EE360D L10

Review for Exam 3

Oct. 15th 2021

ZIR

$$x(n) = 0 \longrightarrow \boxed{h(n)} \longrightarrow y_{ZIR}(n)$$

Digital $y[n] - 2r\cdot\cos(w_0)\,y[n-1] + r^2 y[n-2] = r\sin(\cancel{w_0})$ $\cancel{x[n-1]}$

$$y[n] - 2r\cos(w_0)\,y[n-1] + r^2 y[n-2] = 0$$

$$\left[1\lambda^{-0} - 2r\cos(w_0)\,\lambda^{-1} + r^2\lambda^{-2} = 0\right)\lambda^2$$

$\cancel{\lambda^{-N} = y[n-N]}$

$$\lambda^2 - 2r\cos(w_0)\,\lambda^1 + r^2 = 0$$

$\boxed{\lambda^{-N} = y[n-N]}$

minus

1st

DSP:

2nd: Quadratic Eqn $= \lambda = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Euler's Eqn: $\cos(w_0) = \frac{1}{2}\left[e^{+jw_0} + e^{-jw_0}\right]$

2)

$$\lambda^2 - 2r\left[\frac{1}{2}\left\{e^{+j\omega_0} + e^{-j\omega_0}\right\}\right]\lambda + r^2 = 0$$

$$\lambda^2 - \left[re^{+j\omega_0} + re^{-j\omega_0}\right]\lambda + r^2 = 0$$

After Solving

$$\boxed{\lambda_{1,2} = re^{\pm j\omega_0}}$$

$$y_{ZIR}[n] = c_1\lambda_1^n + c_2\lambda_2^n$$

$$\boxed{y_{ZIR}[n] = c_1 re^{+j\omega_0 n} + c_2 re^{-j\omega_0 n}}$$

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3)

① $y[0]=0$

② $y[n=-1] = -r^{-1}\sin(\omega_0)$

$y[n=-2] = -r^{-2}\sin(2\omega_0)$

①

$$y[n=0] = 0 = c_1 r \cancel{e^{+j\omega_0(0)}} + c_2 r \cancel{e^{-j\omega_0(0)}}$$

$$0 = c_1 \cancel{r} + c_2 \cancel{r}$$

$$\boxed{c_1 = -c_2} \rightarrow \boxed{c_2 = -c_1}$$

$j\omega(-1)$ $\quad -j\omega(-1)$

②

$$y[n=-1] = -r^{-1}\sin(\omega_0) = c_1 r e + c_2 r e$$

$$-r^{-1}\sin(\omega_0) = c_1 r e^{-j\omega} + c_2 r e^{+j\omega_0}$$

$$+r^{-1}\sin(w_0) = \left(-C_1 r e^{-jw} + C_1 r e^{+jw}\right)\left(\frac{2j}{2j}\right)$$

Eulers' eqn

$$\sin(w_0) = \frac{1}{2j}\left[e^{+jw_0} - e^{-jw_0}\right]$$

$$r^{-1}\cancel{\sin(w_0)} = r2j\left[\cancel{\sin(w_0)}\right]C_1$$

$$r^{-1} = r2jC_1$$

$$\boxed{C_1 = \frac{1}{2j}r^{-2}}$$

$$\boxed{C_2 = -C_1 = \frac{-1}{2j}r^{-2}}$$

$$y_{ztk}[n] = \left[\frac{1}{2j} r^{-2}\right] r e^{+j\omega_0 n} - \left[\frac{1}{2j} r^{-2}\right] r e^{-j\omega_0 n}$$

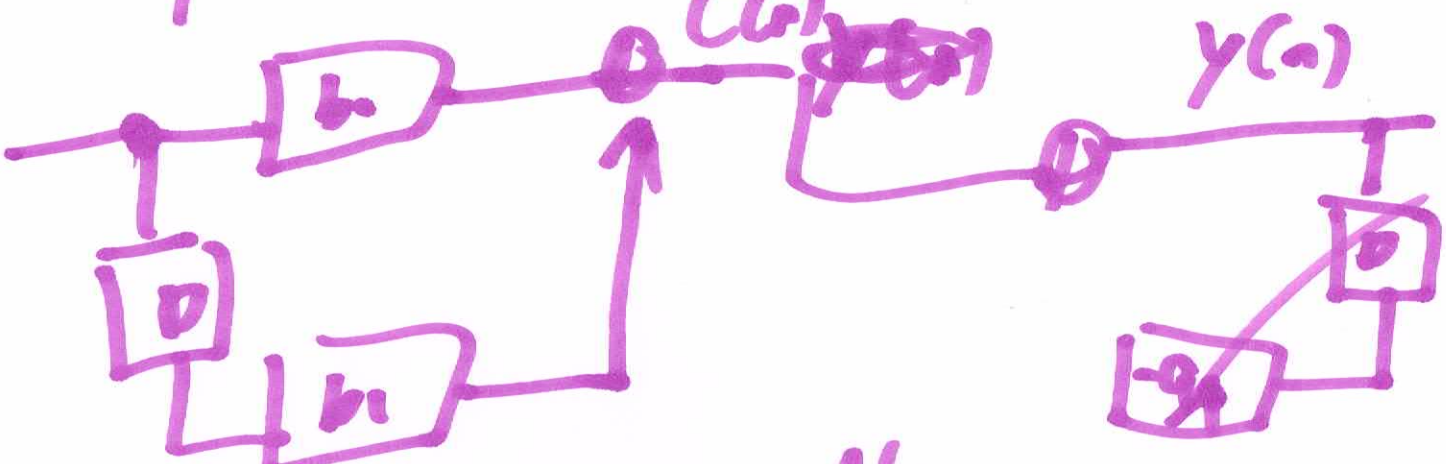
$$= \frac{1}{r^2 j}\left[e^{+j\omega_0 n} - e^{-j\omega_0 n}\right]$$

$$y_{ztk}[n] = r^{n} \sin(\omega_0 n) \cdot u(n)$$

$$|a| < 1$$

$$h[n] = a^{n} u(n)$$

$$y[n] = b_0\, x[n] + b_1\, x[n-1]$$



DFI

No FB!

FIR Filter

Finite Impulse Response

$h = [b_0, b_1, b_2]$ $x = [c_1\ c_2]$

$N_h = 3$ $N_x = 2$

$y = h * x$

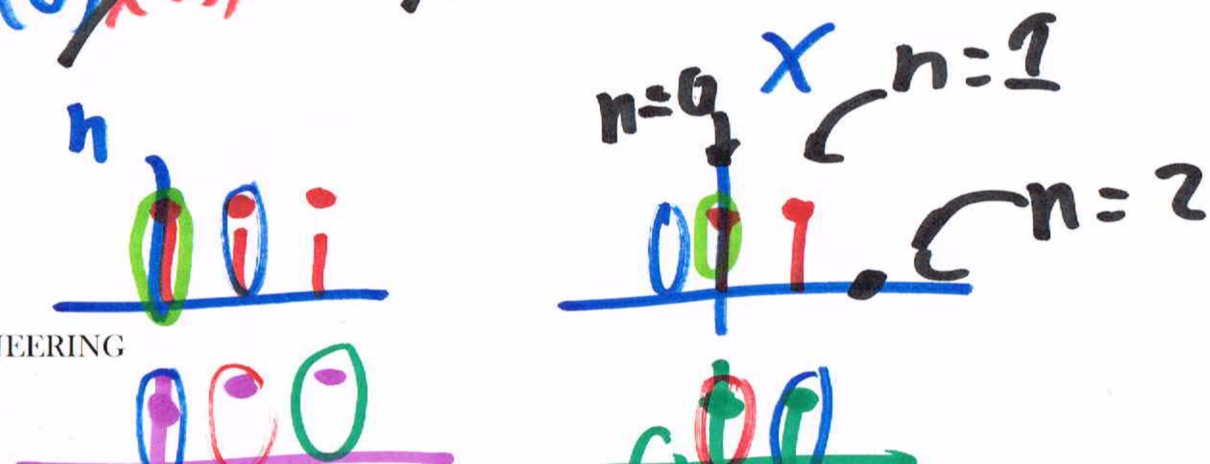
$N_y = N_h + N_x - 1 = 3 + 2 - 1 = 4$

$y[0] = h(0)x(0) + h(1)\cancel{x(-1)} + h(2)\cancel{x(-2)}$

$y[1] = h(0)x(1) + h(1)x(0) + h(2)\cancel{x(-1)}$

$y[2] = h(0)\cancel{x(2)} + h(1)x(1) + h(2)x(0)$

$y[3] = h(0)\cancel{x(3)} + h(1)\cancel{x(2)} + h(2)x(1)$



x

(1×3)

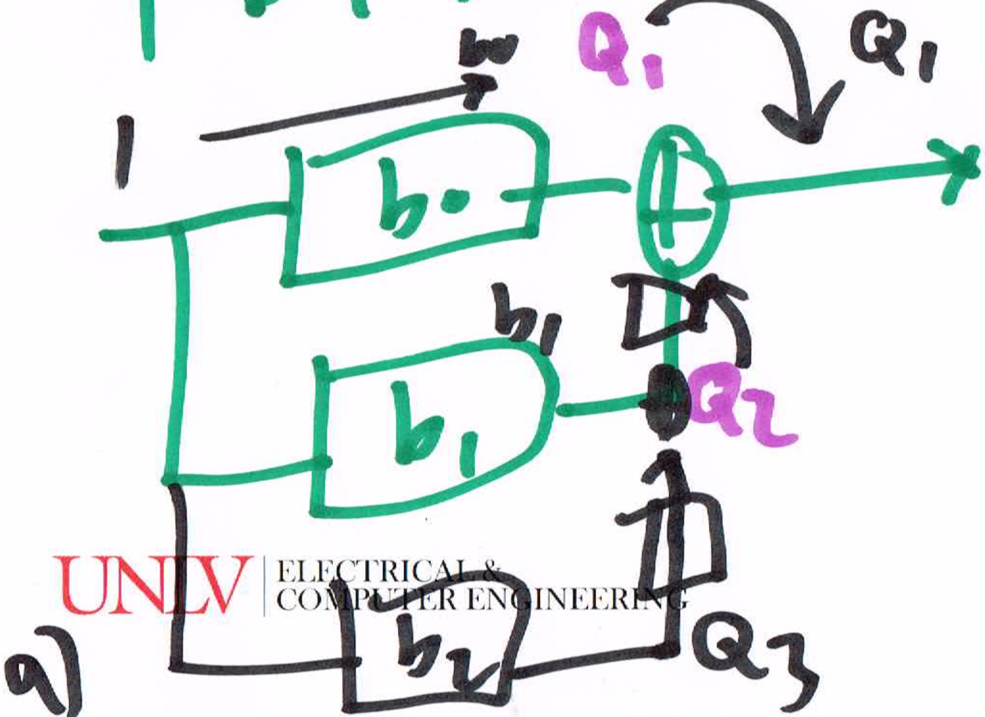
$h \times [x(\text{start}) \quad x(\text{start}-1) \quad x(\text{start}-2) \quad \ldots \quad x(\text{start}-\text{length}(h))]$

start

$[b_0 \; b_1 \; b_2]$

$[3 \times 1]$

TDF II



1. b_0

b_1

Prev!

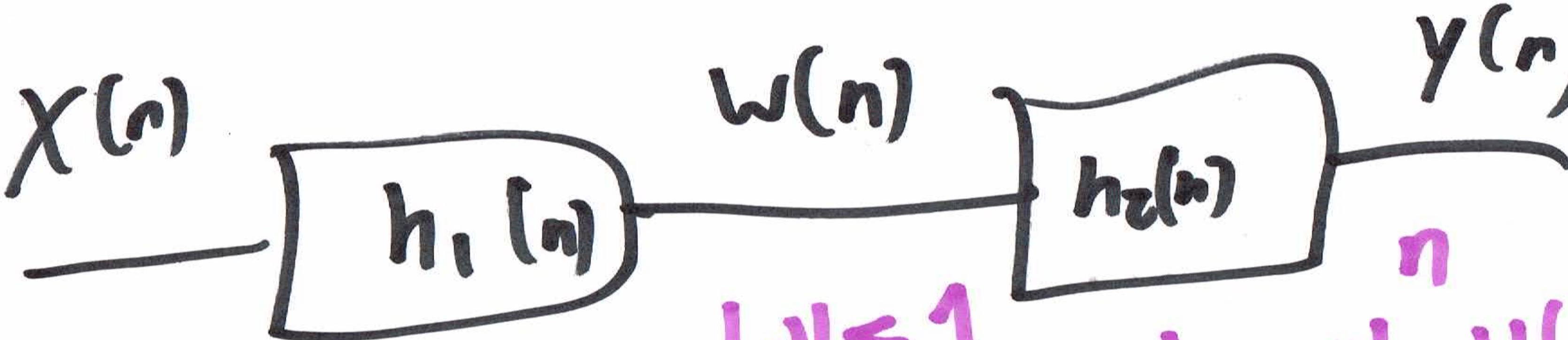
$[1 \times 1] \; [1 \times N]$

$$Q = x(1) \times h + Q$$

$$y = Q(1,1)$$

$$\text{Circshift}(Q, -1)$$

$$Q(\text{end}) = 0$$



$|\alpha| < 1$

$h_1 = \alpha^n u(n)$

$h_2 = \beta^n u(n)$

$w(n) = x(n) * h_1(n)$

$$w(n) = \sum_{k=-\infty}^{k=\infty} x(k)\, h_1(n-k)$$

$n = l$

$$y(n) = w(n) * h_2(n) = \sum_{l=-\infty}^{l=\infty} \left[\sum_{k=-\infty}^{k=\infty} x(k)\, h_1(n-k) \right]$$