SULIT

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

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI 1 2018/2019

BEU5163 : SIGNAL AND SYSTEM

TARIKH : 03 JANUARI 2019
MASA : 9.00 PAGI – 12.00 TENGAH HARI (3 JAM)

Kertas ini mengandungi **EMPAT BELAS (14)** halaman bercetak.

Esei (4 soalan)

Dokumen sokongan yang disertakan : i. Transform Pairs
ii. Laplace Transform Pairs
iii. Fourier Transform Pairs

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

INSTRUCTION:

This section consists of **FOUR (4)** essay questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan esei. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1
C2

a) A discrete-time signal $x[n]$ is shown in **Figure 1**.

Sebuah isyarat masa berterusan $x[n]$ *ditunjukkan dalam **Rajah 1**.*

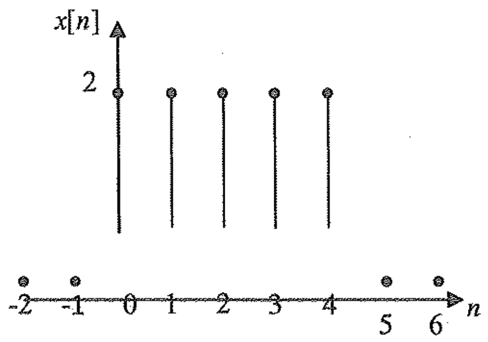

Figure 1 / *Rajah 1*

Sketch and label the following signals.

Lakar dan label isyarat berikut.

i) $x[n+1]$

ii) $x[2n]$

iii) $x[-n]$

iv) $x[-2-n]$

[4 marks]

[*4 markah*]

CLO1 C2

b) i) A continuous time-domain signal $x(t)$ is shown in **Figure 1**.

*Sebuah isyarat masa berterusan $x(t)$ ditunjukkan dalam **Rajah 1**.*

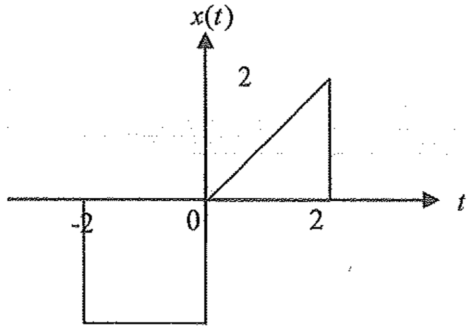

Figure 1 / *Rajah 1*

Sketch and label for the following signals.

Lakar dan label isyarat berikut.

A) $x(-0.2t)$

B) $x(-t+3)$

[4 marks]

[4 markah]

CLO1
C3

ii) Consider signal $x(t)$ shown in **Figure 2**.

Pertimbangkan isyarat yang ditunjukkan dalam ***Rajah 2****.*

A) Express $x(t)$ as a linear combination equation.

Ungkapkan $x(t)$ *sebagai kombinasi persamaan linear.*

B) Express $x(t)$ by intervals.

Ungkapkan $x(t)$ *dengan intervals.*

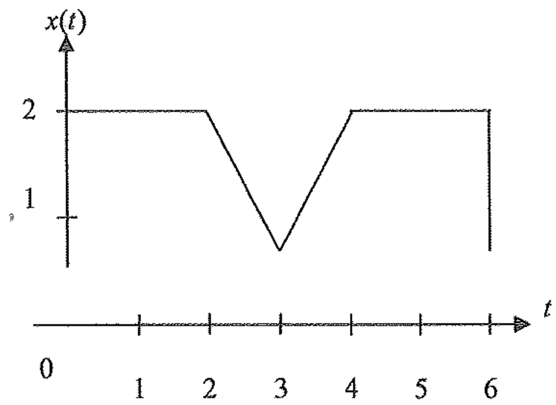

Figure 2 / ***Rajah 2***

[6 marks]

[*6 markah*]

CLO1 C3

b) Consider signal $x(t)$ and $h(t)$ shown in **Figure 2** and **Figure 3** respectively.

*Pertimbangkan isyarat $x(t)$ dan $h(t)$ ditunjukkan dalam **Rajah 2** dan **Rajah 3**.*

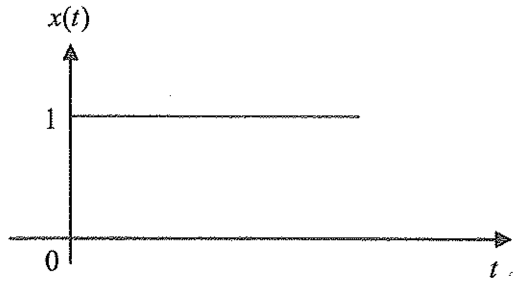

Figure 2 / *Rajah 2*

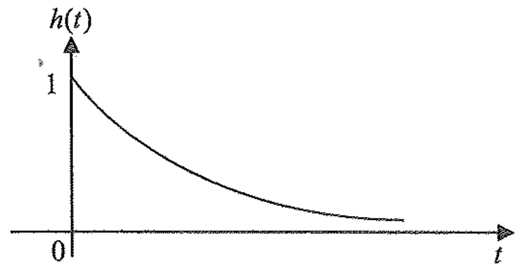

Figure 3 / *Rajah 3*

Where :

$x(t) = u(t)$ and $h(t) = e^{-\alpha t}u(t)$ $\alpha > 0$

If an output $y(t)$ is the response of the continuous time LTI system, determine its expression using convolution integral.

Dimana :

$x(t) = u(t)$ dan $h(t) = e^{-\alpha t}u(t)$ $\alpha > 0$

Jika keluaran $y(t)$ adalah tindak balas sistem LTI masa yang berterusan, tentukan ungkapan dengan menggunakan konvolusi kamiran.

[11 marks]

[*11 markah*]

QUESTION 2

SOALAN 2

CLO2 C2

a) Consider the signal

$$x[n]=\left(\frac{1}{2}\right)^n u[n]+\left(\frac{1}{3}\right)^n u[-n-1]$$

Using z-transform, determine the expression for $X(z)$.

Pertimbangkan isyarat

$$x[n]=\left(\frac{1}{2}\right)^n u[n]+\left(\frac{1}{3}\right)^n u[-n-1]$$

Gunakan z-transfrom, dapatkan perwakilan $X(z)$.

[7 marks]

[7 *markah*]

CLO2 C3

b) Find the inverse z-transform of the following expression:

$$X(z)=\frac{z}{z(z-1)(z-2)^2} \qquad |z|>2$$

Cari ungkapan songsang z-transfrom berikut:

$$X(z)=\frac{z}{z(z-1)(z-2)^2} \qquad |z|>2$$

[8 marks]

[8 *markah*]

CLO1 C4

c) Solve the following differential equation.

$$\frac{d^2y}{dx} + 7\frac{dy}{dt} + 12y(t) = 6x(t)$$

Where:

$$x(t) = u(t), \qquad y(0) = 0, \qquad \frac{dy}{dt}(0) = -2$$

Selesaikan persamaan pembezaan

$$\frac{d^2y}{dx} + 7\frac{dy}{dt} + 12y(t) = 6x(t)$$

Dimana:

$$x(t) = u(t), \qquad y(0) = 0, \qquad \frac{dy}{dt}(0) = -2$$

[11 marks]

[*11 markah*]

QUESTION 3

SOALAN 3

CLO1 C2

a) Describe the Laplace transform for the following signal $x(t)$. Then, sketch its pole-zero plot.

$$x(t) = e^{-2t}u(t) + e^{3t}u(-t)$$

Cari Laplace transform untuk isyarat $x(t)$. *Seterusnya, lakarkan graf* pole-zero.

$$x(t) = e^{-2t}u(t) + e^{3t}u(-t)$$

[7 marks]

[7 *markah*]

CLO1 C3

b) Obtain the inverse Laplace transform for the following expression:

$$X(s) = \frac{s^3 + 2s^2 + 6}{s^2 + 3s} \qquad \text{Re}(s) > 0$$

Dapatkan songsangan Laplace untuk ungkapan berikut:

$$X(s) = \frac{s^3 + 2s^2 + 6}{s^2 + 3s} \qquad \text{Re}(s) > 0$$

[8 marks]

[8 *markah*]

CLO1 C4

c) A continuous time-domain system whose input $x(t)$ and output $y(t)$ are represented as follows :

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

Given the auxiliary condition:

$$y(0) = 2,\ y'(0) = 1 \text{ and } x(t) = e^{-t}u(t), \text{ by.}$$

Determine the output expression $y(t)$, using unilateral Laplace Transform.

Assume that, $y(0) = y(0^-)$ and $y'(0) = y'(0^-)$.

Pertimbangkan sistem masa berterusan di mana input $x(t)$ *dan output* $y(t)$ *diwakili oleh*

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

Diberi syarat tambahan:

$$y(0) = 2\ y'(0) = 1\, dan\ x(t) = e^{-t}u(t),$$

Tentukan ungkapan keluaran $y(t)$, *menggunakan unilateral Laplace transfrom.*

Dengan angapan , $y(0) = y(0^-)$ *dan* $y'(0) = y'(0^-)$.

[10 marks]

[*10 markah*]

QUESTION 4
SOALAN 4

CLO2
C2

a) i) Express the signal $x(t)$ as in **Figure 4** using Fourier Transform.
*Ungkapkan isyarat yang ditunjukkan dalam **Rajah** 4 kepada jelmaan Fourier.*

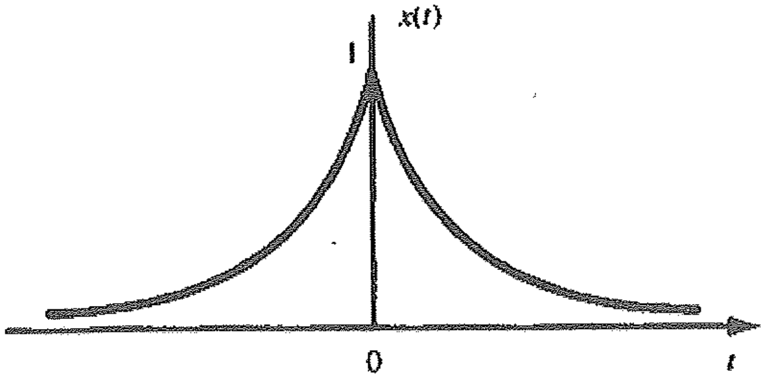

Figure 4 / *Rajah 4*

[3 marks]
[*3 markah*]

ii) Obtain Fourier Transform for the signal shown in **Figure 5**.
*Rumuskan jelmaan Fourier bagi isyarat dalam **Rajah** 5.*

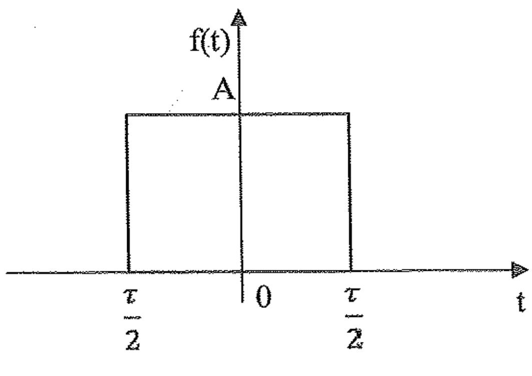

Figure 5 / *Rajah 5*

[3 marks]
[*3 markah*]

CLO2
C3

b) Demonitrate that

$$x_1(t)\cos\omega_0 t \leftrightarrow \frac{1}{2}X(\omega-\omega_0)+\frac{1}{2}X(\omega+\omega_0)$$

and

$$x_1(t)\sin\omega_0 t \leftrightarrow j\left[\frac{1}{2}X(\omega-\omega_0)-\frac{1}{2}X(\omega+\omega_0)\right]$$

Tunjukkan

$$x_1(t)\cos\omega_0 t \leftrightarrow \frac{1}{2}X(\omega-\omega_0)+\frac{1}{2}X(\omega+\omega_0)$$

dan

$$x_1(t)\sin\omega_0 t \leftrightarrow j\left[\frac{1}{2}X(\omega-\omega_0)-\frac{1}{2}X(\omega+\omega_0)\right]$$

[9 marks]

[9 *markah*]

CLO2
C4

c) For the linear circuit as in **Figure 6**, the input-output relationship is given by:

$$\frac{d}{dt}v_{out}(t) + 4v_{out}(t) = 10v_{in}(t)$$

where $v_{in}(t)$ is the input voltage. Determine:

i) the expression of $v_{out}(t)$ using the Fourier transform method,

ii) the transfer function $H(\omega)$ of the system.

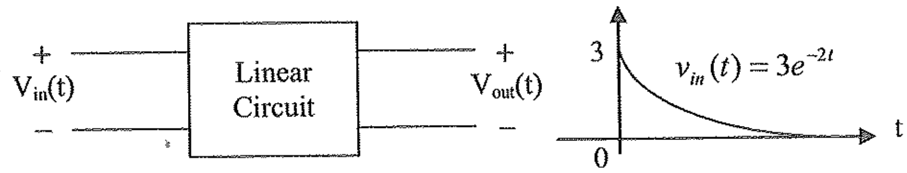

Figure 6 / *Rajah 6*

*Bagi litar linear **Rajah 6**, hubungan masukan dan keluaran diberikan oleh:*

$$\frac{d}{dt}v_{out}(t) + 4v_{out}(t) = 10v_{in}(t)$$

di mana $v_{in}(t)$ ialah voltan input. Dapatkan:

i) pernyataan menggunakan Fourier transfrom,

ii) rangkap pindah sistem.

[10 marks]

[10*markah*]

SOALAN TAMAT

z-TRANSFORM PAIRS

The index-domain signal is $x[n]$ for $-\infty < n < \infty$; and the z-transform is:

$$X(z) = \sum_{n=-\infty}^{\infty} x[n]\, z^{-n} \qquad \Longleftrightarrow \qquad x[n] = \frac{1}{2\pi j} \oint X(z)\, z^{n} \frac{dz}{z}$$

The ROC is the set of complex numbers z where the z-transform sum converges.

Signal: $x[n] \quad -\infty < n < \infty$	z-Transform: $X(z)$	Region of Convergence
$\delta[n]$	1	All z
$\delta[n - n_o]$	z^{-n_o}	$\lvert z\rvert > 0$, if $n_o > 0$ $\lvert z\rvert < \infty$, if $n_o < 0$
$u[n]$	$\dfrac{1}{1 - z^{-1}}$	$\lvert z\rvert > 1$
$-u[-n-1]$	$\dfrac{1}{1 - z^{-1}}$	$\lvert z\rvert < 1$
$a^n u[n]$	$\dfrac{1}{1 - az^{-1}}$	$\lvert z\rvert > \lvert a\rvert$
$-a^n u[-n-1]$	$\dfrac{1}{1 - az^{-1}}$	$\lvert z\rvert < \lvert a\rvert$
$n a^n u[n]$	$\dfrac{az^{-1}}{(1 - az^{-1})^2}$	$\lvert z\rvert > \lvert a\rvert$
$-n a^n u[-n-1]$	$\dfrac{az^{-1}}{(1 - az^{-1})^2}$	$\lvert z\rvert < \lvert a\rvert$
$(n+1) a^n u[n]$	$\dfrac{1}{(1 - az^{-1})^2}$	$\lvert z\rvert > \lvert a\rvert$
$[\cos \omega_o n]\, u[n]$	$\dfrac{1 - [\cos \omega_o] z^{-1}}{1 - 2[\cos \omega_o] z^{-1} + z^{-2}}$	$\lvert z\rvert > 1$
$[\sin \omega_o n]\, u[n]$	$\dfrac{[\sin \omega_o] z^{-1}}{1 - 2[\cos \omega_o] z^{-1} + z^{-2}}$	$\lvert z\rvert > 1$
$[r^n \cos \omega_o n]\, u[n]$	$\dfrac{1 - [r \cos \omega_o] z^{-1}}{1 - 2r[\cos \omega_o] z^{-1} + r^2 z^{-2}}$	$\lvert z\rvert > \lvert r\rvert$
$[r^n \sin \omega_o n]\, u[n]$	$\dfrac{[r \sin \omega_o] z^{-1}}{1 - 2r[\cos \omega_o] z^{-1} + r^2 z^{-2}}$	$\lvert z\rvert > \lvert r\rvert$
$x[n] = \begin{cases} a^n, & 0 \le n < L \\ 0, & \text{otherwise} \end{cases}$	$\dfrac{1 - a^L z^{-L}}{1 - az^{-1}}$	$\lvert z\rvert > 0$

LAPLACE TRANSFORM PAIRS

$$F(s) = \int_0^\infty e^{-st} f(t)dt$$

Sl. No.	Time Domain f(t)	S Domain F(s)
1	Unit impulse $\delta(t)$	1
2	Unit step	$\frac{1}{s}$
3	t	$\frac{1}{s^2}$
4	t^n	$\frac{n!}{s^{n+1}}$
5	$f'(t)$	$sF(s) - f(0)$
6	$f''(t)$	$s^2F(s) - sf(0) - f'(0)$
7	e^{at}	$\frac{1}{s-a}$; s > a
8	$t^n e^{at}$	$\frac{n!}{(s-a)^{n+1}}$
9	$\sin at$	$\frac{a}{s^2+a^2}$; $s > 0$
10	$\cos at$	$\frac{s}{s^2+a^2}$; $s > 0$
11	$\sinh at$	$\frac{a}{s^2-a^2}$; $s > \lvert a \rvert$
12	$\cosh at$	$\frac{s}{s^2-a^2}$; $s > \lvert a \rvert$
13	$e^{at}\sin bt$	$\frac{b}{(s-a)^2+b^2}$
14	$e^{at}\cos bt$	$\frac{(s-a)}{(s-a)^2+b^2}$
15	$e^{at}\sinh bt$	$\frac{b}{(s-a)^2-b^2}$
16	$e^{at}\cosh bt$	$\frac{(s-a)}{(s-a)^2-b^2}$
17	n^{th} derivative	$s^nF(s) - s^{n-1}f(0) - s^{n-2}f'(0) \ldots - f^{n-1}(0)$
18	$\int_0^t f(\tau)\,d\tau$	$\frac{1}{s}F(s)$
19	$\int_0^t f(t-\tau)\,g(\tau)d\tau$	$F(s)G(s)$
20	$f(at)$	$\frac{1}{a}F\left(\frac{s}{a}\right)$
21	$e^{at}f(t)$	$F(s-a)$
22	$\delta(t-a)$	$\frac{1}{s}e^{-as}$
23	$\frac{t^{n-1}}{(n-1)!}$	$\frac{1}{s^n}$; $n = 1,2,3,\ldots$
24	$\frac{t^{n-1}}{(n-1)!}e^{at}$	$\frac{1}{(s+a)^n}$; $n = 1,2,3,\ldots$
25	$\frac{1}{a^2}[1 - \cos at]$	$\frac{1}{s(s^2+a^2)^2}$
26	$e^{-at}\sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$

FOURIER TRANSFORM PAIRS

	$g(t)$	$G(\omega)$	
1	$e^{-at}u(t)$	$\frac{1}{a+j\omega}$	$a>0$
2	$e^{at}u(-t)$	$\frac{1}{a-j\omega}$	$a>0$
3	$e^{-a\lvert t\rvert}$	$\frac{2a}{a^2+\omega^2}$	$a>0$
4	$te^{-at}u(t)$	$\frac{1}{(a+j\omega)^2}$	$a>0$
5	$t^n e^{-at}u(t)$	$\frac{n!}{(a+j\omega)^{n+1}}$	$a>0$
6	$\delta(t)$	1	
7	1	$2\pi\delta(\omega)$	
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	
9	$\cos\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$	
10	$\sin\omega_0 t$	$j\pi[\delta(\omega+\omega_0)-\delta(\omega-\omega_0)]$	
11	$u(t)$	$\pi\delta(\omega)+\frac{1}{j\omega}$	
12	$\text{sgn}\, t$	$\frac{2}{j\omega}$	
13	$\cos\omega_0 t\, u(t)$	$\frac{\pi}{2}[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]+\frac{j\omega}{\omega_0^2-\omega^2}$	
14	$\sin\omega_0 t\, u(t)$	$\frac{\pi}{2j}[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]+\frac{\omega_0}{\omega_0^2-\omega^2}$	
15	$e^{-at}\sin\omega_0 t\, u(t)$	$\frac{\omega_0}{(a+j\omega)^2+\omega_0^2}$	$a>0$
16	$e^{-at}\cos\omega_0 t\, u(t)$	$\frac{a+j\omega}{(a+j\omega)^2+\omega_0^2}$	$a>0$
17	$\text{rect}\left(\frac{t}{\tau}\right)$	$\tau\,\text{sinc}\left(\frac{\omega\tau}{2}\right)$	
18	$\frac{W}{\pi}\text{sinc}(Wt)$	$\text{rect}\left(\frac{\omega}{2W}\right)$	
19	$\Delta\left(\frac{t}{\tau}\right)$	$\frac{\tau}{2}\text{sinc}^2\left(\frac{\omega\tau}{4}\right)$	
20	$\frac{W}{2\pi}\text{sinc}^2\left(\frac{Wt}{2}\right)$	$\Delta\left(\frac{\omega}{2W}\right)$	
21	$\sum_{n=-\infty}^{\infty}\delta(t-nT)$	$\omega_0\sum_{n=-\infty}^{\infty}\delta(\omega-n\omega_0)$	$\omega_0=\frac{2\pi}{T}$
22	$e^{-t^2/2\sigma^2}$	$\sigma\sqrt{2\pi}e^{-\sigma^2\omega^2/2}$	