EE 360 D - Lecture 8.

Convolution & Impulse Responses

Friday, October 1st, 2021

$$\underset{a_0}{y[n]} - \underbrace{2r\cos(w_0)}_{a_1} y[n-1] + \underbrace{r^2}_{a_2} y[n-2] = \underbrace{r\sin(w_0)}_{b_1} x[n-1]$$

$b_0 = 0$

LTI!

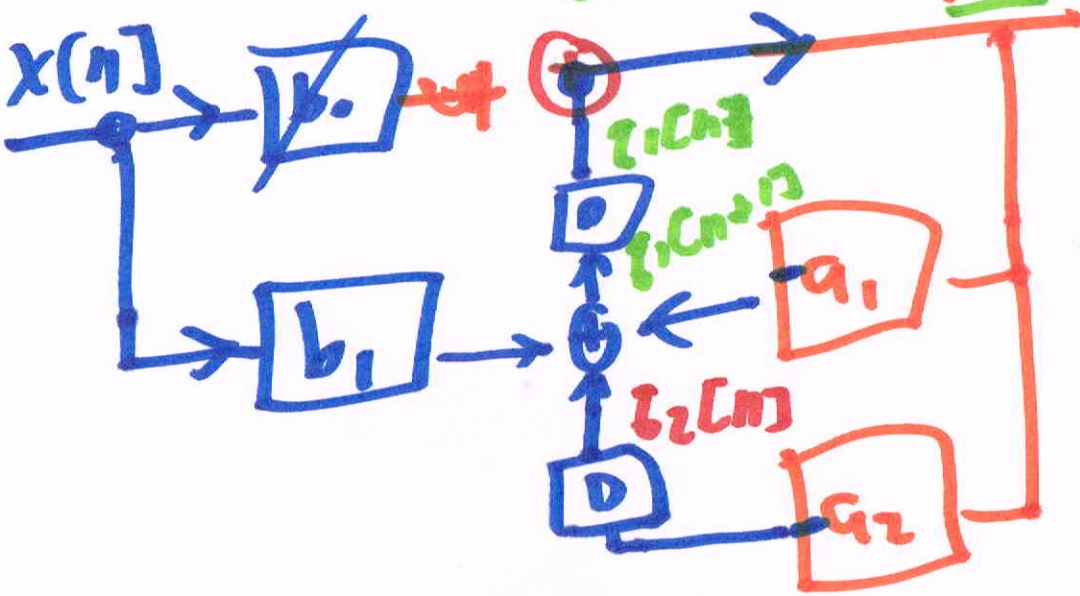
$a_0 y[n] + a_1 y[n-1] + a_2 y[n-2] = b_1 x[n-1]$

TDF II

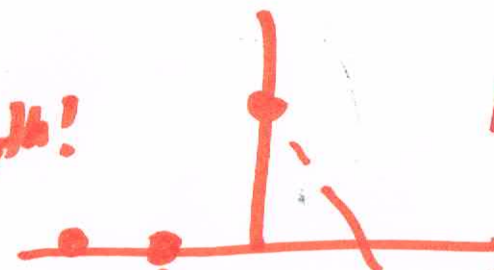
$b_0 = 0$

$q_1[n]$

$y(n) = \cancel{b_0 x[n]} + q_1[n]$



x



Prelength!

n = 0

n=-2

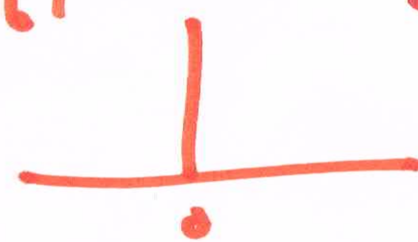
n=-1

$x = [0 \quad 0 \quad 1, \text{zero}(1, \text{end})$

Array

$q_2[n+1]$

$q_1[n]$



zero(1, prelength); n=

$q_1 = [0, \; 0, \; 0, \; \text{zero}(1,\text{end})$

n=-2 n=-1 n=0

gz = [zeros(1, length(n))]

n=1 → 50

x = [0, 0, 1 0, zeros(1, end/length)]

δ[n]

n=-2, -1   n=0

ZIR

gz = [0, 0, r*sin(w0), zeros(1, end length)]

n=-2   n=-1   n=0

zeros(1, pfclength)

2

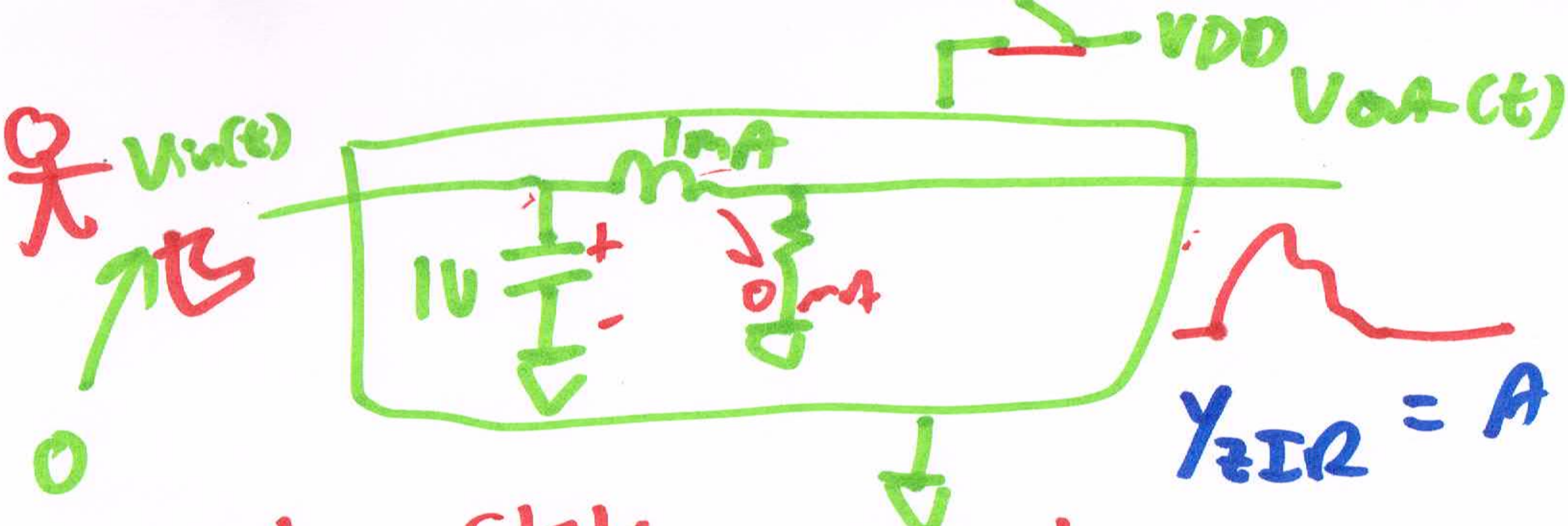
$y = [-r^{-2}\sin(2w_0), -r\sin(w_0),$

n=-2   n=-1   n=0

ZIR = Zero Input Response!

$[-r^{-2}\sin(2w_0),\ -r\sin(w_0),\ 0$

n=-2   n=-1   n=0

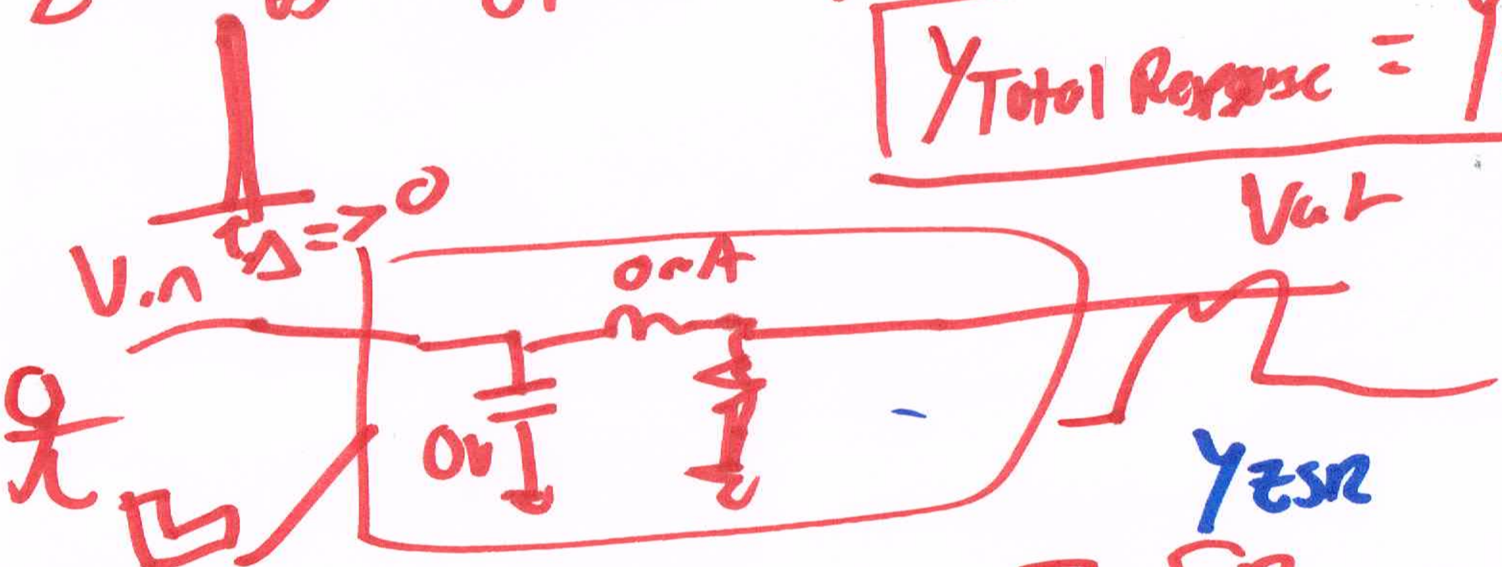


$Y_{ZIR} = A$

ZIR!

State of our system!

$$\boxed{Y_{\text{Total Response}} = Y_{ZIR} + Y_{ZSR}}$$



Y_{ZSR}

Kick the box (system)

ZSR

Zero State Response!

Ex2

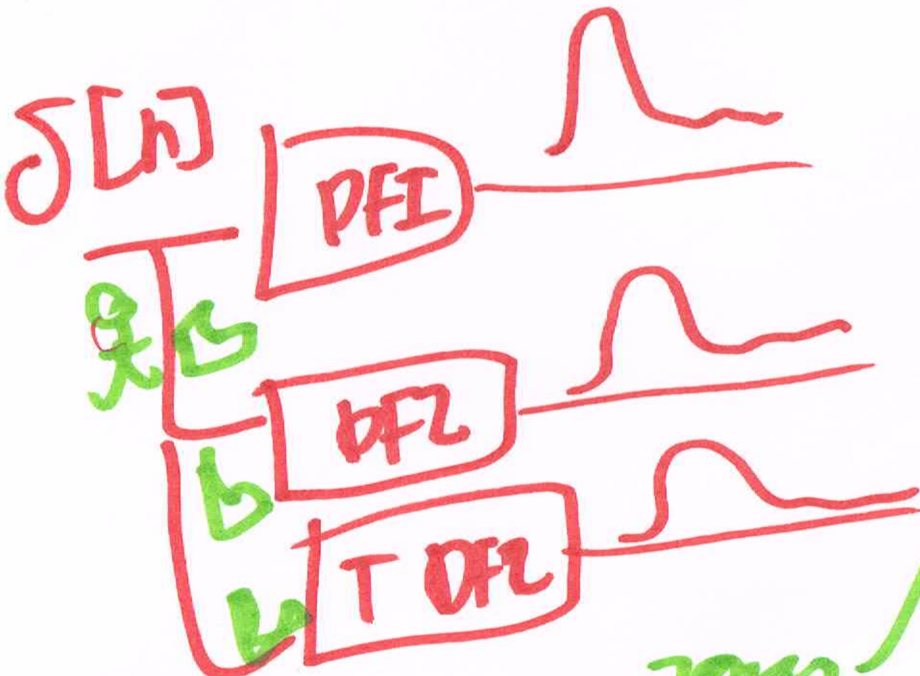
x = [zeros(1, prelength), 1, zeros(1, ...)]

# of Delays

0

n=50

δ[n]



Ex3

ZIR

$q_1 = [0, A, B]$

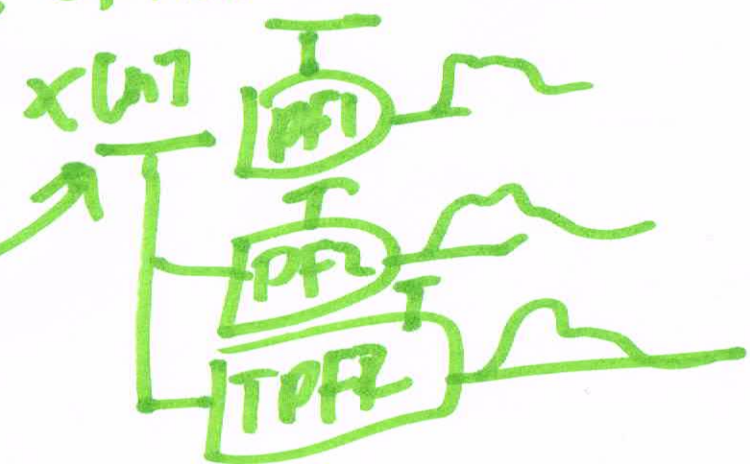
n=-2 n=-1 n=0

States!

q = zeros
1,2

ZSR

y = zeros



$A = [a_0, a_1, a_2]$

$B = [\underline{b_0}, b_1, \underline{b_2}]$

$Y = \text{filter}(B, A, \delta)$

$h(0) = b_0$

$h(1) = b_1$

$h(8) = b_{8}$

$\delta(1-0) = \cancel{\delta}(1)$

$\delta(1-1) = \delta(0)$

$$Y = \sum_{k=0}^{k=N=3} b_n x(n-k) = b_0 \underline{x(n-0)} + b_1 \underline{x[n-1)} + b_2 \underline{x[n-2)} + b_3 \underline{x[n-3)}$$

$n=0$

$x(n) = \delta(n]$

$x[n-1) = \delta[n-1)$

$n=1$

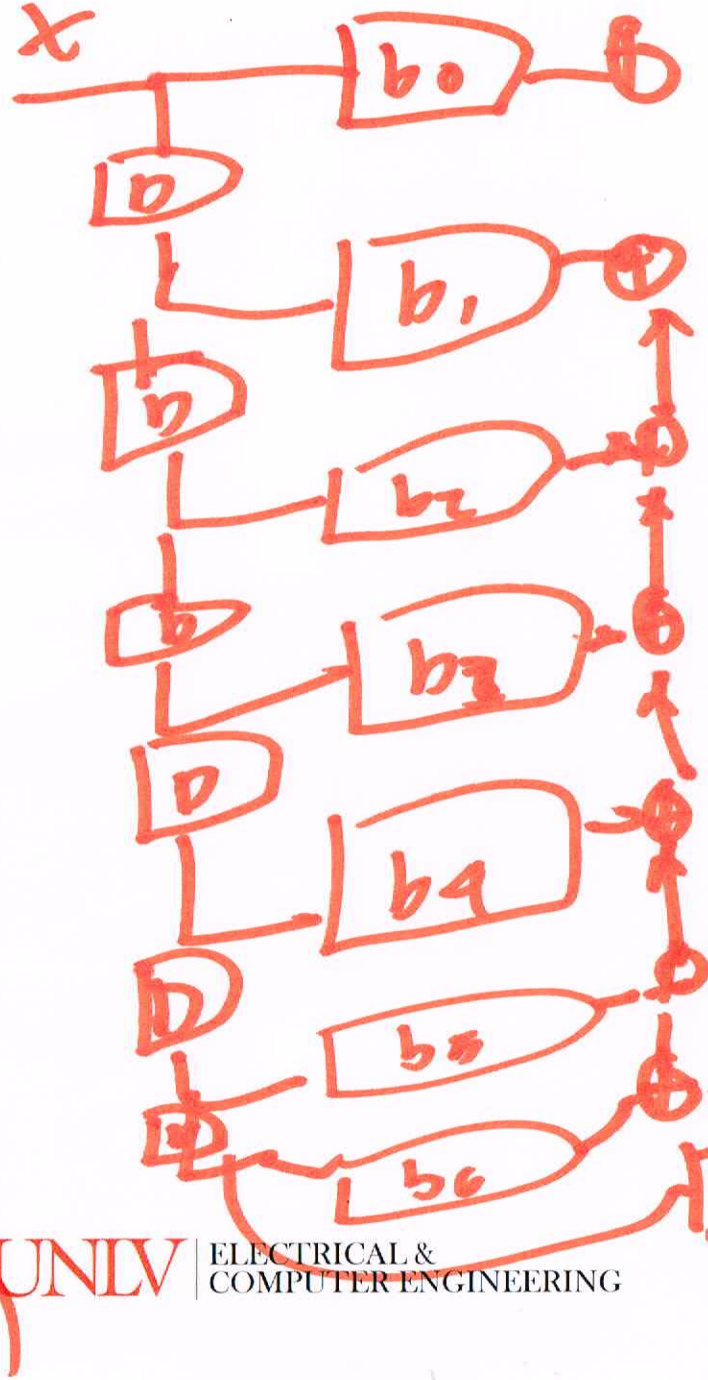
$\underline{h(1)} = \underline{b_1}$

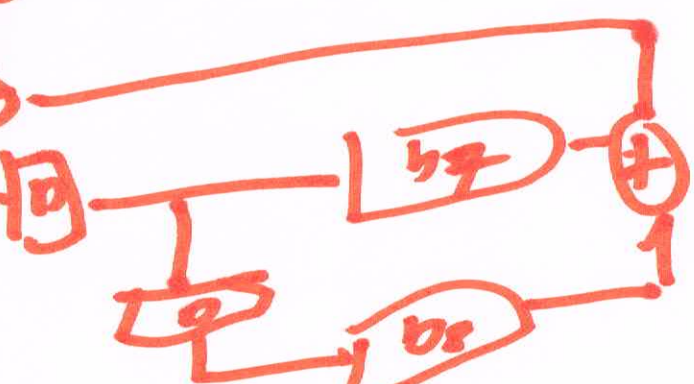
$n=1$

$h(2) = b_2 \ldots$

6)

$c(n) =$



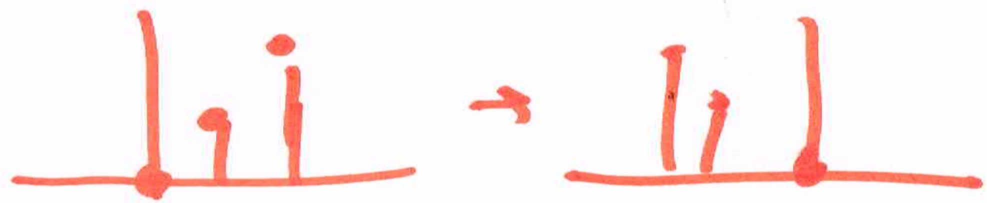


Convolut.n

$$y(n) = \sum_{+\infty}^{+\infty} \underline{h(k)}\, \underline{x(n-k)}$$

Same! flip!

x(k) → x(-k)



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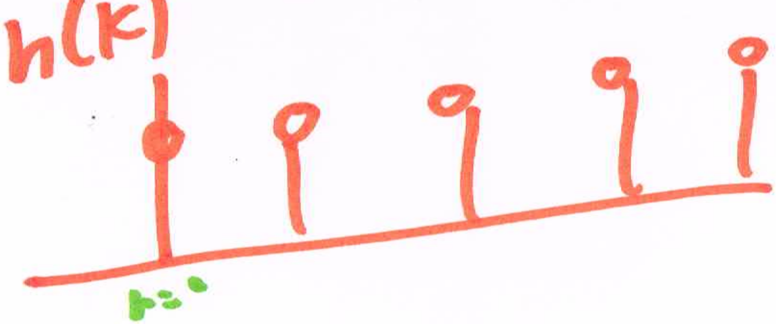
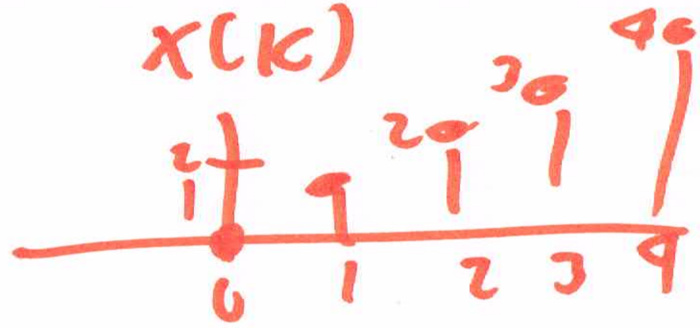
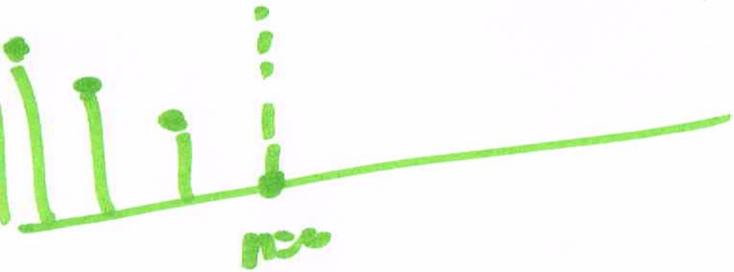
8)





flip!



$$y(n) = \sum_{-\infty}^{\infty} h(k)\, x(n-k)$$

n=0

k=0

n=0

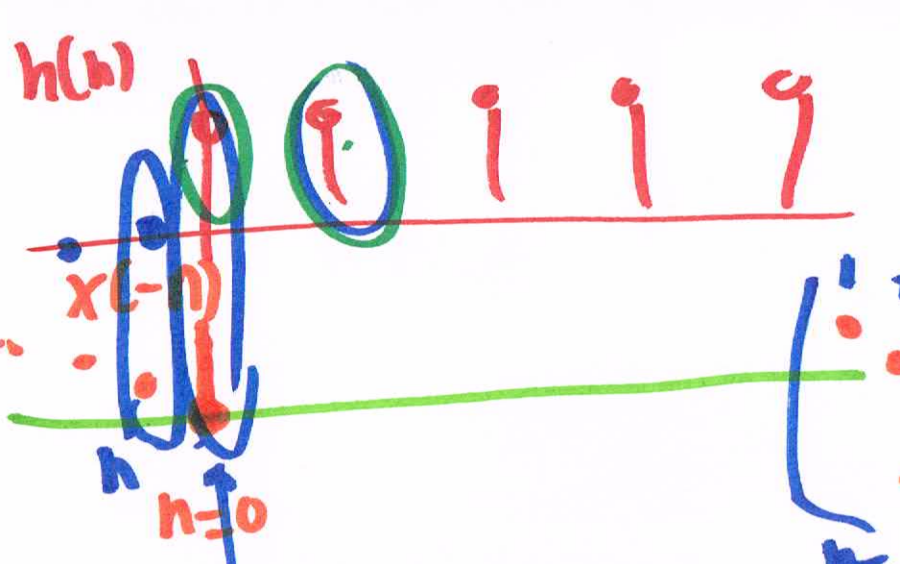
$$y(0) = h(-1)x(1) + h(0)x(0) + h(1)x(-1)$$

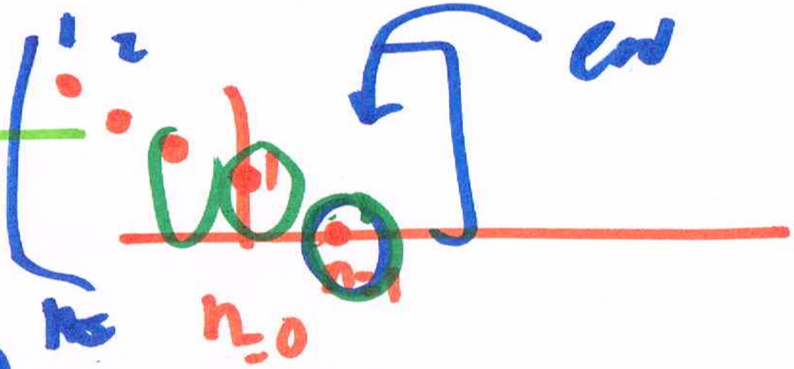
k=-1   k=0   k=1

$$x(1+(+1))$$ k=-1

$$y(n=1) = h(-1)x(2) + h(0)x(1-(0)) + h(1)x(1-(1))$$

k=-1   k=0   k=1





$+h(0)x(0) + h(1)x(-1)$

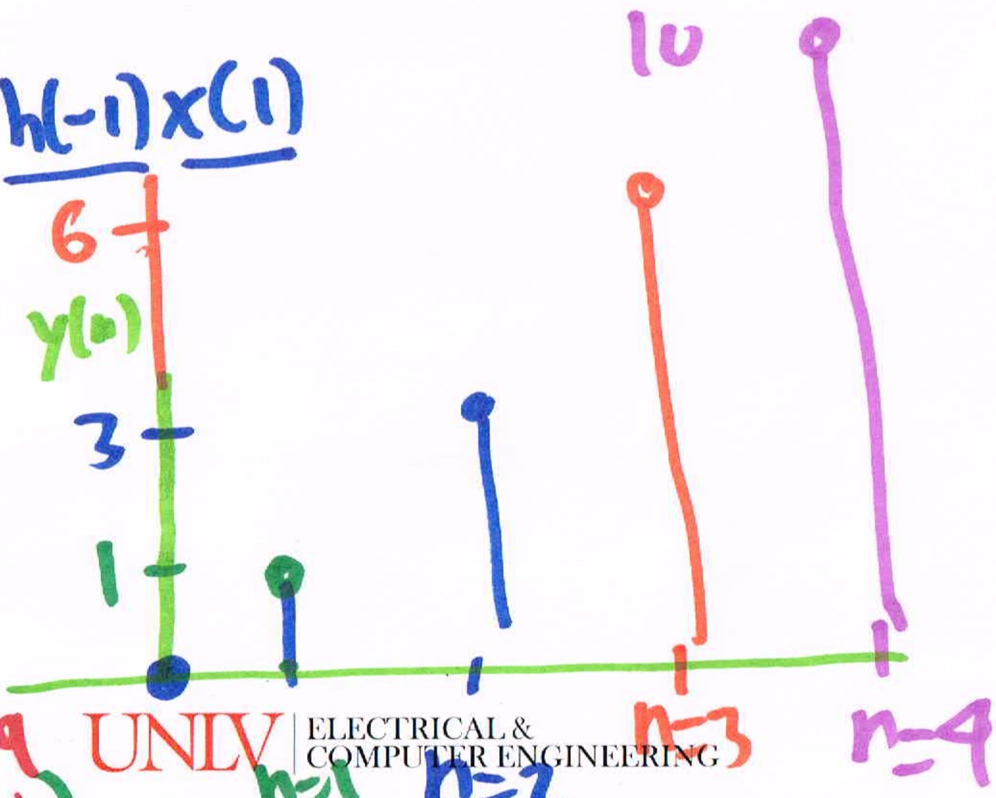
$1 + 0$

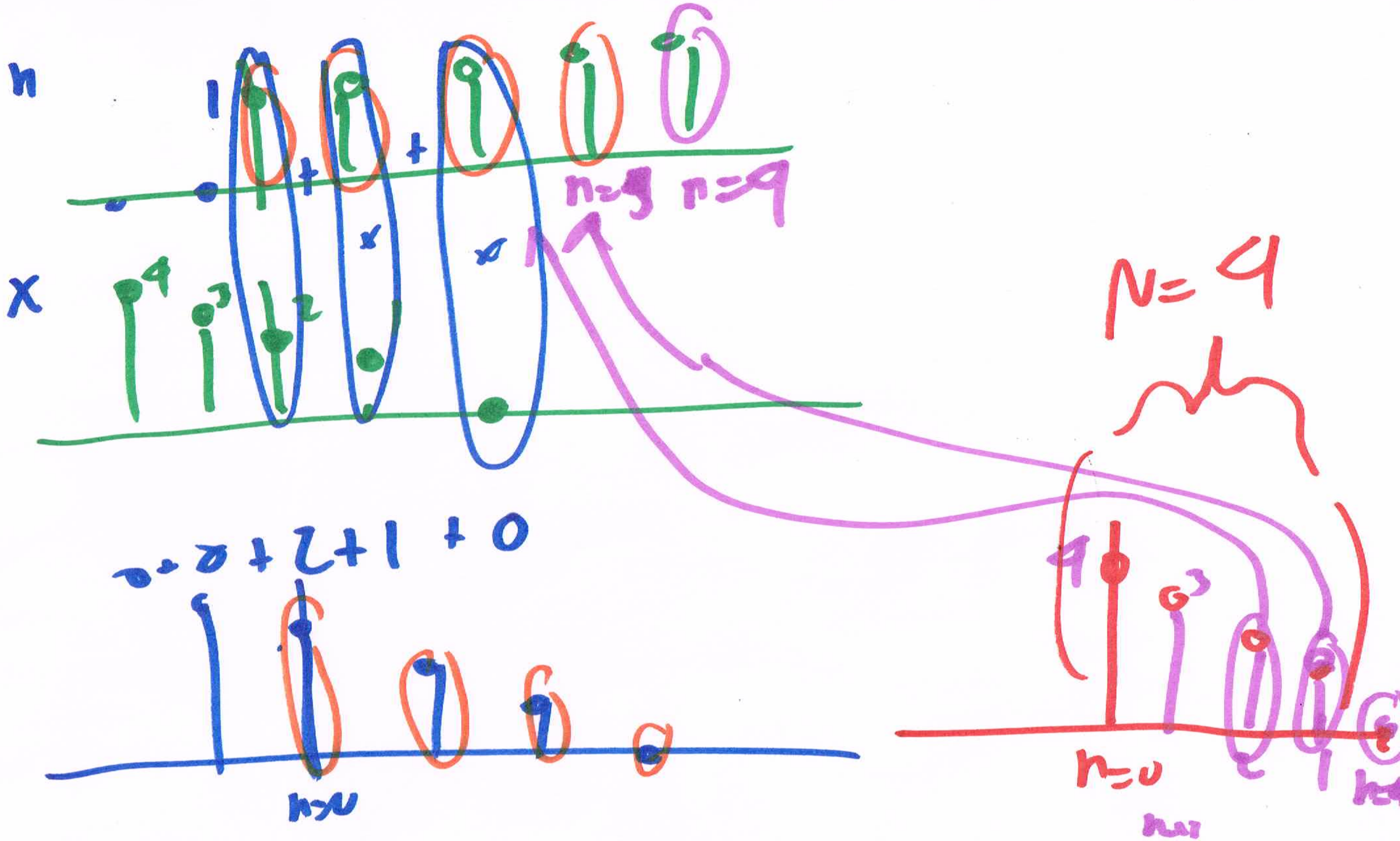
# of Delay

$x(1, \underline{end} : -1 : \underline{end-8})$

$x(1, end)$

$\underline{h(-1)}\,\underline{x(1)}$

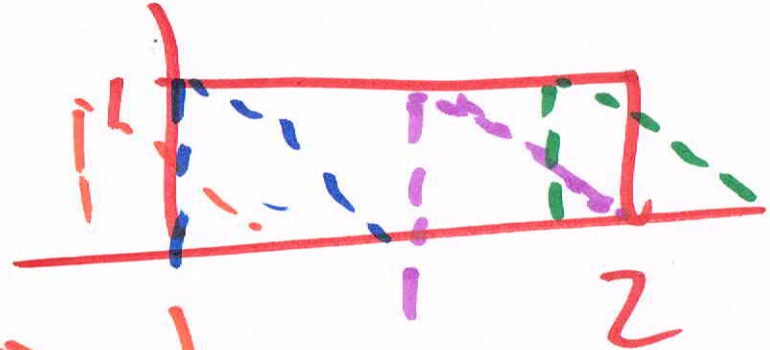


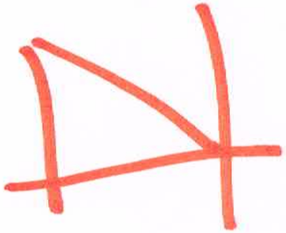


0+0+3+2+1+0 = 6

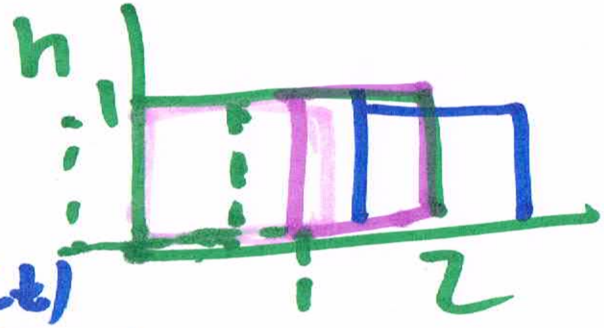
0+4+3+2+1+0

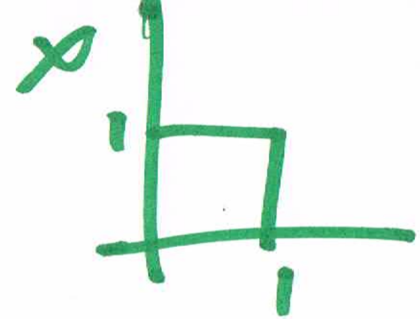
= 10

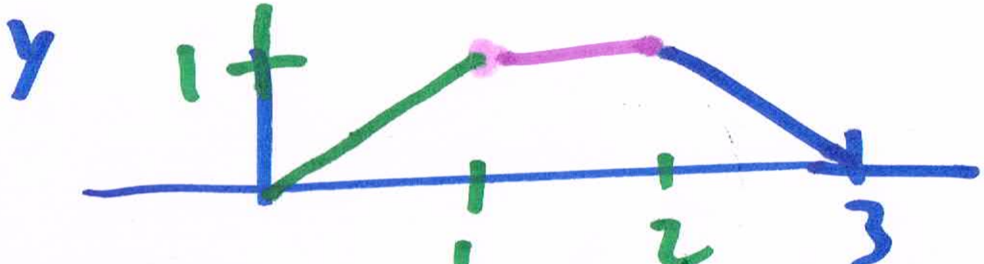


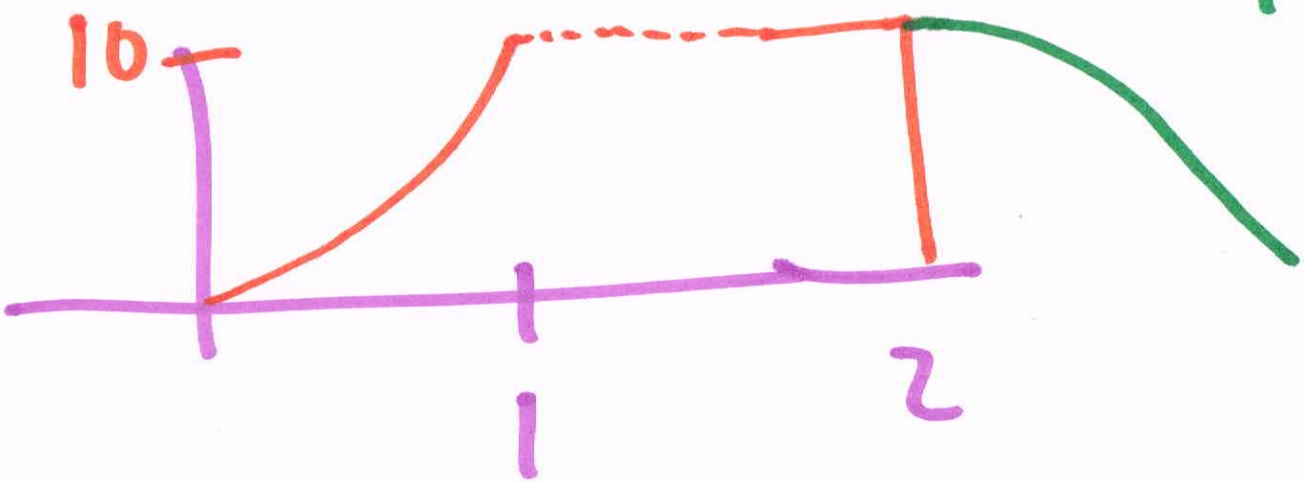


x









$$y = {}^{h}\begin{bmatrix} \underline{h(0)} & \underline{h(1)} & h(2) \end{bmatrix}_{\infty} \begin{bmatrix} \underline{x(0)} \\ \underline{x(1)} \\ x(2) \\ \\ \\ \end{bmatrix}^{x}$$

1X1 = 1 X Delay · Delay X 1

$$h(0)x(0) + h(1)x(1) \ldots$$

$$\ldots h(2)x(2) \ldots$$

(3)

(2)