t) = 5x(t)$$

Tentukan fungsi pindah, h(t) dan kestabilan sistem ini dengan ROC melalui Jelmaan Laplace dan kaedah Pengembangan Pecahan Separa.

[20 marks]

[*20 markah*]

QUESTION 2

SOALAN 2

CLO1 According to Fourier Theory, a signal can be broken down into basic sinusoidal signals that are harmonic to each other. The weighted sum of these basic signals are called Fourier series. Evaluate the periodic signal in Figure B2 into a Trigonometric Fourier Series as follows:

Berdasarkan Teori Fourier, suatu isyarat boleh dipecahkan kepada beberapa isyarat asas sinusoidal yang harmonik antara satu sama lain. Hasil tambah isyarat-isyarat asas ini dikenali sebagai Siri Fourier. Nilaikan isyarat berkala pada Rajah B2 kepada Siri Fourier Trigonometri seperti berikut:

$$y(t) = a_0 + \sum_{k=1}^{4} a_k \cos(k\omega t) + b_k \sin(k\omega t)$$

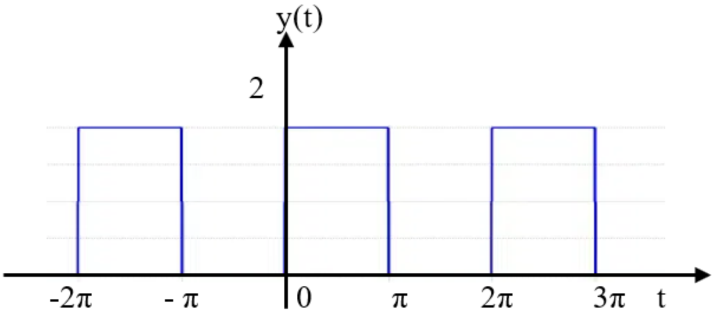

Figure B2 / *Rajah B2*

[20 marks]

[*20 markah*]

SOALAN TAMAT

Appendix 1

Laplace Transform Pairs

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

Appendix 2

Z-Transform Pairs

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

Fourier Transform Pair

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

Appendix 4

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	$x_e(t)$	$\mathrm{Re}\{X(\omega)\} = A(\omega)$
Odd component	$x_o(t)$	$j\,\mathrm{Im}\{X(\omega)\} = jB(\omega)$
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	$\mathrm{u(t)}\cos(at)$	$\frac{s}{s^2+a^2}$
11	$e^{at}\mathrm{u(t)}\sin(bt)$	$\frac{b}{(s-a)^2+b^2}$	14	$e^{at}\mathrm{u(t)}\cos(bt)$	$\frac{s-a}{(s-a)^2+b^2}$
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	$\mathrm{ax_1}(t)+bx_2(t)$	$aX_1(z)+bX_2(z)$
2	Time shifting	$\mathrm{x(t-t_0)}$	$e^{-st_0}X(s)$
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	$\int_{-\infty}^t x(\tau)d\tau$	$\frac{1}{s}X(s)$