**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 : 2025/2026**

**DEE40113 : SIGNAL AND SYSTEM**

**TARIKH : 05 DISEMBER 2025**
**MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)**

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

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**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) The signal y[t] in Figure A1(a) can be described based on its characteristics. Explain its classification by determining whether it is a continuous-time or discrete-time signal, an even or odd signal, a periodic or non-periodic signal, and whether it is deterministic or non-deterministic.
*Isyarat y[t] dalam Rajah A1(a) boleh dihuraikan berdasarkan ciri-cirinya. Terangkan klasifikasi isyarat tersebut dengan menentukan sama ada ia merupakan isyarat masa selanjar atau diskrit, genap atau ganjil, berkala atau tidak berkala dan deterministik atau tidak deterministik.*

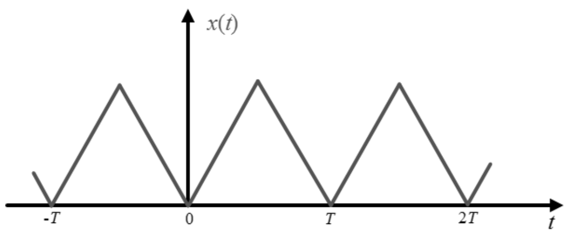


Figure A1(a) / *Rajah A1(a)*

[4 marks]
[*4 markah*]

CLO1 (b) Signal f(t) is defined as

$$f(t) = x(t)[u(t+1) - u(t-1.5)].$$

Using the input signal x(t) shown in Figure A1(b), sketch the output signal f(t).

*Isyarat f(t) ditakrifkan sebagai*

$$f(t) = x(t)[u(t+1) - u(t-1.5)].$$

*Berdasarkan isyarat masukan x(t) yang ditunjukkan dalam Rajah A1(b), lakarkan isyatrat keluaran f(t).*

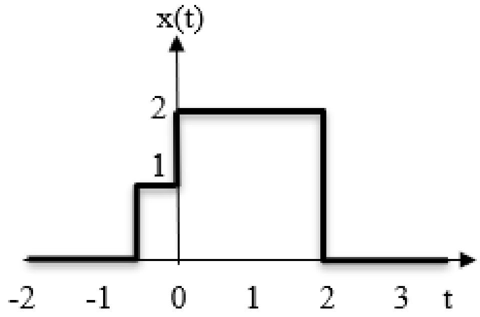


Figure A1(b) / *Rajah A1(b)*

[8 marks]

[*8 markah*]

CLO1 (c) Show the classification of the system y(t) = x(3 + t) as either causal or non-causal and either time-variant or time-invariant.

*Tunjukkan klasifikasi sistem y(t) = x(3 + t) sama ada kausal atau bukan kausal dan sama ada masa-invarian atau masa-varian.*

[8 marks]

[*8 markah*]

**QUESTION 2**

***SOALAN 2***

CLO1 (a) Explain the steps involved in performing the convolution sum operation in a Linear Time-Invariant (LTI) discrete-time system.

*Terangkan langkah-langkah yang terlibat dalam operasi jumlah konvolusi bagi sistem LTI masa diskrit.*

[4 marks]

[*4 markah*]

CLO1 (b) A discrete-time Linear Time-Invariant (LTI) system has an impulse response $h[n] = 2\delta[n] + 3\delta[n-1] + \delta[n-2]$ and the input signal to the system is $x[n] = \delta[n] + 3\delta[n-1] - 2\delta[n-2]$. Sketch the output signal y[n] = x[n] * h[n] by using the graphical method of convolution.

*Satu sistem LTI masa diskrit mempunyai sambutan dedenyut* $h[n] = 2\delta[n] + 3\delta[n-1] + \delta[n-2]$ *dan isyarat masukan kepada sistem tersebut adalah* $x[n] = \delta[n] + 3\delta[n-1] - 2\delta[n-2]$. *Lakarkan keluaran y[n] = x[n] * h[n] dengan menggunakan kaedah grafik konvolusi.*

[8 marks]

[*8 markah*]

CLO1 (c) Use the convolution integral equation to obtain the output y(t) of the continuous-time LTI system, given the input signal x(t) and impulse response h(t) as shown in Figure A2(c).

*Gunakan persamaan kamiran konvolusi untuk mendapatkan keluaran y(t) bagi sebuah sistem LTI masa selanjar, diberi isyarat masukan x(t) dan sambutan dedenyut h(t) adalah seperti yang ditunjukkan dalam Rajah A2(c).*

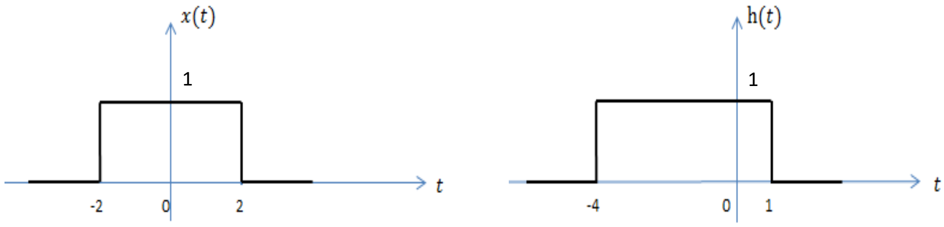


Figure A2(c) / *Rajah A2(c)*

[8 marks]

[*8 markah*]

**QUESTION 3**

***SOALAN 3***

CLO1 (a) The causality and stability of a continuous-time LTI system can be illustrated using a zero-pole diagram. Represent a system that is causal but unstable with the aid of a zero-pole diagram.

*Kausaliti dan kestabilan sebuah sistem LTI masa selanjar boleh digambarkan melalui rajah kutub-sifar. Gambarkan sebuah sistem yang kausal tetapi tidak stabil dengan bantuan rajah kutub-sifar.*

[4 marks]

[*4 markah*]

CLO1 (b) Solve the inverse transform of Y(z) using the partial fraction expansion method.

*Selesaikan Jelmaan Songsang bagi Y(z) menggunakan kaedah pengembangan pecahan separa.*

$$Y(z) = \frac{z}{(z^2 - 1.5z + 0.5)}$$

[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 dalam Rajah A3(c).*

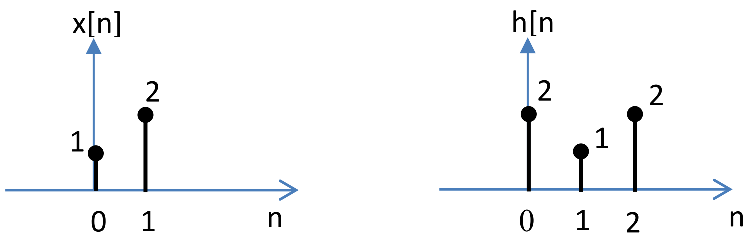


Figure A3(c) / *Rajah A3(c)*

[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:

$$y''(t) + 3y'(t) + 2y(t) = 3x(t)$$

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 menggambarkan sebuah sistem kausal yang mempunyai nilai keadaan awal 0:*

$$y''(t) + 3y'(t) + 2y(t) = 3x(t)$$

*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 Fourier Theory states that any periodic signal can be represented as a combination of simple sinusoidal components that are harmonically related. This combination is expressed through the Fourier series. Evaluate the periodic signal shown in Figure B2 by expanding it into its Trigonometric Fourier Series form as follows:

*Teori Fourier menyatakan bahawa setiap isyarat berkala boleh diwakili sebagai gabungan komponen sinusoidal asas yang saling harmonik. Gabungan ini dinyatakan melalui Siri Fourier. Nilaikan isyarat berkala yang ditunjukkan dalam Rajah B2 dengan mengembangkan kepada bentuk Siri Fourier Trigonometri seperti berikut:*

$$y(t) = a_0 + \sum_{k=1}^{3} a_k \cos(k\omega t) + b_k \sin(k\omega t)$$

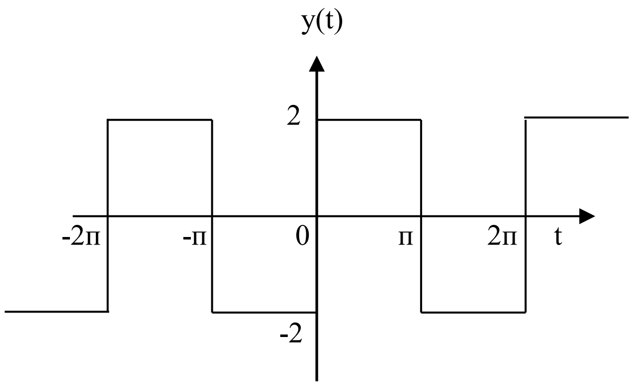


Figure B2 / *Rajah B2*

[20 marks]

[*20 markah*]

**SOALAN TAMAT**

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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 | $\int_{-\infty}^t x(\tau)d\tau$ | $\frac{1}{s}X(s)$ |

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TABLE 3.2(a): COMMON Z- TRANSFORM PAIRS

| | x[n] =Z⁻¹{X(z)} | X(z) = Z{x[n]} | | x[n] =Z⁻¹{X(z)} | X(z) = Z{x[n]} |
|---|---|---|---|---|---|
| 1 | $\delta[n]$ | 1 | 2 | $\delta[n-m]$ | $z^{-m}$ |
| 3 | $u[n]$ | $\frac{z}{z-1}=\frac{1}{1-z^{-1}}$ | 4 | $-u[-n-1]$ | $\frac{z}{z-1}$ |
| 5 | $a^n u[n]$ | $\frac{1}{1-az^{-1}}=\frac{z}{z-a}$ | 6 | $-a^n u[-n-1]$ | $\frac{1}{1-az^{-1}}=\frac{z}{z-a}$ |
| 7 | $\text{n}a^n u[n]$ | $\frac{az^{-1}}{(1-az^{-1})^2}=\frac{az}{(z-a)^2}$ | 8 | $\text{-n}a^n u[n]$ | $\frac{az^{-1}}{(1-az^{-1})^2}=\frac{az}{(z-a)^2}$ |
| 9 | $(n+1)a^n u[n$ | $\frac{1}{(1-az^{-1})^2}$ | 10 | $\text{-n}a^n u[-n-1]$ | $\frac{az^{-1}}{(1-az^{-1})^2}=\frac{az}{(z-a)^2}$ |
| 11 | $[\cos\omega_0 \text{n}]\text{u}(n)$ | $\frac{1-[\cos\omega_0]z^{-1}}{1-[2\cos\omega_0]z^{-1}+z^{-2}}$ | 12 | $[\sin\omega_0 \text{n}]\text{u}(n)$ | $\frac{1-[\sin\omega_0]z^{-1}}{1-[2\cos\omega_0]z^{-1}+z^{-2}}$ |
| 13 | $[r^n\cos\omega_0 \text{n}]\text{u}(n)$ | $\frac{1-[r\cos\omega_0]z^{-1}}{1-[2r\cos\omega_0]z^{-1}+r^2z^{-2}}$ | 14 | $[r^n\sin\omega_0 \text{n}]\text{u}(n)$ | $\frac{[r\sin\omega_0]z^{-1}}{1-[2r\cos\omega_0]z^{-1}+r^2z^{-2}}$ |
| 15 | $\begin{cases} a^n, 0\le n\le N- \\ 0, \; Otherwise\end{cases}$ | $\frac{1-a^Nz^{-N}}{1-az^{-1}}$ | | | |

TABLE 3.2(b): Z- TRANSFORM PROPERTIES

| | | Z Transform X(z) = Z{x[n]} | |
|---|---|---|---|
| 1 | Linearity | $\text{a}x_1[n]+bx_2[n]$ | $aX_1(z)+bX_2(z)$ |
| 2 | Time shifting | $\text{x}[\text{n}-n_0]$ | $z^{-n_0}X(z)$ |
| 3 | Time reversal | x[-n] | $X\left(\frac{1}{z}\right)$ |
| 4 | Multiplication by n | nx[n] | $-z\frac{dX(z)}{dz}$ |
| 5 | Accumulation | $\sum_{k=-\infty}^{n} x[n]$ | $\frac{1}{1-z^{-1}}$ |
| 6 | Convolution | $x_1[n]*x_2[n]$ | $X[z]*X_2[z]$ |
| 7 | Multiplication by $z_0^n$ | $z_0^n x[n]$ | $X\left(\frac{z}{z_0}\right)$ |
| 8 | Multiplication by $e^{j\Omega n}$ | $e^{j\Omega n}X[n]$ | $X[e^{j\Omega n}z]$ |

| TABLE 4.1(a)FOURIER TRANSFORM PROPERTIES | | | |
|---|---|---|---|
| | | Fourier Transform X($\omega$)={(f(t)} | |
| 1 | Linearity | $ax_1(t) + bx_2(t)$ | $aX_1(\omega) + bX_2(\omega)$ |
| 2 | Time shifting | $x(t - t_0)$ | $e^{-j\omega t_0}X(\omega)$ |
| 3 | Frequency Shifting | $e^{-j\omega t_0}x(t)$ | $X(\omega - \omega_0)$ |
| 4 | Time scaling | x(at) | $\frac{1}{\lvert a\rvert}X(\frac{\omega}{a})$ |
| 5 | Time reversal | $x(-t)$ | $X(-\omega)$ |
| 6 | Differentiation in t | $\frac{d^n x(t)}{dt^n}$ | $(j\omega)^n X(\omega)$ |
| 7 | Differentiation in f | $t^n x(t)$ | $(j)^n \frac{d^n}{d\omega^n}X(\omega)$ |
| 8 | Multiplication by | $x_1(t)x_2(t)$ | $\frac{1}{2\pi}X_1(\omega) * X_2(\omega)$ |
| 9 | Convolution | $x_1(t) * x_2(t)$ | $X_1[\omega]X_2[\omega]$ |
| 10 | Integration | $\int_{-\infty}^{t} x(\tau)d\tau$ | $X(0)\delta(\omega) + \frac{1}{2\omega}X(\omega)$ |

| TABLE 4.1(b): COMMON FOURIER TRANSFORM PAIRS | | |
|---|---|---|
| | Fourier Transform f(t) $\leftrightarrow$X($\omega$) | |
| 1 | $\delta(t)$ | 1 |
| 2 | $\delta(t - c)$ | $e^{-j\omega c}$ , $c$ $any$ $real$ $number$ |
| 3 | 1 | $2\pi\delta(\omega)$ |
| 4 | $-0.5 + u(t)$ | $\frac{1}{j\omega}$ |
| 5 | $u(t)$ | $\pi\delta(\omega) + \frac{1}{j\omega}$ |
| 6 | $e^{-j\omega_0 t}$ | $2\pi\delta(\omega - \omega_0), \omega_0$ $any$ $real$ $number$ |
| 7 | $e^{-bt}u(t)$ | $\frac{1}{j\omega + b}$ , $b > 0$ |
| 8 | $cos\omega_0 t$ | $\pi[\delta(\omega + \omega_0) + \delta(\omega - \omega_0)]$ |
| 9 | $cos(\omega_0 t + \theta)$ | $\pi[e^{-j\theta}\delta(\omega + \omega_0) + e^{j\theta}\delta(\omega - \omega_0)]$ |
| 10 | $sin\omega_0 t$ | $j\pi[\delta(\omega + \omega_0) - \delta(\omega - \omega_0)]$ |
| 11 | $sin(\omega_0 t + \theta)$ | $j\pi[e^{-j\theta}\delta(\omega + \omega_0) - e^{j\theta}\delta(\omega - \omega_0)]$ |
| 12 | $Rect(\frac{\tau}{t})$ | $\tau sinc\frac{\tau\omega}{2}$ |
| 13 | $\frac{A}{\pi}\sin(At)$ | $Rect(\frac{\omega}{2A})$ |