King Saud University
College of Engineering
Electrical Engineering Department

EE-301: Signals & Systems
٣٠١ كهر (تحليل إشارات)
Final Exam
2nd Semester – 1426-27H

**Question 1:**

**(a)** A discrete-time (DT) linear time-invariant (LTI) system is described by the following input-output relationships:

If the input is $x_1[n]=4\delta[n]+2\delta[n-1]$ the output is $y_1[n]=4\delta[n]+6\delta[n-1]+2\delta[n-2]$.

If input is $x_2[n]=-2\delta[n]-\delta[n-1]+\frac{1}{2}\delta[n-2]$ the output is $y_2[n]=-2\delta[n]-3\delta[n-1]-\frac{1}{2}\delta[n-2]+\frac{1}{2}\delta[n-3]$

Find and sketch the impulse response $h[n]$ of this system.

**(b)** A continuous-time system is described by $y(t)=\exp\left[x(t+1)\right]$, where $x(t)$ is the input and $y(t)$ is the output. (i) Is this system stable? (ii) Is it causal? (iii) Is it time-invariant? Explain why or why not.

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**Question 2:**

**(a)** Figure 1 describes a CT LTI system with input $x(t)$ and output $y(t)$, where:
$h_1(t)=u(t)$, $h_2(t)=\delta(t-1)+\delta(t+1)$,
$h_3(t)=-\delta(t)-\delta(t-2)$, and $h_4(t)=\delta(t-1)$.
Find the overall impulse response $h(t)$ of the system so that $y(t)=x(t)*h(t)$.

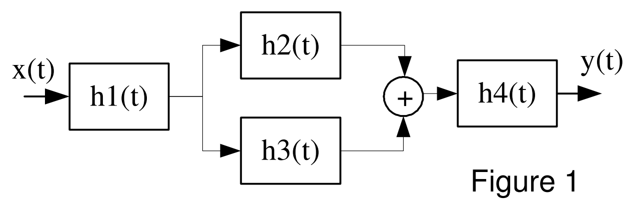


Figure 1

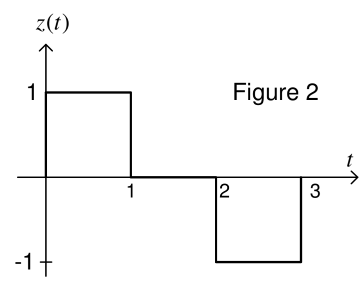


Figure 2

**(b)** A CT signal $z(t)$ is shown in Figure 2.
(i) Determine and sketch the autocorrelation of $z(t)$
(ii) Find the energy of $z(t)$ <u>by using the autocorrelation</u>.

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**Question 3:**

**(a)** $x(t)$ is a periodic signal. One period is given by $x(t)=\exp(-|t|)$ for $-1\le t\le 1$ then the same pattern repeats every 2 seconds. (i) Find the Fourier series coefficients $a_k$ of $x(t)$
(ii) Find the dc component of $x(t)$
(iii) Find the Fourier transform of $x(t)$.

**(b)** Consider the DT filter h[n] = $\begin{cases} 2-|n| & -2\le n\le 2 \\ 0 & \text{elsewhere} \end{cases}$.

(i) Find the frequency response $H(e^{j\omega})$ of this system.
(ii) Determine and sketch the magnitude and phase of $H(e^{j\omega})$.
(iii) Is this system low-pass, band-pass, or high-pass?

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## Question 4:

Let $x(t)$ be a CT signal with Fourier transform $X(\omega) = \begin{cases} 1-\omega^2 & -1 \le \omega \le 1 \\ 0 & \text{elsewhere} \end{cases}$

Using the above information, <u>choose the correct answers</u> from the following and <u>**explain why**</u>:

**(a)** To avoid aliasing when sampling the signal $x(t)$, the sampling angular frequency $\omega_s$ should be

(i) $\omega_s > 1$ (ii) $\omega_s < 1$ (iii) $\omega_s > 2$ (iv) $\omega_s < 2$ (v) $\omega_s > 4$ (vi) $\omega_s < 4$

**(b)** The energy of $x(t)$ is

(i) $\frac{4}{3}$ (ii) $\frac{2}{3\pi}$ (iii) $\frac{6}{13}$ (iv) $\frac{6}{13\pi}$ (v) $\frac{16}{15\pi}$ (vi) $\frac{8}{15\pi}$

**(c)** To avoid aliasing when sampling the signal $y(t) = x(2t)$, the sampling angular frequency $\omega_s$ should be

(i) $\omega_s > 1$ (ii) $\omega_s < 1$ (iii) $\omega_s > 2$ (iv) $\omega_s < 2$ (v) $\omega_s > 4$ (vi) $\omega_s < 4$

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## Question 5:

A linear time invariant discrete system is shown in Figure 3:

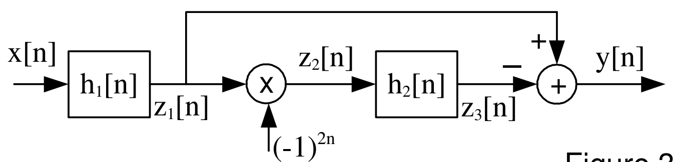


Figure 3

where

$H_1(e^{j\omega}) = \begin{cases} 1 & |\omega| < \pi/2 \\ 0 & \text{otherwise} \end{cases}$ ; $H_2(e^{j\omega}) = \begin{cases} 1 & |\omega| < \pi/4 \\ 0 & \text{otherwise} \end{cases}$

**(a)** Compute the overall frequency response $H(e^{j\omega}) = Y(e^{j\omega})/X(e^{j\omega})$ and draw it against $\omega$.

**(b)** Compute y(n) if $x(n) = \cos(3\pi n/8) + 2\sin(\pi n/8) + \cos(3\pi n/4)$

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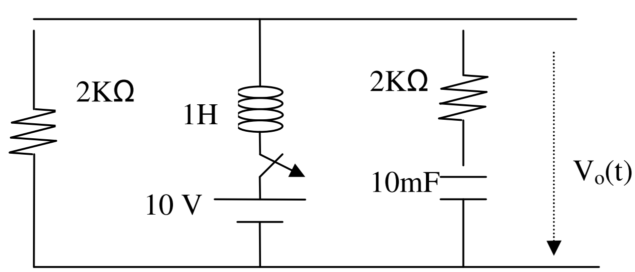
## Question 6:

Given the RLC circuit as shown in figure. The switch is closed for long time at t<0. The switch is opened at t=0.




**(a)** Compute $V_o(t)$ for all t>0

**(b)** Compute the steady state value for $V_o(t)$

**(c)** Compute the transient response for $V_o(t)$

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مع تمنياتنا لكم بالتوفيق