EE6401 Assignment

Answer 1:

a) $Y(z)=D_3D_3D_3A(z^9)A(z^3)A(z)X(z)$

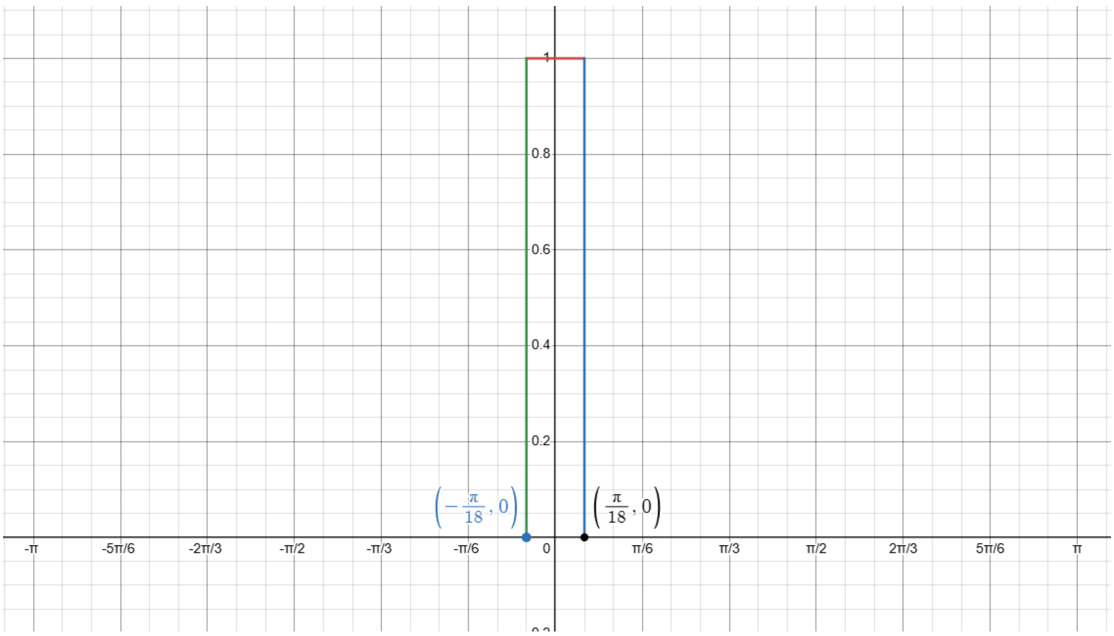
$Y(z)=D_{27}A(z^9)A(z^3)A(z)X(z)$

b) $H(e^{j\omega}) = A(e^{j9\omega})\ A(e^{j3\omega})\ A(e^{j\omega})$

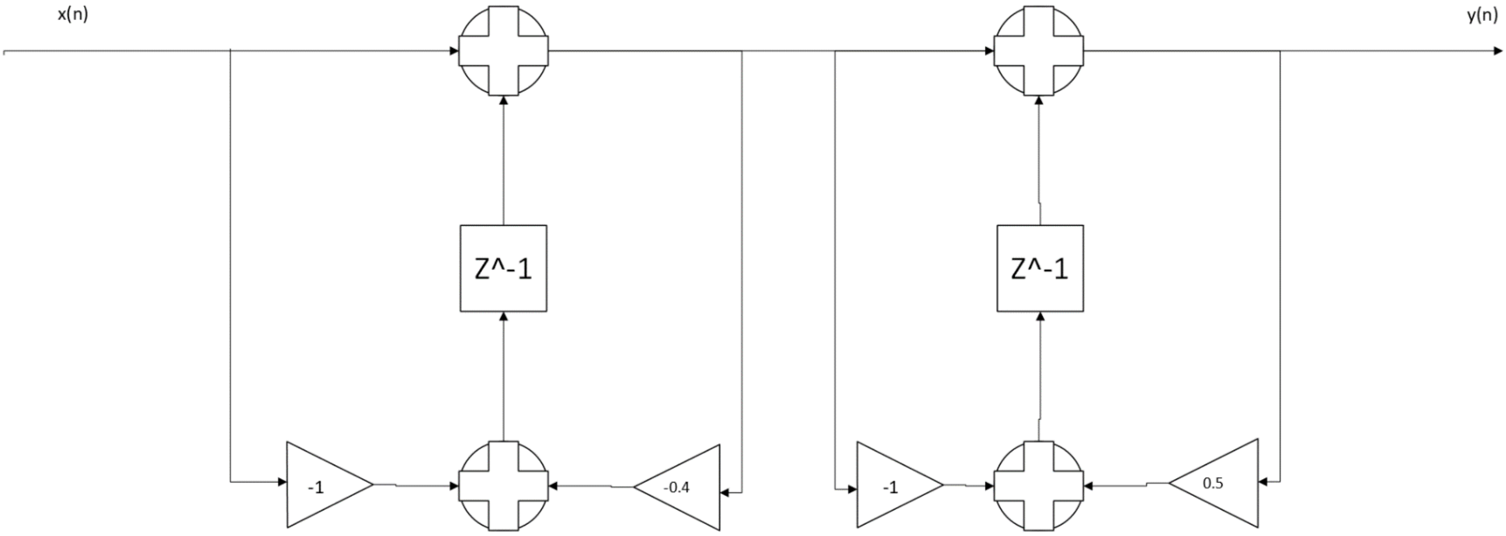
the $\omega_{cutoff}=\frac{\pi}{2} \div 9=\frac{\pi}{18}$ for leftmost A in eq.

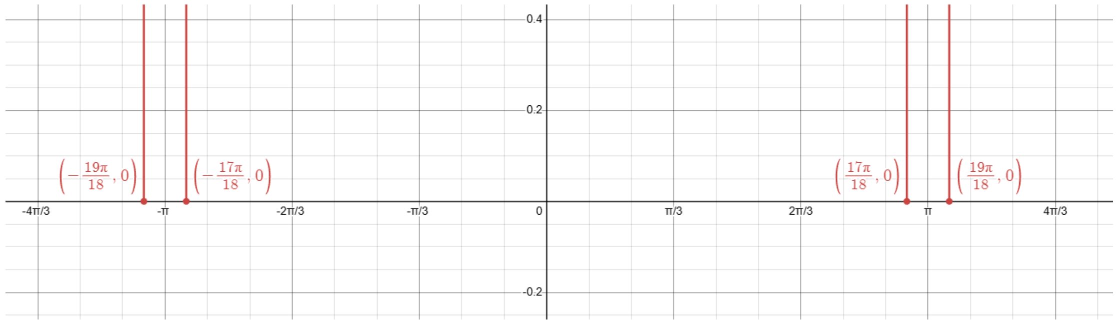
similarly $\frac{\pi}{6}$ for second A, $\frac{\pi}{2}$ for third A

since A is low-pass filter, cascade A will only preserve the lowest frequency(transfer function product), namely $\frac{\pi}{18}$



c) When A is high-pass filter, cascade of A will





Answer 2:

a) w(n) = 0.2y(n) +x(n)

v(n) = -2x(n) + w(n-1) +0.1y(n)

y(n) = x(n) + v(n-1)

= x(n) -2x(n-1) +w(n-2) +0.1y(n-1)

= x(n) -2x(n-1) + 0.2y(n-2) +x(n-2) +0.1y(n-1)

= 0.1y(n-1)+ 0.2y(n-2)+ x(n) -2x(n-1) +x(n-2)

b) transfer function: $H(z) = \frac{Y(z)}{X(z)} = \frac{1-2z^{-1}+z^{-2}}{1-0.1z^{-1}-0.2z^{-2}} = \frac{1-z^{-1}}{1+0.4z^{-1}} \frac{1-z^{-1}}{1-0.5z^{-1}}$

Answer 3:

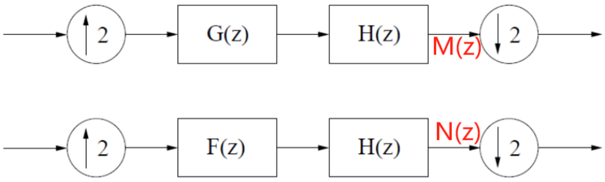
a) Move H_2 to the left of first up sampler, we get $H_2(z^{2*0.5})=H_2(z)$, move H_1 to the rightmost position, $H_1(z^{2*0.5})=H_1(z)$.

The up samplers and down samplers have canceled each other.

Finally, we have entire transfer function of :

$$\frac{Y(z)}{X(z)} = H_1(z)H_2(z)$$

b) We denote intermediate signal as M(z) and N(z) as illustrated in picture



(b)

$$M(z) = H(z)G(z)X(z^2)$$

$$Y_1(z) = \frac{1}{2}\sum_{l=0}^{1} H(z^{\frac{1}{2}}e^{-j\frac{2\pi l}{2}})G(z^{\frac{1}{2}}e^{-j\frac{2\pi l}{2}})X(ze^{-j\frac{2\pi l}{2}2})$$

$$Y_1(z) = \frac{1}{2}(H\left(z^{\frac{1}{2}}\right)G\left(z^{\frac{1}{2}}\right) + H\left(-z^{\frac{1}{2}}\right)G\left(-z^{\frac{1}{2}}\right))X(z)$$

according to the known constraint:

$$H(z)G(z) + H(-z)G(-z) = 2$$

Substitute z by $z^{0.5}$, we have:

$$Y_1(z) = \frac{1}{2}2X_1(z)$$

$$\frac{Y_1(z)}{X_1(z)} = 1$$

Similarly

$$N(z) = H(z)F(z)X(z^2)$$

$$Y_2(z) = \frac{1}{2}\left(H\left(z^{\frac{1}{2}}\right)F\left(z^{\frac{1}{2}}\right) + H\left(-z^{\frac{1}{2}}\right)F\left(-z^{\frac{1}{2}}\right)\right)X(z)$$

$$Y_2(z) = 0X_2(z)$$

$$\frac{Y_2(z)}{X_2(z)} = 0$$