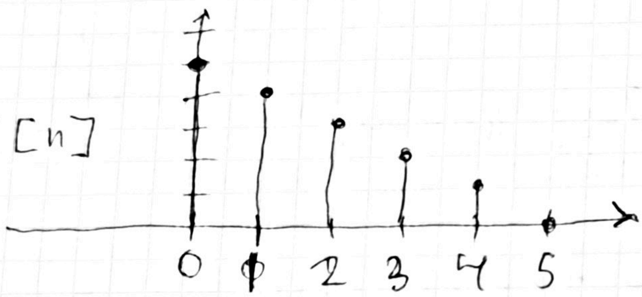
TTT 4120 Digi sig Øving 1

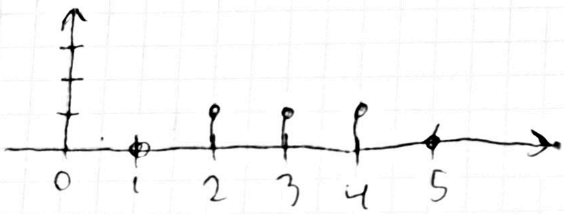
a)
$$x[n] = \begin{cases} 5 - n & n \in [0,4] \\ 0 & \text{else} \end{cases}$$

$$y[n] = \begin{cases} 1 & n \in [2,4] \\ 0 & \text{else} \end{cases}$$

x[n]

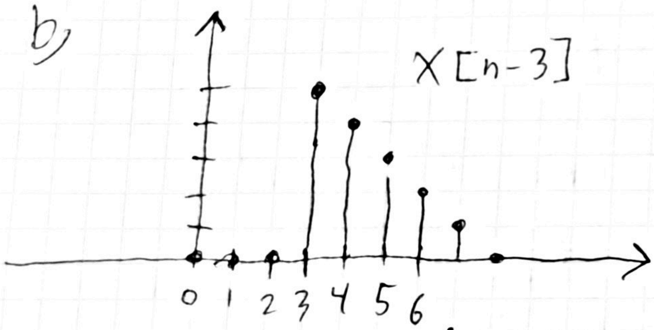


y[n]

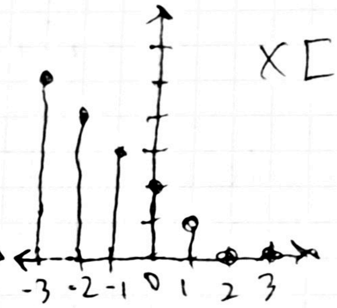


b)

x[n-3]

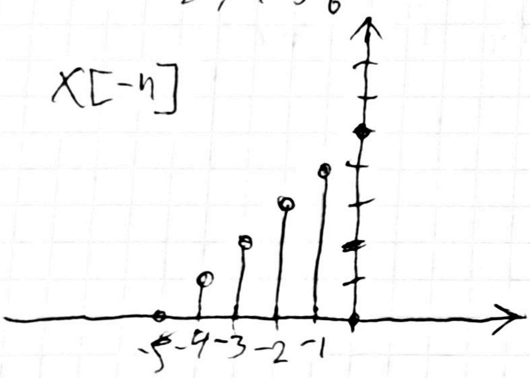


x[n+3]

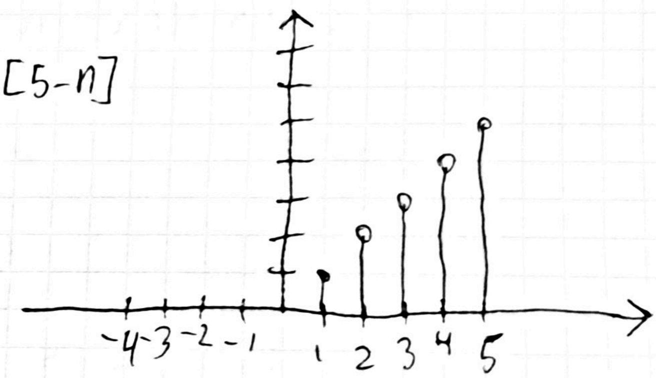


c)

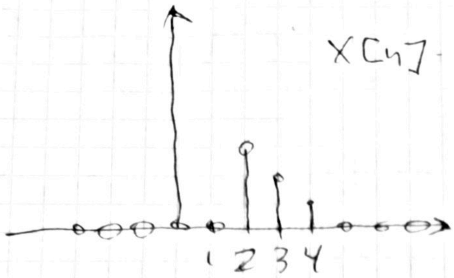
x[-n]



x[5-n]



e) $x[n] \cdot y[n]$



f) $k = n$.. hele

$$x[n] = 5\delta[k] + 4\delta[k-1] + 3\delta[k-2] + 2\delta[k-3] + \delta[k-4]$$

g) $\underline{y[n] = u[n-2] - u[n-4]}$

h) $= \sum_{i=-\infty}^{\infty} |x[i]|^2 = 25 + 16 + 9 + 4 + 1 = \underline{\underline{55}}$

oppg 2)

a) gitt $F_s = 6000\,Hz$

bur de f_1 kunne svare til alle frekvenser $F_1 < 3000\,Hz$ uten at vi mister informasjon c)

1K Hz, sligthly low tone, ~~so~~ mono tone beeb

3KHz, higher the pitch than 1k, still mono tone, annoying sound.

12KHz, very high pitch, mono tone very very annoying sound..

d) $F_s = 8KHz$

$F_1 = 1kHz$

$F_2 = 3KHz$

$F_3 = 6kHz$

$$f_i = \frac{F_i}{F_s} \Rightarrow f_1 = \underline{\underline{\frac{1}{8}}}, \quad f_2 = \underline{\underline{\frac{3}{8}}} \quad f_3 = \underline{\underline{\frac{3}{4}}}$$

1K, same as before

3k, still annoying

6k, some where inbetween ~~6~~ and 12k

3

a) $y[n] = x[n] - x^2[n-1]$

causal, nonlinear

time-invariant

b) $y[n] = n\,x[n] + 2\,x[n-2]$

causal, linear,

not time-invariant.

c) $y[n] = x[n] - x[n-1]$

causal linear time invariant system (LTI)

d) $y[n] = x[n] + 3\,x[n+4]$

non causal LTI

P4

Sys 1

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

a) ~~$x[1] =$~~

$x = \{ \ldots 0, \underline{1}, 0 \ldots \}$

$y[0] = 1$ $\quad y = \{ \underline{1}, 2, 1 \}$

$y[1] = 2$

$y[2] = 1$

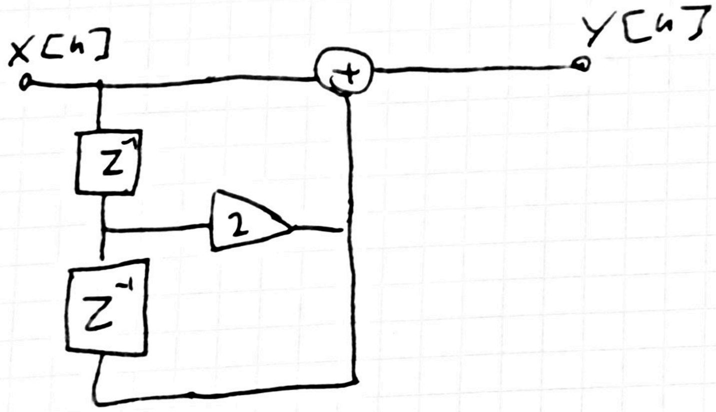
$y[3] = 0$

$\vdots$

b) FIR, output only dependent on input signal not system state.

c) stable, all FIR systems are stable.

d)



P4

Sys 2

$$y[n] = -0{,}9\, y[n-1] + x[n]$$

$$Y(z) = -0{,}9\, Y(z) z^{-1} + X(z)$$

$$(1 + 0{,}9 z^{-1}) Y(z) = X(z)$$

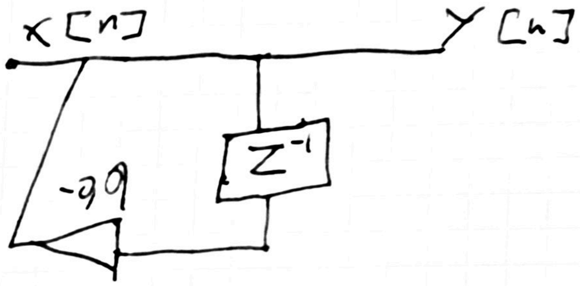
$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1 + 0{,}9 z^{-1}} = \frac{z}{z + 0{,}9}$$

$$\underline{h[n] = (-0{,}9)^n}$$

b) IIR, state dependent system
ie, feed back

c) negative feed back $\Rightarrow$ stable.

d) ?



P5

$$x[n] = \begin{cases} n+1 & n \in [0,2] \\ 0 & \text{else.} \end{cases}$$

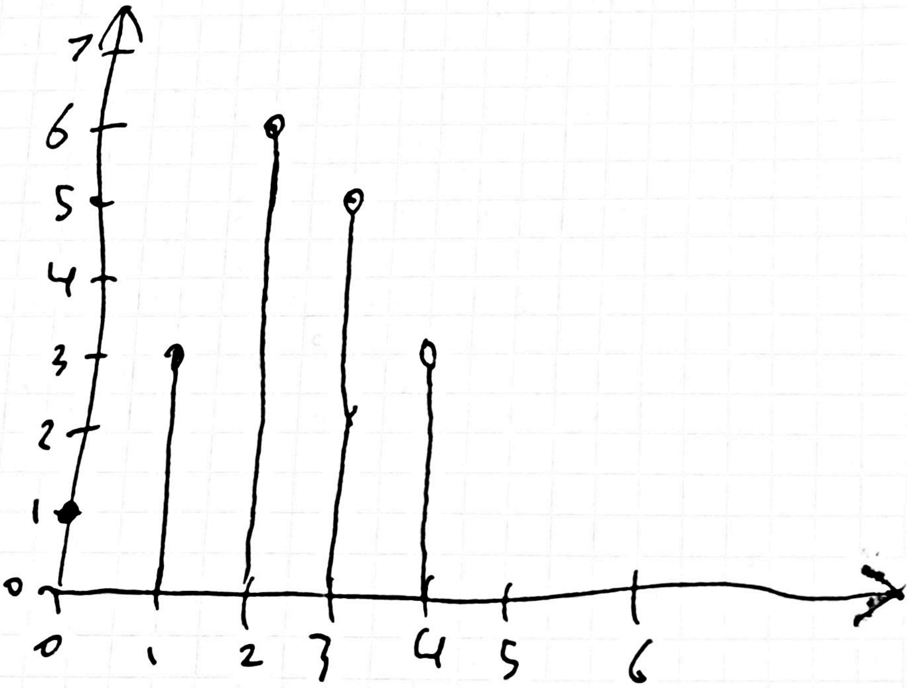
$$h_1 = \delta[n] + \delta[n-1] + \delta[n-2]$$

$$h_2 = \begin{cases} 0{,}9^n & 0 \le n \le 10 \\ 0 & \text{else.} \end{cases}$$

a) $y_1 = x[n] * h_1[n]$

~~$y_1[0] = 1 + 0 + 0 = 1$~~
~~$y_1[1] = 2 + 1 + 0 = 3$~~
~~$y_1[2] = 3 + 2 + 1 = 6$~~
~~$y_1[3] = 0 + 3 + 2 = 5$~~
~~$y_1[4] = 0 + 0 + 3 = 3$~~

$y_1[0] = 1$
$y_1[1] = 3$
$y_1[2] = 6$
$y_1[3] = 5$
$y_1[4] = 3$



c)

$len(x[n]) = 3$ $\quad$ $len(x * y) = len(x) + len(y) - 1$

$len(h_1[n]) = 3$

$len(h_2[n]) = 11$

$len(x * h_1) = 3 + 3 - 1 = 5$

$len(y_1 * h_2) = 5 + 11 - 1 = \underline{15}$

$\frac{15}{3} = 5 \times$ longer.

d)

~~the filter order is not relevant,~~

~~this~~

We see that this plot is the same as the one in b)

It is due to the convolution being commutative.

this can most easily be seen in frequency space where convolution is a product