DATE:

Question (1)

$\boxed{1}$ $X(t) = e^{-2t} u(t)$

$$X(t) = \begin{cases} e^{-2t} & \text{when } t \geq 0 \\ 0 & \text{Otherwise} \end{cases}$$

$$E = \lim_{T \to \infty} \int_0^T e^{-4t} \, dt = \frac{1}{-4} e^{-4t} \Big]_0^T$$

$$= \lim_{T \to \infty} \left[\frac{-1}{4} e^{-4T} + \frac{1}{4} \right]$$

$$= 0 + \frac{1}{4} = \boxed{\frac{1}{4}}$$

$$P = \lim_{T \to \infty} \frac{1}{2T} * \left[\frac{-1}{4} e^{-4T} + \frac{1}{4} \right]$$

$$= \lim_{T \to \infty} \frac{-1 e^{-4T}}{8T} + \frac{1}{8T} = \frac{0}{\infty} + \frac{1}{\infty} =$$

$\boxed{\text{Zero}}$

$$x(t) = \sin(t)$$

$$E = \lim_{T \to \infty} \int_{-T}^{T} \sin^2(t)\, dt$$

$$= \lim_{T \to \infty} \int_{-T}^{T} \frac{1}{2} - \frac{1}{2}\cos(2t)\, dt$$

$$= \lim_{T \to \infty} \left[\frac{1}{2}t - \frac{1}{4}\sin(2t) \right]_{-T}^{T}$$

$$= \lim_{T \to \infty} \left[\frac{1}{2}T - \frac{1}{4}\sin(2T) - \left(-\frac{1}{2}T + \frac{1}{4}\sin(2T)\right)\right)$$

$$= \lim_{T \to \infty} \left[T - \frac{1}{2}\sin(2T) \right]$$

$$= \boxed{\infty}$$

$$P = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} x^2(t)\, dt$$

$$= \lim_{T \to \infty} \frac{1}{2T} * \left[T - \frac{1}{2}\sin(2T) \right]$$

$$= \lim_{T \to \infty} \frac{1}{2} - \frac{1}{2}\frac{\sin(2T)}{T}$$

$$= \cancel{\lim_{T \to}} \quad \frac{1}{2} - \frac{1}{\cancel{2}} * \frac{\cancel{2}}{1} = \boxed{\frac{-1}{2}}$$

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Question (2)

$$X[n] = \left(\frac{1}{2}\right)^n u[n]$$

$$X[n] = \begin{cases} \left(\frac{1}{2}\right)^n & \text{if } n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

$$E = \lim_{N \to \infty} \sum_{n=-N}^{N} X^2[n] = \lim_{N \to \infty} \sum_{n=0}^{N} \left(\frac{1}{2}\right)^{2N} = \sum_{0}^{N} \left(\frac{1}{4}\right)^N$$

$$\text{Geometric series} = \frac{1}{1-r} = \frac{1}{1-1/4}$$

$$= \boxed{\frac{4}{3} = 1.33}$$

$$P = \lim_{N \to \infty} \frac{1}{2N+1} \sum_{n=-N}^{N} X^2[n] = \lim_{N \to \infty} \frac{1}{2N+1} \sum_{0}^{N} \left(\frac{1}{4}\right)^N$$

$$= \frac{1}{\infty} * \frac{4}{3} = \boxed{\text{Zero}}$$

Question (2)

$$x[n] = \cos\left[\frac{\pi}{4} n\right]$$

$$E = \lim_{N \to \infty} \sum_{n=-n}^{N} x^2[n] = \lim_{N \to \infty} \sum_{N=-N}^{N} \cos^2\left[\frac{\pi}{4} n\right]$$

$$= \infty$$

$$P = \lim_{N \to \infty} \frac{1}{2N+1} \sum_{-N}^{N} \frac{1}{2} + \frac{1}{2}\cos\left(\frac{\pi}{2} n\right) = \frac{1}{2}$$

$$\because \quad \frac{-1}{2} \leq \frac{\cos\left(\frac{\pi}{2} n\right)}{2} \leq \frac{1}{2}$$

$$+\frac{1}{2} - \frac{1}{2} \leq \frac{1}{2} + \frac{1}{2}\cos\left(\frac{\pi}{2} n\right) \leq \frac{1}{2} + \frac{1}{2}$$

$$0 \leq \frac{1}{2} + \frac{1}{2}\cos\left(\frac{\pi}{2} N\right) \leq 1$$

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Question (3)

$\boxed{1}$ $y(t) = x(t-2) + x(2-t)$

- needs memory because of $X(t-2)$

- invertable as I can get the ~~out~~ input from the output again by doing some operation

$y_1 = x(t-2)$ invertable
$y_2 = x(2-t)$ invertable

- Non Causal → depends on past signal as well as future signals ex: when $y(0) = x(-2) + x(2)$ → future
- stable → output finite when input is finite.

- $y(t) \xrightarrow{t_0} y(t-t_0) \longrightarrow x(t-t_0-2) + x(2-t+t_0)$

- $x(t) \xrightarrow{t_0} x(t-t_0) \xrightarrow{sys} x(t-t_0-2) + x(2-t-t_0)$

time varient system

- it's a linear system

$y_1(t) + y_2(t) = x_1(t-2) + x_1(2-t) + x_2(t-2) + x_2(2-t)$

$x_1(t) + x_2(t) = x_1(t-2) + x_1(2-t) + x_2(t-2) + x_2(2-t)$

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$x(t) \longrightarrow sys \longrightarrow y(t) \longrightarrow \text{"}k\text{"} \longrightarrow k\,y(t) = k[(\ )+(\ )]$

$x(t) \longrightarrow \text{"}k\text{"} \longrightarrow k\,x(t) \longrightarrow k(\ )+k(\ ) = k[(\ )+(\ )]$

The system follows the law of homogenity.

it's a linear system as it follows the law of superposition.

$y(t) = X\left(\frac{t}{3}\right)$

- it needs memory as ex: $y(9) = X(\underline{3})$ Past

- $y(t) \longrightarrow y(t - t_0) = X\left(\frac{t - t_0}{3}\right)$
  $X(t) \longrightarrow X\left(\frac{t}{3} - t_0\right) = X\left(\frac{t - 3t_0}{3}\right)$

The system is time Varient

- $y(t) \longrightarrow$ "K" $\longrightarrow Ky(t) = K X(t/3)$
  $X(t) \longrightarrow$ "K" $\longrightarrow K X(t/3)$

This system is linear.

- non Causal as it depends on the Past input and the future as well $Y(-3) = X(-1) \rightarrow$ Future
- stable $\rightarrow$ Finite input $\Rightarrow$ Finite output

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$\boxed{3}$ $y(t) = \frac{d}{dt} x(t)$

- Memoryless

- $y(t-t_0) \longrightarrow \frac{d\,x}{dx}(t-t_0)$

$x(t-t_0) \longrightarrow d\,x(t-t_0)$

This is time Varient

- $y(t) \longrightarrow "k" \longrightarrow k y(t) = k \cdot \frac{d}{dt} x(t)$

$x(t) \longrightarrow "k" \longrightarrow k \cdot \frac{d}{dt} x(t)$

This is a linear system

- Causal system, the output depends on the Current input

nonstable → ~~finite input → finite output~~ it maybe undefined for some functions at finite input

Question (4)

$y[n] = x[n-2] - 2x[n-8]$

- needs memory

- $y[n-n_0] \longrightarrow x[n-n_0-2] - 2x[n-n_0-8]$
$x[n] \rightarrow x[n-n_0] \rightarrow x[n-n_0-2] - 2x[n-n_0-8]$

This system is Time invarient

- $y[n] \longrightarrow Ky[n] \longrightarrow K[x[n-2] - 2x[n-8]]$
$x[n] \longrightarrow Kx[n] \longrightarrow Kx[n-2] - 2Kx[n-8]$

follows superposition $\longrightarrow$ linear!

- Causal, depends on Previous "Past" input

- stable $\longrightarrow$ finite input $\longrightarrow$ finite output

ATE:

[2] $y[n] = n^2 x[n]$

- Memoryless

- $y[n] \rightarrow y[n-n_0] \rightarrow (n-n_0)^2 x[n-n_0]$
  $x[n] \rightarrow x[n-n_0] \rightarrow n^2 x[n-n_0]$

Time Varient

- $y[n] \rightarrow k y[n] \rightarrow k n^2 x[n]$
  $x[n] \rightarrow k x[n] \rightarrow n^2 k x[n]$

linear

- Causal, depends on the current signal

- stable $\rightarrow$ finite input $\rightarrow$ finite output

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$y[n] = x[4n+3]$

- needs memory

- $y[n-n_0] \longrightarrow x[4n-4n_0+3]$
  $x[n-n_0] \longrightarrow x[4n-n_0+3]$

Time Varient

- $K y[n] = K x[4n+3]$
  $K x[n] \longrightarrow K x[4n+3]$
  lineer

- non Causal $\longrightarrow$ depends on the future

- stable finite input $\longrightarrow$ finite output.

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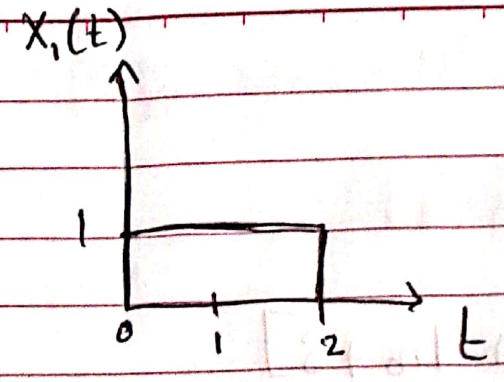
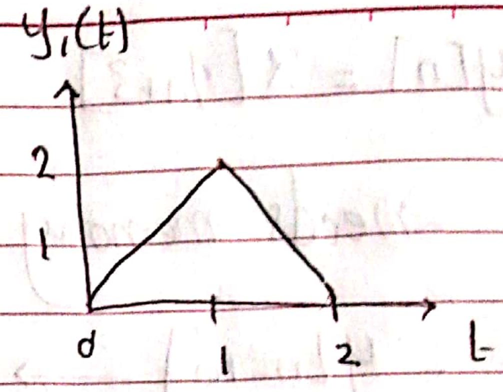
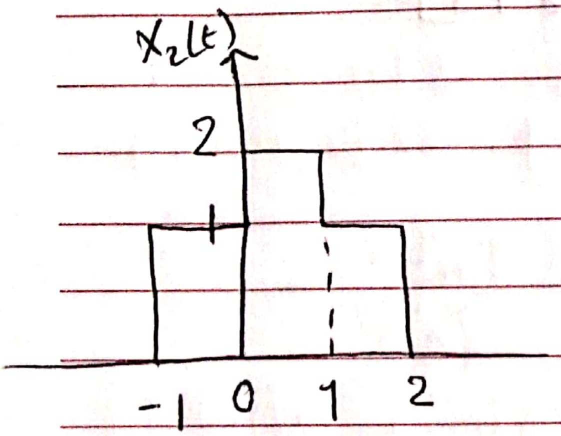
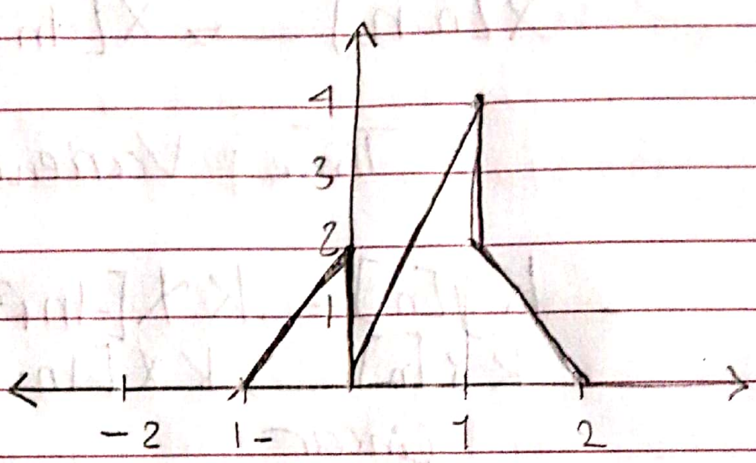


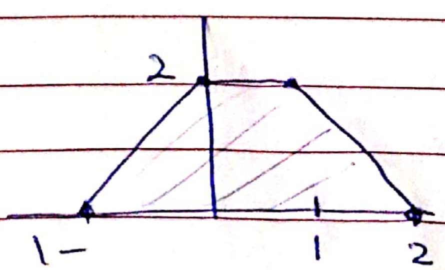






another answer: if I miss understood the Concept of linearty above (dealing with each part of the function as linear, not The whole function)

$x_2(t) = x_1(t) + x_1(t+1)$



$y_2(t) = y_1(t) + y_1(t+1)$

$y_2(-1) = y_1(0) = 0$

$y_2(0) = y_1(0) + y_1(1) = 2$

$y_2(1) = y_1(1) + y_1(2) = 2$

$y_2(2) = y_1(2) + y_1(3) = 0$