SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENGAJIAN POLITEKNIK
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI 1 2015/2016

BEU5163: SIGNAL AND SYSTEM

TARIKH : 29 DISEMBER 2015
MASA : 8.30 AM – 11.30 AM (3 JAM)

Kertas ini mengandungi **TIGA BELAS (13)** halaman bercetak.
Bahagian A: Struktur (10 soalan)
Bahagian B: Esei (3 soalan)
Dokumen sokongan yang disertakan : Kertas Graf, Formula dsb / Tiada

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A : 40 MARKS
BAHAGIAN A : 40 MARKAH

INSTRUCTION:
This section consists of **TEN (10)** structured questions. Answer **ALL** questions.

ARAHAN:
Bahagian ini mengandungi ***SEPULUH (10)*** *soalan berstruktur. Jawab* ***semua soalan****.*

CLO1
C1

QUESTION 1

Define signal and system with the aid of diagram.

Dengan bantuan gambarajah, tentukan isyarat dan sistem.

[4 marks]
[4*markah*]

CLO1
C4

QUESTION 2

A function generator signal had produced a sin wave signal as shown in Figure 1. Transform the signal $x(t) = sin\ \omega_0 t$ to the complex exponential Fourier series.

Sebuah penjana isyarat telah menghasilkan sebuah isyara gelombangt sin seperti dalam Rajah 1. Ubahsuaikan isyarat $x(t) = sin\ \omega_0 t$ *kepada siri komplek exponen Fourier.*

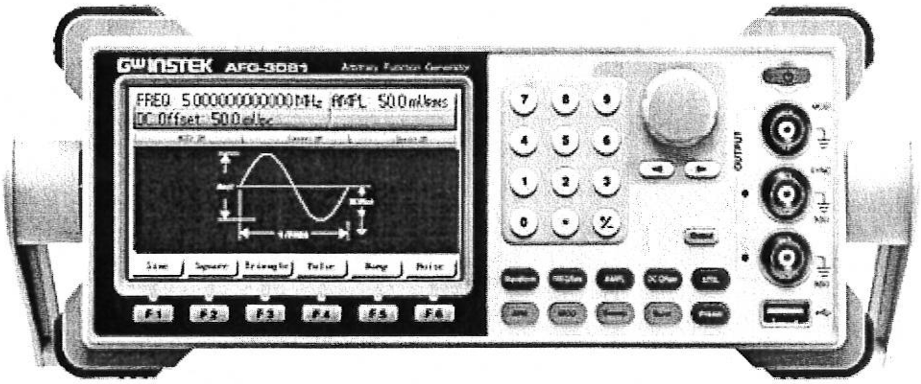

Figure 1
Rajah 1

[4 marks]
[4*markah*]

CLO1
C3

QUESTION 3

Solve the linear differential equations to find following signal $y(t)$.

$$\frac{dy}{dt} + 2y(t) = 2x(t);$$

Where

$$x(t) = u(t), y(0) = -1$$

Selesaikan persamaan pembezaan linear berikutan untuk mendapatkan isyarat $y(t)$.

$$\frac{dy}{dt} + 2y(t) = 2x(t);$$

Dimana

$$x(t) = u(t), y(0) = -1$$

[4 marks]
[4*markah*]

CLO1
C4

QUESTION 4

Transform the signal $x(t) = e^{-3t}u(t) + e^{2t}u(-t)$ to the Laplace transform X(S).

Ubahkan isyarat $x(t) = e^{-3t}u(t) + e^{2t}u(-t)$ *kepada Jelmaan Laplas X(S).*

[4 marks]
[4*markah*]

CLO2
C5

QUESTION 5

A general discrete-time signal x[n] and the z-transform *X(z)* are defined as

$$X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$$

Consider the sequence

$$x[n] = a^{-n}u[-n]$$

Construct the signal $x[n] = a^{-n}u[-n]$ to the z-transfrom.

Sebuah isyarat umum diskret x[n] dan tranformasi X(z) ditakrifkan sebagai

$$X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$$

Pertimbangkan urutan

$$x[n] = a^{-n}u[-n]$$

Bina isyarat $x[n] = a^{-n}u[-n]$ *kepada z-transfrom.*

[4 marks]
[4*markah]*

CLO2
C3

QUESTION 6

The input $x(t)$ and the impulse response $h(t)$ of a continuous time linear time-invariant (LTI) system are given by

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

Compute the output $y(t)$by using the equation of convolution integral.

Input $x(t)$ dan impulse response $h(t)$ sistem masa berterusan linear time-invariant (LTI) adalah diberikan oleh

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

Kirakan output $y(t)$ dengan menggunakan persamaan convolution integral.

[4 marks]
[4*markah*]

CLO2
C5

QUESTION 7

Construct the inverse Laplace transform of the following $X(s)$to signal $x(t)$:

$$X(s) = \frac{2s+1}{s+2}$$

Re (s)>-2

Binakan songsangan Laplace $X(s)$berikut kepada isyarat $x(t)$:

$$X(s) = \frac{2s+1}{s+2}$$

Re (s)>-2

[4 marks]
[4*markah*]

CLO2
C4

QUESTION 8

Analyse the signal shown in Figure 2, to the Fourier transform.

Analisis isyarat yang ditunjukkan dalam Rajah 2, kepada jelmaan Fourier.

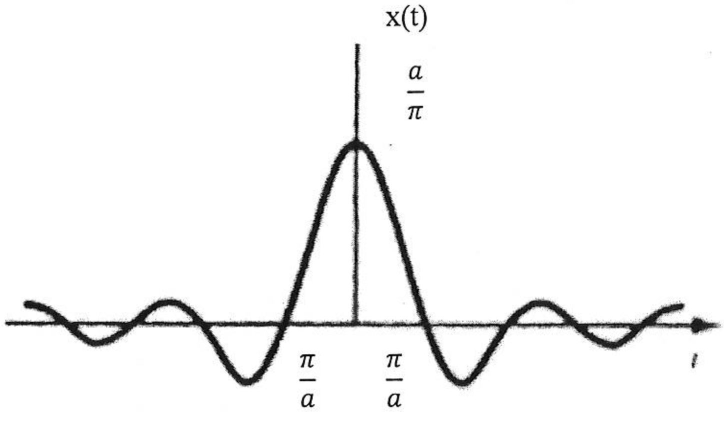

Figure 2
Rajah 2

[4 marks]
[*4 markah*]

CLO2
C5

QUESTION 9

Formulate Fourier transform for the signal shown in Figure 3.

Formulasikan jelmaan Fourier bagi isyarat yang ditunjukkan dalam Rajah 3.

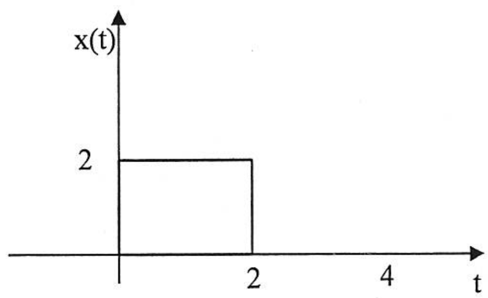

Figure 3
Rajah 3

[4 marks]
[4*markah*]

CLO2
C5

QUESTION 10

Construct a Fourier transform sequence $X(\Omega)$ for a rectangular pulse as shown in Figure 4.

Bina jujukan jelmaan Fourier untuk $X(\Omega)$ bagi denyut segi empat tepat seperti yang ditunjukkan dalam Rajah 4.

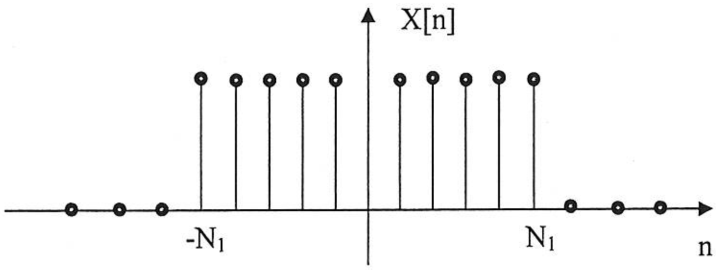

Figure 4
Rajah 4

[4marks]
[*4markah*]

SECTION B : 60 MARKS
BAHAGIAN B : 60 MARKAH

INSTRUCTION:
This section consists of **THREE (3)** essay questions. Answer **ALL** questions
ARAHAN:
Bahagian ini mengandungi ***TIGA (3)*** *soalan esei. Jawab* ***semua soalan.***

CLO1
C2

QUESTION 1

a) Identify and explain whether the following systems are time-invariant, linear, causal, and/or memoryless.

i) $\frac{dy}{dt} + 6y(t) = 4x(t)$

ii) $y[n+1] + 4y[n] = 3x[n+1] - x[n]$.

Kenal pasti dan jelaskan sama ada sistem berikut adalah masa berubah, linear, penyebab, dan atau ingatan.

i) $\frac{dy}{dt} + 6y(t) = 4x(t)$

ii) $y[n+1] + 4y[n] = 3x[n+1] - x[n]$.

[4 marks]
[4 *markah*]

CLO1
C3

b) Solve the differential equations shown below.

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 20y(t) = 2\frac{dx}{dt} - x(t)$$

Where:

$$x(t) = u(t), \qquad y(0) = 0, \qquad \frac{dy}{dt}(0) = 1$$

Selesaikan persamaan pembezaan

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 20y(t) = 2\frac{dx}{dt} - x(t)$$

Dimana:

$$x(t) = u(t), \qquad y(0) = 0, \qquad \frac{dy}{dt}(0) = 1$$

[6 marks]
[6 *markah*]

CLO1 C4

c) Analyze the differential equations by using the First order Principle (For n = 0 until n = 4), and construct MATLAB programming (For n = 0 until n = 30). Sketch the output signal of MATLAB stem.

$$y[n] + 0.5y[n-1] = 2x[n-1]$$

Where :

$$x[n] = \delta[n]\ ,\quad y[-1] = 0$$

Analisa persamaan pembezaan berikut dengan menggunakan Prinsip Pertama (Untuk n = 0 hingga n = 4), kemudian bina pengaturcaraan MATLAB (Untuk n = 0 hingga n = 30). Lukiskan keluaran isyarat stem MATLAB.

$$y[n] + 0.5y[n-1] = 2x[n-1]$$

Dimana :

$$x[n] = \delta[n]\ ,\quad y[-1] = 0$$

[10 marks]
[10 *markah*]

QUESTION 2

CLO1 C2

a) Explain the signal $x(t)$ converted to Laplace Transform using table given in the appendix.

$$x(t) = 2u(t) + \delta(t-4)$$

Terangkan isyarat $x(t)$ tukarkan kepada Laplace Transform menggunakan jadual yang diberikan dalam lempiran.

$$x(t) = 2u(t) + \delta(t-4)$$

[4 marks]
[4 *markah*]

CLO1 C4

b) Construct the inverse Laplace Transforms for the following functions.

$$X(s)\frac{2s+100}{(s+1)(s+8)(s+10)}$$

Bina jelmaan Laplace songsang untuk fungsi-fungsi berikut.

$$X(s)\frac{2s+100}{(s+1)(s+8)(s+10)}$$

[6 marks]
[6*markah*]

CLO1 C5

c) A time-continuous system whose input $x(t)$ and output $y(t)$ are related by

$$\frac{dy(t)}{dt} + ay(t) = x(t)$$

Transform signal $y(t)$with the auxiliary condition, $y(0) = y_o$ and $x(t) = Ke^{-bt}u(t)$, by using the unilateral Laplace transform.

Pertimbangkan sistem masa berterusan di mana input $x(t)$ dan output $y(t)$adalah berkaitan dengan

$$\frac{dy(t)}{dt} + ay(t) = x(t)$$

Ubahkan isyarat $y(t)$ dengan syarat tambahan $y(0) = y_o$ and $x(t) = Ke^{-bt}u(t)$, dengan menggunakan jelmaan Laplace unilateral.

[10 marks]
[10 *markah*]

QUESTION 3

CLO2 C3

a) Transfer signal

$$u(t) = \int_{-\infty}^{t} \delta(\tau)d\tau$$

to the Fourier transform by using time domain.

Pindahkan isyarat

$$u(t) = \int_{-\infty}^{t} \delta(\tau)d\tau$$

kepada Fourier transform dengan menggunakan domain masa.

[4 marks]
[4 *markah*]

CLO2 C4

b) Show that :

$$x_1(t)x_2(t) \leftrightarrow \frac{1}{2\pi} X_1(\omega) * X_2(\omega)$$

Buktikan:

$$x_1(t)x_2(t) \leftrightarrow \frac{1}{2\pi} X_1(\omega) * X_2(\omega)$$

[6 marks]
[6 *markah*]

CLO2
C6

c) The linear circuit is shown in Figure 5 (a) and the impulse response is shown in Figure 5 (b). Formulate the response, $f(t)$ using Fourier transform method as shown in Figure 5 (c).

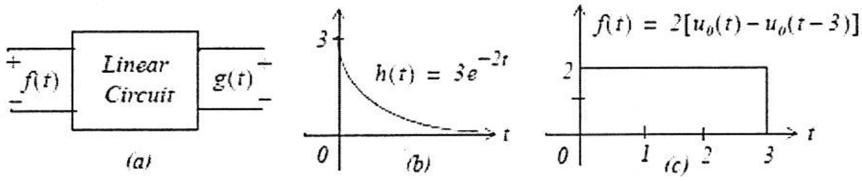

Figure 5
Rajah 5

Litar linear ditunjukkan dalam Rajah 5 (a) dan sambutan dedenyut ditunjukkan dalam Rajah 5 (b). Merumuskan sambutan, $f(t)$ dengan menggunakan kaedah jelmaan Fourier seperti yang ditunjukkan dalam Rajah 5 (c).

[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:

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

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 $n_o < 0$
$u[n]$	$\frac{1}{1-z^{-1}}$	$\lvert z\rvert > 1$
$-u[-n-1]$	$\frac{1}{1-z^{-1}}$	$\lvert z\rvert < 1$
$a^n u[n]$	$\frac{1}{1-az^{-1}}$	$\lvert z\rvert > \lvert a\rvert$
$-a^n u[-n-1]$	$\frac{1}{1-az^{-1}}$	$\lvert z\rvert < \lvert a\rvert$
$n a^n u[n]$	$\frac{az^{-1}}{(1-az^{-1})^2}$	$\lvert z\rvert > \lvert a\rvert$
$-n a^n u[-n-1]$	$\frac{az^{-1}}{(1-az^{-1})^2}$	$\lvert z\rvert < \lvert a\rvert$
$(n+1) a^n u[n]$	$\frac{1}{(1-az^{-1})^2}$	$\lvert z\rvert > \lvert a\rvert$
$[\cos\omega_o n]\, u[n]$	$\frac{1-[\cos\omega_o]z^{-1}}{1-2[\cos\omega_o]z^{-1}+z^{-2}}$	$\lvert z\rvert > 1$
$[\sin\omega_o n]\, u[n]$	$\frac{[\sin\omega_o]z^{-1}}{1-2[\cos\omega_o]z^{-1}+z^{-2}}$	$\lvert z\rvert > 1$
$[r^n \cos\omega_o n]\, u[n]$	$\frac{1-[r\cos\omega_o]z^{-1}}{1-2r[\cos\omega_o]z^{-1}+r^2z^{-2}}$	$\lvert z\rvert > \lvert r\rvert$
$[r^n \sin\omega_o n]\, u[n]$	$\frac{[r\sin\omega_o]z^{-1}}{1-2r[\cos\omega_o]z^{-1}+r^2z^{-2}}$	$\lvert z\rvert > \lvert r\rvert$
$x[n] = \begin{cases} a^n, & 0 \le n < L \\ 0, & \text{otherwise} \end{cases}$	$\frac{1-a^L z^{-L}}{1-az^{-1}}$	$\lvert z\rvert > 0$

LAPLACE TRANSFORM PAIRS

Sl. No.	Time Domain f(t)	S Domain F(s)
		$F(s) = \int_0^\infty e^{-st} f(t) dt$
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	$\sinh at$	$\frac{a}{s^2-a^2}$; $s > \|a\|$
12	$\cosh at$	$\frac{s}{s^2-a^2}$; $s > \|a\|$
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	$e^{-at}u(t)$	$\dfrac{1}{a+j\omega}$	$a>0$
2	$e^{at}u(-t)$	$\dfrac{1}{a-j\omega}$	$a>0$
3	$e^{-a\|t\|}$	$\dfrac{2a}{a^2+\omega^2}$	$a>0$
4	$te^{-at}u(t)$	$\dfrac{1}{(a+j\omega)^2}$	$a>0$
5	$t^n e^{-at}u(t)$	$\dfrac{n!}{(a+j\omega)^{n+1}}$	$a>0$
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	$u(t)$	$\pi\delta(\omega)+\dfrac{1}{j\omega}$	
12	$\operatorname{sgn} t$	$\dfrac{2}{j\omega}$	
13	$\cos\omega_0 t\, u(t)$	$\dfrac{\pi}{2}[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]+\dfrac{j\omega}{\omega_0^2-\omega^2}$	
14	$\sin\omega_0 t\, u(t)$	$\dfrac{\pi}{2j}[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]+\dfrac{\omega_0}{\omega_0^2-\omega^2}$	
15	$e^{-at}\sin\omega_0 t\, u(t)$	$\dfrac{\omega_0}{(a+j\omega)^2+\omega_0^2}$	$a>0$
16	$e^{-at}\cos\omega_0 t\, u(t)$	$\dfrac{a+j\omega}{(a+j\omega)^2+\omega_0^2}$	$a>0$
17	$\operatorname{rect}\left(\dfrac{t}{\tau}\right)$	$\tau\operatorname{sinc}\left(\dfrac{\omega\tau}{2}\right)$	
18	$\dfrac{W}{\pi}\operatorname{sinc}(Wt)$	$\operatorname{rect}\left(\dfrac{\omega}{2W}\right)$	
19	$\Delta\left(\dfrac{t}{\tau}\right)$	$\dfrac{\tau}{2}\operatorname{sinc}^2\left(\dfrac{\omega\tau}{4}\right)$	
20	$\dfrac{W}{2\pi}\operatorname{sinc}^2\left(\dfrac{Wt}{2}\right)$	$\Delta\left(\dfrac{\omega}{2W}\right)$	
21	$\sum_{n=-\infty}^{\infty}\delta(t-nT)$	$\omega_0\sum_{n=-\infty}^{\infty}\delta(\omega-n\omega_0)$	$\omega_0=\dfrac{2\pi}{T}$
22	$e^{-t^2/2\sigma^2}$	$\sigma\sqrt{2\pi}\,e^{-\sigma^2\omega^2/2}$	