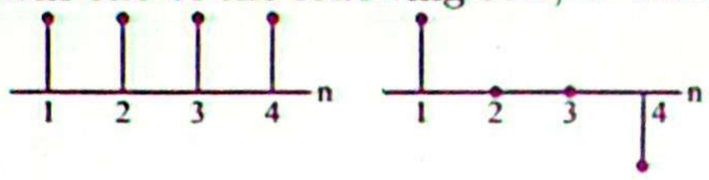
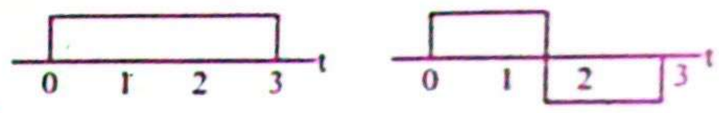
1. Let $e^{-4t}\cos(3t) = \mathcal{R}e\{e^{st}\}$, which ones of the followings is the value of s?
   A. -4 B. 3 C. $-4+3j$ D. $-4+(3+\frac{\pi}{2})j$

2. Which one of the following sets, or functions are not orthogonal to each other?

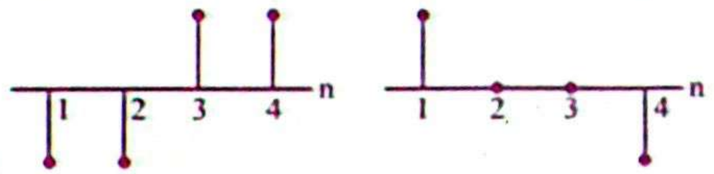
A.



B.



C.



D. $\{e^{j\frac{2\pi}{13}n}\}, \{e^{j\frac{6\pi}{13}n}\}$

3. Which one of the followings is not an LTI system?
   A. $y[n] = \sum_{k=n-3}^{n} x[k] + 3$
   B. $y(t) = \int_{-3}^{0} x(t-\tau)e^{\tau}d\tau$
   C. $y(t) = \int_{t-3}^{t} x(\tau)e^{t-\tau}d\tau$
   D. $y[n] = \sum_{k=-\infty}^{\infty} x[k]\frac{1}{(n-k)^2}$

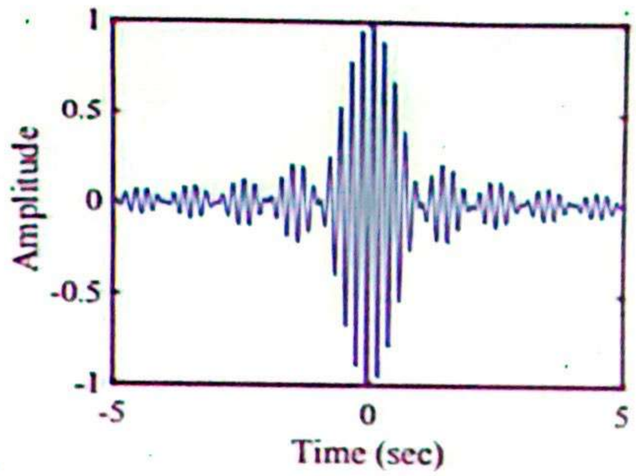
4. Which one of the following signals is aperiodic?
   A. $x(t) = \sin(3t) + \cos(10t + \frac{\pi}{6})$
   B. $x[n] = \sin(3n) + \cos(10\pi n)$
   C. $x[n] = e^{j\frac{\pi}{2}n} + e^{j\frac{\pi}{4}n}$
   D. $x(t) = 2\cos(\frac{n\pi}{4}) + 3\cos(\frac{n\pi}{2})$

5. Which one of the following systems is not linear?
   A. $y[n] = (n+6)x[n]$
   B. $y[n] = \sum_{k=0}^{5} x[n-k]$
   C. $y[n] = x[n] \cdot x[n-3]$
   D. $y[n] = x[2n]$

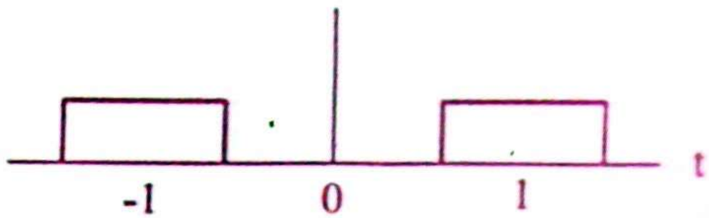
6. Which of the signals specified below have Fourier series?
   A. $x(t) = e^{2t}u(t)$
   B. $x(t) = e^{t} + e^{-t}$
   C. $FT\{x(t)\} = \sin(\omega)$
   D. $FT\{x(t)\} = \delta(\omega-2) * \delta(\omega-4)$

7. Which one of the following impulse responses is a bandpass filter?

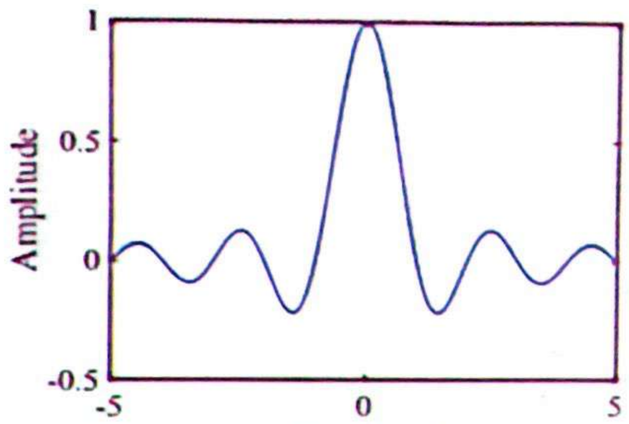
A.



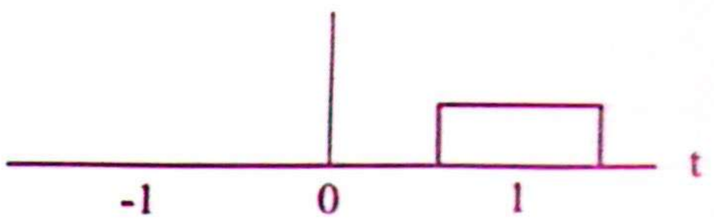
B.



C.

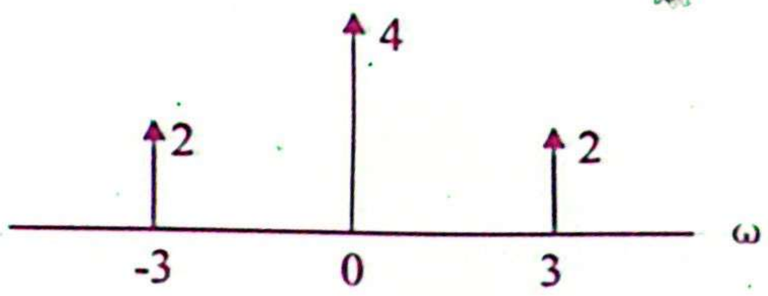


D.



8. A CT system $h(t)$ has frequency response of $H(j\omega) = e^{-j3\omega}$, which one of the following statements is false?
   A. The magnitude response is the same at all frequency
   B. This is a linear phase system
   C. This is a casual system
   D. This is not a stable system

9. The spectrum of a signal is shown below, which one of the followings is false?



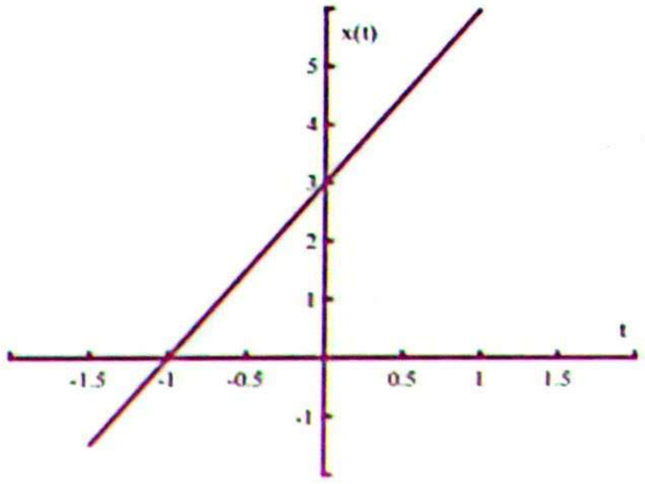
A. This signal is a CT signal
B. This signal has a DC term
C. This signal is a periodic signal
D. This signal is a DT signal

10. Which one of the following systems is not time invariant?

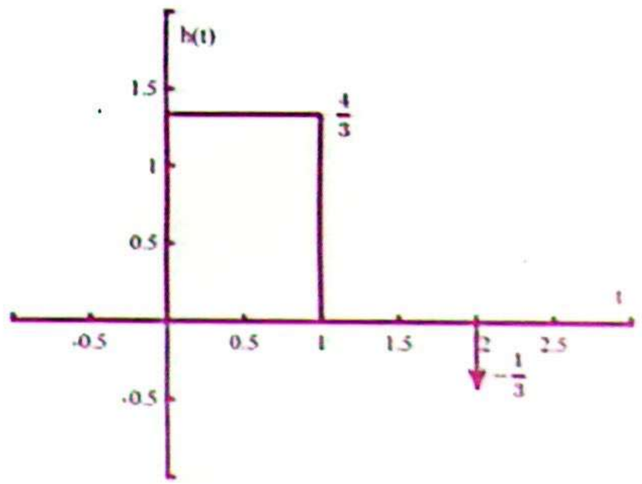
A. $y(t) = x(t + 0.3)$
B. $y(t) = x(t)e^{-\sqrt{2}t}$
C. $y(t) = \sin(x(t + 0.2))$
D. $y(t) = x(t - 1.4) + x(t + 1.4)$

Question 11 (10′)

For the pair of waveforms shown in the figures below, use the convolution integral to find the response $y(t)$ of the LTI system with impulse response $h(t)$ to the input $x(t)$. Plot the waveform of $y(t)$.



Q.11 figure of $x(t)$



Q.11 figure of $h(t)$

Question 12 ($4' + 6' = 10'$)

a) Classify the following signals as periodic or aperiodic and find the fundamental period, if periodic:

i) $x(t) = [\cos(2t + \frac{2\pi}{3})]^2$

ii) $x[n] = \cos(\frac{\pi}{4}n) + \sin(\frac{\pi}{8}n) - \cos(\frac{\pi}{2}n + \frac{\pi}{3})$

b) i) For a continuous signal $x(t) = 0.5e^{-2t}u(t)$, determine the total energy and the average power of the signal.

ii) State (without proof), whether the system with input-output relation $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$, possess the the following properties: invertibility, linearity, time invariance, memoryless, causality.

Question 13 ($5' + 5' + 5' = 15'$)

For a discrete-time periodic signal $x[n] = \sin(\frac{\pi n}{4}) + 2\cos(\frac{\pi n}{2})$,

a) What is its period value (N)?

b) Determine its non-zero Fourier series coefficients from a_{-5} to a_3.

c) What are the values of its Fourier series coefficients a_{20} and a_{2022}?

Question 14 (15′)

Suppose we are given the following information about a continuous-time periodic signal with period 3 and Fourier coefficients a_k:

(1) $a_k = a_{k+2}$

(2) $a_k = a_{-k}$

(3) $\int_{-0.5}^{0.5} x(t)dt = 1$

(4) $\int_{0.5}^{1.5} x(t)dt = 2$

Determine $x(t)$.

Question 15 ($5' + 5' + 10' = 20'$)

A casual and stable LTI system S has the frequency response

$$H(j\omega) = \frac{3j\omega + 1}{2 - \omega^2 + 3j\omega}$$

a) Determin a differential equation relating the input $x(t)$ and output $y(t)$ of S.

b) Determine the impulse response $h(t)$ of S.

c) What is the output of S when the input is $x(t) = \frac{1}{3}e^{-\frac{1}{3}t}u(t) + \frac{2}{9}te^{-\frac{1}{3}t}u(t)$?