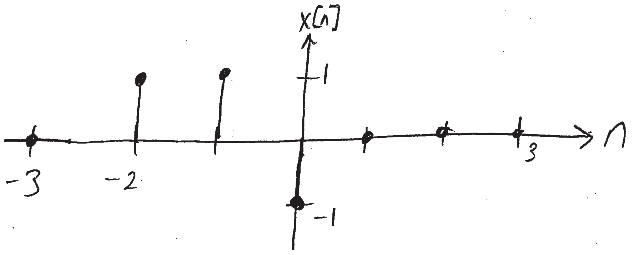
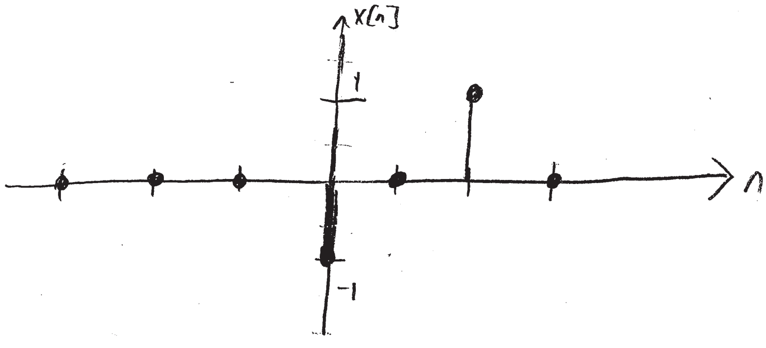
Question 32

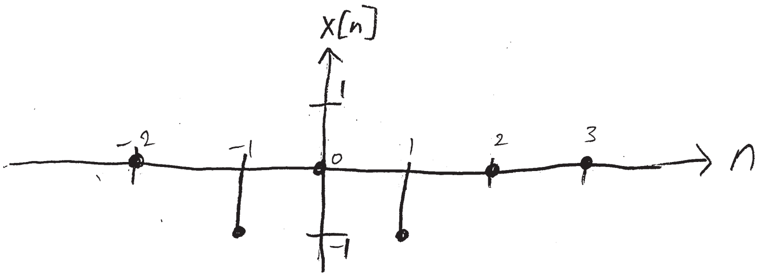
- $x[n] = u[n+2] - 2u[n] + u[n-1]$, $n = -2$ to $n = 3$



- $x[n] = (n+1)u[n+1] - 2u[n] - (n-1)u[n-3]$



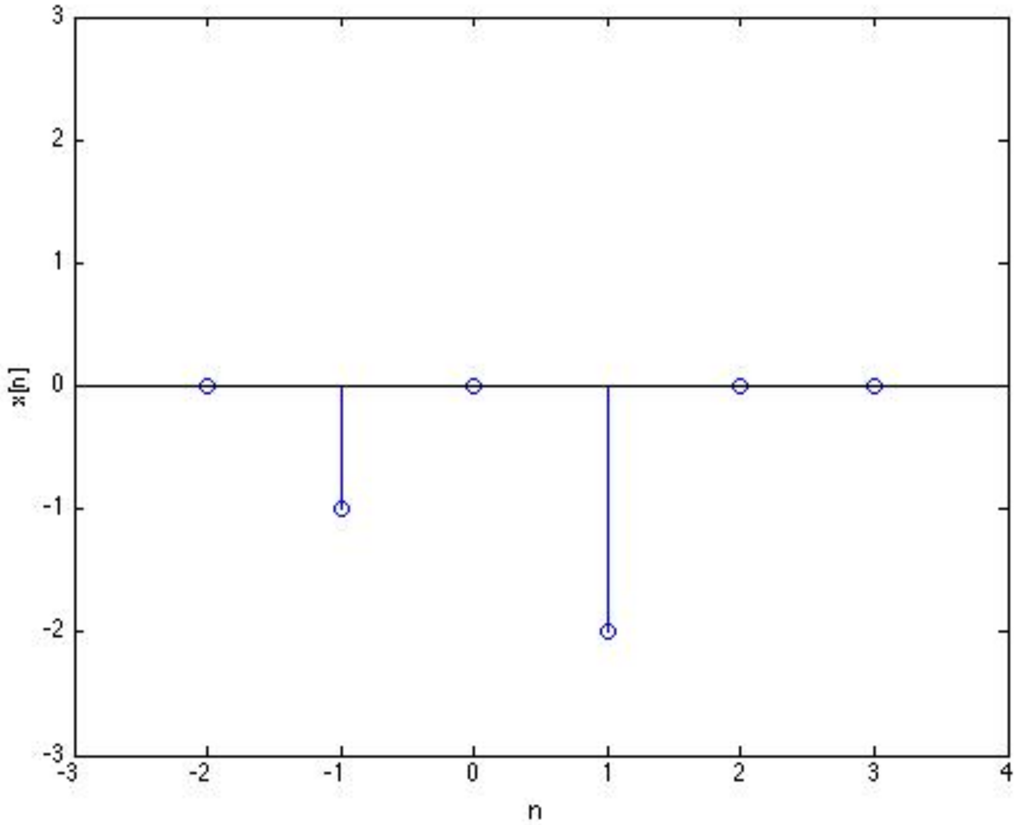
- $x[n] = \delta[n] - \delta[n-1] + u[n-2] - u[n+1]$



The above signal graph for 8(c) is incorrect. The correct graph is given below.

Corrected Solution for Q8 part (c)

$$x[n] = \delta[n] - \delta[n-1] + u[n-2] - u[n+1]$$



Question 33

- $$x[n] = \sum_{k=-\infty}^{\infty} a_k \, \delta[n-k]$$

we know for some $l \in \mathbb{Z}$

$$x[l] = x[n] \, \delta[n-l]$$

$$x[l] = \sum_{k=-\infty}^{\infty} a_k \, \delta[n-k] \, \delta[n-l]$$

$$x[l] = \begin{cases} a_k & l=k \\ 0 & l \neq k \end{cases}$$

$$\Rightarrow \boxed{a_k = x[k]}$$

- $$x[n] = \sum_{k=-\infty}^{\infty} x[k] \, \delta[n-k]$$

$$= \sum_{k=-\infty}^{\infty} x[k] \left(u[n-k] - u[n-k-1]\right) = \sum_{k=-\infty}^{\infty} x[k] u[n-k] - \sum_{k=-\infty}^{\infty} x[k] u[n-k-1]$$

let $l = k+1$ $\quad k = l-1$

$$= \sum_{k=-\infty}^{\infty} x[k] u[n-k] - \sum_{l=-\infty}^{\infty} x[l-1] \, u[n-l]$$

now redefine l with k

$$= \sum_{k=-\infty}^{\infty} x[k] u[n-k] - \sum_{k=-\infty}^{\infty} x[k-1] \, u[n-k]$$

$$= \sum_{k=-\infty}^{\infty} \left(x[k] - x[k-1]\right) u[n-k]$$

$$= \sum_{k=-\infty}^{\infty} \beta_k \, u[n-k] \qquad \Rightarrow \boxed{\beta_k = x[k] - x[k-1]}$$

- $X(t) = \int_{-\infty}^{\infty} \alpha_s \, \delta(t-s) \, ds$

  if we consider any realization of t, say r, we have

  $X(r) = \int_{-\infty}^{\infty} \alpha_s \, \delta(r-s) \, ds$

  $X(r) = \alpha_s \int_{-\infty}^{\infty} \delta(r-s) \, ds$

  $X(r) = \alpha_s \cdot 1$

  $X(r) = \alpha_s$

  $\Rightarrow \boxed{\alpha_s = X(t)}$

Question 34

1.27)

a.) $y(t) = x(t-2) + x(2-t)$

1.) Memoryless?

system $\boxed{\text{has memory}}$ since it depends on past values of the input — $x(t-2)$

2.) Time Invariant?

let $x_1(t) = x(t-t_0)$

$$x_1(t) \xrightarrow{\text{system}} x_1(t-2) + x_1(2-t) = x(t-2-t_0) + x(2-t-t_0)$$

$$y(t-t_0) = x((t-t_0)-2) + x(2-(t-t_0)) = x(t-2-t_0) + x(2-t+t_0)$$

since the two outputs are different $\Rightarrow$ $\boxed{\text{Time Variant}}$

3.) Linear?

$$x_3(t) = \alpha_1 x_1(t) + \alpha_2 x_2(t)$$

$$x_3(t) \xrightarrow{\text{system}} x_3(t-2) + x_3(2-t)$$

$$= \alpha_1 x_1(t-2) + \alpha_2 x_2(t-2) + \alpha_1 x_1(2-t) + \alpha_2 x_2(2-t) \quad (1.)$$

$$x_1(t) \xrightarrow{\text{sys}} [x_1(t-2) + x_1(2-t)]\alpha_1$$

$$x_2(t) \xrightarrow{\text{sys}} [x_2(t-2) + x_2(2-t)]\alpha_2$$

$$= \alpha_1 x_1(t-2) + \alpha_2 x_2(t-2) + \alpha_1 x_1(2-t) + \alpha_2 x_2(2-t) \quad (2.)$$

since (1.) = (2.) System $\boxed{\text{is Linear}}$

4.) Causal?

if $t < 2$, the system depends on a future value

ex. $y(0) = x(-2) + x(2)$

$\Rightarrow$ $\boxed{\text{not Causal}}$

5.) stable?

if the input $x(t)$ is bounded by B, that is $|x(t)| < B$,

then for $y(t) = x(t-2) + x(2-t)$, $|y(t)| \le |x(t-2)| + |x(2-t)| \le 2B$

for all t $\Rightarrow$ $\boxed{\text{stable}}$

6.) $y(t) = [\cos(3t)]\, x(t)$

1.) Memoryless?

The system $\boxed{\text{is memoryless}}$ because it only depends on the current value of t

2.) Time-Invariant?

$x_1(t) = x(t - t_0)$

$x_1(t) \xrightarrow{sys} [\cos(3t)]\, x_1(t) = [\cos(3t)]\, x(t-t_0)$ ①

$y(t-t_0) = [\cos(3(t-t_0))]\, x(t-t_0)$ ②

① ≠ ② $\Rightarrow$ $\boxed{\text{Time-Variant}}$

3.) Linear?

$x_3(t) = \alpha_1 x_1(t) + \alpha_2 x_2(t)$

$x_3(t) \xrightarrow{sys} \cos(3t)\, x_3(t) = \cos(3t)\, \alpha_1 x_1(t) + \cos(3t)\, \alpha_2 x_2(t)$ ①

$x_1(t) \xrightarrow{sys} \cos(3t)\, x_1(t) \xrightarrow{\alpha_1}$

$x_2(t) \xrightarrow{sys} \cos(3t)\, x_2(t) \xrightarrow{\alpha_2}$ $\oplus \rightarrow = \alpha_1 \cos(3t)\, x_1(t) + \alpha_2 \cos(3t)\, x_2(t)$ ②

① = ② $\Rightarrow$ system $\boxed{\text{is Linear}}$

4.) Causal?

the system $\boxed{\text{is causal}}$ because it doesn't depend on any future values of time.

5.) if $|x(t)| < B$, then $|y(t)| \le |\cos(3t)|\,|x(t)| \le B$

for all t $\Rightarrow$ $\boxed{\text{System is stable}}$

c.) $y(t) = \int_{-\infty}^{2t} x(\tau)\,d\tau$

1.) Memoryless?

system $\boxed{\text{has memory}}$ because it depends on past values of time (times $-\infty$ to t)

2.) Time-Invariant?

$x_1(t) = x(t-t_0)$

$$x_1(t) \xrightarrow{sys} \int_{-\infty}^{2t} x_1(\tau)\,d\tau = \int_{-\infty}^{2t} x(\tau - t_0)\,d\tau \overset{s=\tau-t_0}{\Rightarrow} \int_{-\infty}^{2t-t_0} x(s)\,ds \quad (1.)$$

$$y(t-t_0) = \int_{-\infty}^{2(t-t_0)} x(\tau)\,d\tau = \int_{-\infty}^{2t-2t_0} x(\tau)\,d\tau \quad (2)$$

$(1.) \neq (2.) \Rightarrow \boxed{\text{Time - Variant}}$

3.) Linear?

$x_3(t) = \alpha_1 x_1(t) + \alpha_2 x_2(t)$

$$x_3(t) \xrightarrow{sys} \int_{-\infty}^{2t} x_3(\tau)\,d\tau = \int_{-\infty}^{2t} [\alpha_1 x_1(\tau) + \alpha_2 x_2(\tau)]\,d\tau \quad (1.)$$

$$x_1(t) \xrightarrow{sys} \int_{-\infty}^{2t} x_1(\tau)\,d\tau \xrightarrow{\alpha_1}$$

$$x_2(t) \xrightarrow{sys} \int_{-\infty}^{2t} x_2(\tau)\,d\tau \xrightarrow{\alpha_2}$$

$$\oplus \rightarrow = \int_{-\infty}^{2t} \alpha_1 x_1(\tau)\,d\tau + \int_{-\infty}^{2t} \alpha_2 x_2(\tau)\,d\tau \quad (2)$$

$(1.) = (2) \Rightarrow \boxed{\text{Linear}}$

4.) Causal?

system is $\boxed{\text{not Causal}}$ because it depends on future values of time (up to $2t$)

5.) stable?

It is clear that the system is $\boxed{\text{not stable}}$. An example is if $x(t) = 1 \leq 1$ for all t. Here $y(t) = \int_{-\infty}^{2t} 1\,d\tau$

if $t = 0$, $|y(t)| = \left|\int_{-\infty}^{0} 1\,d\tau\right| = |-\infty| = \infty$

Question 35

1.28)

a.) $y[n] = x[-n]$

1.) Memoryless ?

If $n>0$, then the output depends on a past value of the input

$\Rightarrow$ $\boxed{\text{has memory}}$

2.) Time-Invariant ?

Let $x[n-N] = x_1[n] \xrightarrow{sys} x_1[-n] = x[-n-N]$ ①

$y[n-N] = x[-(n-N)] = x[-n+N]$ ②

Since ① $\neq$ ② $\Rightarrow$ $\boxed{\text{Time-Variant}}$

3.) Linear ?

$\alpha_1 x_1 + \alpha_2 x_2 = x_3 \xrightarrow{sys} x_3[-n] = \alpha_1 x_1[-n] + \alpha_2 x_2[-n]$ ①

$x_1[n] \xrightarrow{sys} x_1[-n] \xrightarrow{\alpha_1}$

$\oplus \rightarrow \alpha_1 x_1[-n] + \alpha_2 x_2[-n]$ ②

$x_2[n] \xrightarrow{sys} x_2[-n] \xrightarrow{\alpha_2}$

Since ① = ② $\Rightarrow$ $\boxed{\text{Linear}}$

4.) Causal ?

if $n<0$, then the output depends on a future value of the input

$\Rightarrow$ $\boxed{\text{not Causal}}$

5.) Stable ?

if $|x[n]| \leq B$, then $|y[n]| = |x[-n]| \leq B$

$\Rightarrow$ $\boxed{\text{Stable}}$

b.) $y[n] = x[n-2] - 2x[n-8]$

1.) Memoryless?

depends on past values of the input $\Rightarrow$ $\boxed{\text{has memory}}$

2.) Time-Invariant?

$$x[n-N] = x_1[n] \xrightarrow{sys} x_1[n-2] - 2x_1[n-8] = x[n-N-2] - 2x[n-N-8] \quad (1)$$

$$y[n-N] = x[(n-N)-2] - 2x[(n-N)-8] \quad (2)$$

Since $(1) = (2)$ $\Rightarrow$ $\boxed{\text{Time-Invariant}}$

3.) Linear?

$$\alpha_1 x_1[n] + \alpha_2 x_2[n] = x_3[n] \xrightarrow{sys} x_3[n-2] - 2x_3[n-8]$$
$$= \alpha_1 x_1[n-2] + \alpha_2 x_2[n-2] - 2(\alpha_1 x_1[n-8] + \alpha_2 x_2[n-8]) \quad (1)$$

$$x_1[n] \xrightarrow{sys} x_1[n-2] - 2x_1[n-8] \xrightarrow{\alpha_1}$$
$$x_2[n] \xrightarrow{sys} x_2[n-2] - 2x_2[n-8] \xrightarrow{\alpha_2}$$
$$\oplus \rightarrow \alpha_1 x_1[n-2] - 2\alpha_1 x_1[n-8] + \alpha_2 x_2[n-2] - 2\alpha_2 x_2[n-8] \quad (2)$$

Since $(1) = (2)$ $\Rightarrow$ $\boxed{\text{Linear}}$

4.) Causal?

does not depend on any future value of time $\Rightarrow$ $\boxed{\text{Causal}}$

5.) stable?

let $|x[n]| \leq B$, so $|y[n]| = |x[n-2] - 2x[n-8]| \leq |x[n-2]| + |2x[n-8]|$

$\leq 3B$ $\Rightarrow$ $\boxed{\text{Stable}}$

C.) $y[n] = n\,x[n]$

1.) Memoryless?

output only depends on current value of input $\Rightarrow$ $\boxed{\text{memoryless}}$

5/15

2.) Time-Invariant?

$$x[n-N] = x_1[n] \xrightarrow{sys} n\,x_1[n] = n\,x[n-N] \quad (1)$$

$$y[n-N] = (n-N)\,x[n-N] \quad (2)$$

$$(1) \neq (2) \Rightarrow \boxed{\text{Time-Variant}}$$

3.) Linear?

$$\alpha_1 x_1[n] + \alpha_2 x_2[n] = x_3[n] \xrightarrow{sys} n\,x_3[n] = n\,\alpha_1 x_1[n] + n\,\alpha_2 x_2[n] \quad (1)$$

$$x_1[n] \xrightarrow{sys} n\,x_1[n] \xrightarrow{\alpha_1} \oplus \to \alpha_1 n\,x_1[n] + \alpha_2 n\,x_2[n] \quad (2)$$

$$x_2[n] \qquad n\,x_2[n] \xrightarrow{\alpha_2}$$

$$(1) = (2) \Rightarrow \boxed{\text{Linear}}$$

4.) Causal?

doesn't depend on any future time input $\Rightarrow \boxed{\text{Causal}}$

5.) Stable?

if $x[n] = 1 \leq 1$, $y[n] = n \cdot 1 = n$ which doesn't have a bound

$\Rightarrow \boxed{\text{not stable}}$

Question 36

1.28.)

e.) $$y[n] = \begin{cases} x[n] & n \geq 1 \\ 0 & n = 0 \\ x[n+1] & n \leq -1 \end{cases}$$

1.) Memoryless?

output depends on a future value of the input $\Rightarrow \boxed{\text{has memory}}$

2.) Time-Invariant?

$$x[n-N] = x_1[n] \xrightarrow{sys} \begin{cases} x_1[n] & , n \geq 1 \\ 0 & , n = 0 \\ x_1[n+1] & , n \leq 1 \end{cases} = \begin{cases} x[n-N] & , n \geq 0 \\ 0 & , n = 0 \\ x[n+1-N] & , n \leq 1 \end{cases} \quad (1)$$

$$y[n-N] = \begin{cases} x[n-N] & n-N \geq 1 \\ 0 & n-N = 0 \\ x[n-N+1] & n-N \leq -1 \end{cases} \quad (2)$$

$$(1) \neq (2) \Rightarrow \boxed{\text{Time-Variant}}$$

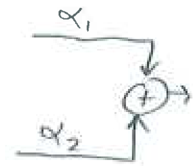
6/15

3.) Linear?

$$\alpha_1 X_1 + \alpha_2 X_2 = X_3 \xrightarrow{sys} \begin{cases} X_3[n] & n \geq 1 \\ 0 & n = 0 \\ X_3[n+1] & n \leq 1 \end{cases} = \begin{cases} \alpha_1 X_1[n] + \alpha_2 X_2[n] & n \geq 1 \\ 0 & n = 0 \\ \alpha_1 X_1[n+1] + \alpha_2 X_2[n+1] & n \leq 1 \end{cases} \quad (1.)$$

$$X_1[n] \xrightarrow{sys} \begin{cases} X_1[n] & n \geq 1 \\ 0 & n = 0 \\ X_1[n+1] & n \leq 1 \end{cases}$$

$$X_2[n] \qquad \begin{cases} X_2[n] & n \geq 1 \\ 0 & n = 0 \\ X_2[n+1] & n \leq 1 \end{cases}$$



$$\begin{cases} \alpha_1 X_1[n] + \alpha_2 X_2[n] & n \geq 1 \\ 0 & n = 0 \\ \alpha_1 X_1[n+1] + \alpha_2 X_2[n+1] & n \leq 1 \end{cases} \quad (2)$$

$$(1.) = (2) \Rightarrow \boxed{\text{Linear}}$$

4.) Causal?

depends on a future value of the input for $n \leq 1 \Rightarrow \boxed{\text{not Causal}}$

5.) Stable?

$$\text{if } |X[n]| \leq B, \text{ then } |y[n]| = \begin{cases} |X[n]| & n \geq 1 \\ |0| & n = 0 \\ |X[n+1]| & n \leq 1 \end{cases} \leq \begin{cases} B \\ 0 \\ B \end{cases} \leq B$$

$$\Rightarrow \boxed{\text{Stable}}$$

f.) $y[n] = \begin{cases} X[n] & n \geq 1 \\ 0 & n = 0 \\ X[n] & n \leq -1 \end{cases}$

1.) memoryless?

only depends on current value of input $\Rightarrow \boxed{\text{memoryless}}$

2.) Time-Invariant?

$$X[n-N] = X_1[n] \xrightarrow{sys} \begin{cases} X_1[n] & n \geq 1 \\ 0 & n = 0 \\ X_1[n] & n \leq -1 \end{cases} = \begin{cases} X[n-N] & n \geq 1 \\ 0 & n = 0 \\ X[n-N] & n \leq 1 \end{cases} \quad (1.)$$

$$y[n-N] = \begin{cases} X[n-N] & n-N \geq 1 \\ 0 & n-N = 0 \\ X[n-N] & n-N \leq -1 \end{cases} \quad (2)$$

$$(1.) \neq (2) \Rightarrow \boxed{\text{Time-Variant}}$$

3.) Linear?

$$\alpha_1 X_1 + \alpha_2 X_2 = X_3 \xrightarrow{sys} \begin{cases} X_3[n] & , n \geq 1 \\ 0 & , n = 0 \\ X_3[n] & , n \leq -1 \end{cases} = \begin{cases} \alpha_1 X_1[n] + \alpha_2 X_2[n] & ; n \geq 1 \\ 0 & ; n = 0 \\ \alpha_1 X_1[n] + \alpha_2 X_2[n] & ; n \leq -1 \end{cases} \quad (1.)$$

$$X_1[n] \xrightarrow{sys} \begin{cases} X_1[n] & ; n \geq 1 \\ 0 & ; n = 0 \\ X_1[n] & ; n \leq -1 \end{cases} \xrightarrow{\alpha_1}$$

$$X_2[n] \xrightarrow{sys} \begin{cases} X_2[n] & ; n \geq 1 \\ 0 & ; n = 0 \\ X_2[n] & ; n \leq -1 \end{cases} \xrightarrow{\alpha_2}$$

$$\oplus \rightarrow = \begin{cases} \alpha_1 X_1[n] + \alpha_2 X_2[n] & n \geq 1 \\ 0 & n = 0 \\ \alpha_1 X_1[n] + \alpha_2 X_2[n] & n \leq -1 \end{cases} \quad (2)$$

$(1.) = (2) \Rightarrow \boxed{\text{Linear}}$

4.) Causal?

output doesn't depend on future values of input $\Rightarrow$ $\boxed{\text{Causal}}$

5.) Stable?

$$\text{if } |X[n]| \leq B, \text{ then } |y[n]| = \begin{cases} |X[n]| & n \geq 1 \\ |0| & n = 0 \\ |X[n]| & n \leq -1 \end{cases} \leq \begin{cases} B \\ 0 \\ B \end{cases} \leq B$$

$\Rightarrow \boxed{\text{Stable}}$

g.) $y[n] = X[4n+1]$

1.) Memoryless?

output doesn't depend only on the current input $\Rightarrow$ $\boxed{\text{has memory}}$

2.) Time-Invariant?

$$X[n-N] = X_1[n] \xrightarrow{sys} X_1[4n+1] = X[(4n+1) - N] = X[4n+1-N] \quad (1.)$$

$$y[n-N] = X[4(n-N)+1] = X[4n-4N+1] \quad (2.)$$

$(1.) \neq (2) \Rightarrow \boxed{\text{Time-Variant}}$

3.) Linear?

$$\alpha_1 X_1 + \alpha_2 X_2 \Rightarrow X_3[n] \xrightarrow{sys} X_3[4n+1] = \alpha_1 X_1[4n+1] + \alpha_2 X_2[4n+1] \quad (1.)$$

$$X_1 \xrightarrow{sys} X_1[4n+1] \xrightarrow{\alpha_1}$$

$$X_2 \xrightarrow{sys} X_2[4n+1] \xrightarrow{\alpha_2}$$

$$\oplus \rightarrow = \alpha_1 X_1[4n+1] + \alpha_2 X_2[4n+1] \quad (2)$$

$(1.) = (2) \Rightarrow \boxed{\text{Linear}}$

4.) Causal?

output depends on a future value of the input $\Rightarrow$ $\boxed{\text{not causal}}$

5.) Stable?

if $|x[n]| \le B$, then $|y[n]| = |x[4n+1]| \le B$

$\Rightarrow$ $\boxed{\text{Stable}}$

Question 37

$$\delta[n] \xrightarrow[LTI]{system} 2^n e^{-jn} u[n-1]$$

1.) $x[n] = \delta[n-1] \xrightarrow{sys} y[n] = ?$

because system is Time-Invariant $x[n-N] \xrightarrow{sys} y[n-N]$

$$y[n-1] = \boxed{2^{n-1} e^{-j(n-1)} u[n-2]}$$

2.) $x[n] = u[n] - u[n-2]$

$= \delta[n] + \delta[n-1]$

use linearity and time invariance to say

$$\boxed{y[n] = 2^n e^{-jn} u[n-1] + 2^{n-1} e^{-j(n-1)} u[n-2]}$$

Question 38

1.30)

a.) $y(t) = x(t-4)$

let $t' = t-4 \Rightarrow t = t'+4$

$x(t) = y(t'+4)$

$\Rightarrow$ $\boxed{\text{invertible with } x(t) = y(t+4)}$

b.) $y(t) = \cos(x[t])$

$x(t) = \cos^{-1}(y(t))$, but cosine is periodic with period 2π

$$x_1(t) = x(t) \xrightarrow{sys} \cos(x(t))$$
$$x_2(t) = x(t) + 2\pi \qquad \cos(x(t)+2\pi) = \cos(x(t))$$

different input produced the same output $\Rightarrow$ $\boxed{\text{not invertible}}$

c.) $y[n] = n\,x[n]$

$x[n] = \dfrac{y[n]}{n}$ unable to reconstruct input at index 0

$$\delta[n] \xrightarrow{sys} 0 \qquad \Rightarrow \boxed{\text{not invertible}}$$
$$2\delta[n] \xrightarrow{sys} 0$$

e.) $y[n] = \begin{cases} x[n-1] & n \geq 1 \\ 0 & n = 0 \\ x[n] & n \leq -1 \end{cases} \longrightarrow$ $\boxed{x[n] = \begin{cases} y[n+1], & n \geq 0 \\ y[n], & n \leq -1 \end{cases} \quad \text{Invertible}}$

Question 39

1.30)

f.) $y[n] = x[n]\,x[n-1]$

because the system multiplies the input with a time delayed version of the input, the ability to determine the sign of the input is lost

$$x[n] \xrightarrow{sys} x[n]\,x[n-1]$$
$$-x[n] \xrightarrow{sys} (-x[n])(-x[n-1]) = x[n]\,x[n-1]$$

$\Rightarrow$ $\boxed{\text{not invertible}}$

g.) $y[n] = x[1-n]$

$n' = 1-n \Rightarrow n = 1-n'$

$x[n'] = y[1-n']$

$\boxed{\text{invertible with } x[n] = y[1-n]}$

j.) $y(t) = \dfrac{dx(t)}{dt}$

$x(t) = \int y(t)\,dt$

recall that integration results in an additional $+c$ term that can only be determined given initial conditions. This results from many functions having the same derivative

$\frac{d}{dt}(x) = 1$ and $\frac{d}{dt}(x+c) = 1$ where $c \in \mathbb{R}$

$\Rightarrow \boxed{\text{not invertible}}$

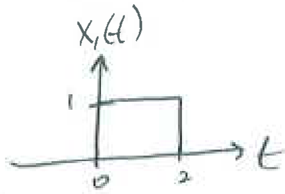
n.) $y[n] = \begin{cases} x[n/2] & , n \text{ even} \\ 0 & , n \text{ odd} \end{cases}$

$\boxed{x[n] = y[2n]}$
invertible

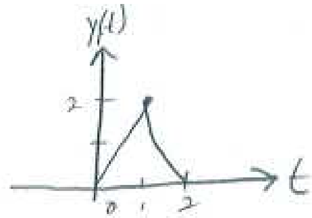
Question 40

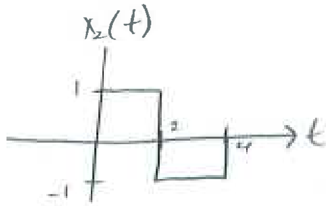
1.31)

a.)



LTI System $\longrightarrow$

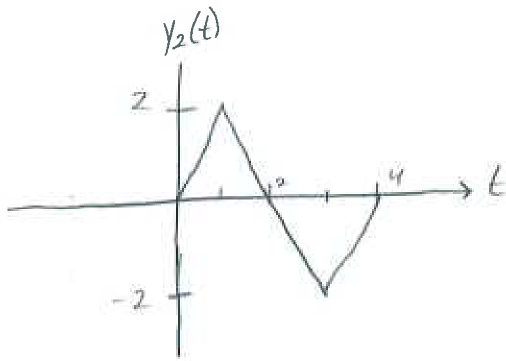




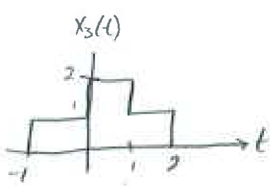
LTI System $\longrightarrow$?

$$X_2(t) = X_1(t) - X_1(t-2)$$

System is LTI $\rightarrow$ time shifts and linear combinations hold



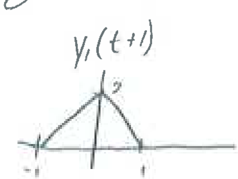
b.)

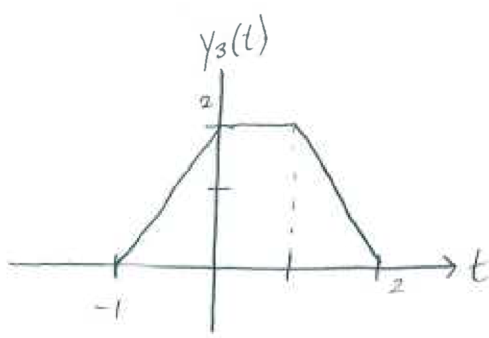


$$X_3(t) = X_1(t) + X_1(t+1)$$

System is LTI so time shifts + linear combinations hold

+





Question 41

$\boxed{1.43}$ a) Since the system is time-invariant,

$$x(t+T) \longrightarrow y(t+T)$$

and $$x[n+N] \longrightarrow y[n+N]$$

Therefore, $y(t)/y[n]$ is also periodic with period T/N

Question 42 - Optional

$\boxed{1.62}$ a) True

b) False $\quad y_1(t) = x(t) + 1$, $\quad y_2(t) = x(t) - 1$ — both nonlinear, but linear when connected in series

c) $$y_1[n] = \begin{cases} x[n/2], & n \text{ even} \\ 0, & n \text{ odd} \end{cases}$$

$$y_2[n] = x[n] + \frac{1}{2}x[n-1] + \frac{1}{4}x[n-2]$$

$$y_3[n] = x[2n]$$

$$y[n] = y_1[2n] + \frac{1}{2}y_1[2n-1] + \frac{1}{4}y_1[2n-2]$$

$$\boxed{y[n] = x[n] + \frac{1}{2}x[n-1] + \frac{1}{4}x[n-2]}$$

LTI system