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Q2) $y[n] = -\frac{1}{\sqrt{2}} y[n-1] + \frac{\sqrt{3}-1}{2\sqrt{2}} x[n] - \frac{\sqrt{3}-1}{2\sqrt{2}} x[n-1]$

Cut off = $\frac{5\pi}{6}$

Ans (a) A.T.O

taking y term on side to Apply z transform

$$Y(z) + \frac{z^{-1}}{\sqrt{2}} Y(z) = \frac{\sqrt{3}-1}{2\sqrt{2}} \left(\frac{1-z^{-1}}{(\sqrt{3}+z^{-1})} \right) \times \sqrt{2}$$

$$H(z) = \frac{\sqrt{3}-1}{2} \frac{(1-z^{-1})}{(\sqrt{3}+z^{-1})} = \left[\frac{1-1/\sqrt{3}}{2} \frac{(1-z^{-1})}{(1+\frac{1}{\sqrt{3}}z^{-1})} \right]$$

here $\alpha = 1/\sqrt{3}$; ①

(b) This is IIR high pass filter because its form is similar to IIR high pass filter $\left[\frac{(1-\alpha)}{2} \left(\frac{1-z^{-1}}{1+\alpha z^{-1}} \right) \right]$

(c) we know IIR high pass has form $= \left(\frac{1-\alpha}{2} \right) \left(\frac{1-z^{-1}}{1+\alpha z^{-1}} \right)$

So $\alpha = \frac{1}{\sqrt{3}}$ from ①

$$\omega_c = \pi - \cos^{-1} \left(\frac{2/\sqrt{3}}{1+1/\sqrt{3}} \right)$$

$$\omega_c = \pi - \cos^{-1} \left(\frac{\sqrt{3}}{2} \right) \Rightarrow \pi - \pi/6 \Rightarrow \boxed{\omega_c = \frac{5\pi}{6}}$$

$$\boxed{\text{cut off freq} = \frac{5\pi}{6}}$$

Ans (d) Inside zip file $M = [0.211, -0.211]$ $B = [1, 0.57735]$ using calculator

Q1) Ans (a) From the figure we can say that we have cascaded system since $H(z) = H_1(z) \cdot H_2(z) \cdot H_3(z)$ and $[H_1(z) = H_2(z) = H_3(z)]$

$$H(z) = (H_1(z))^3 \quad \left[Y(z) = X(z) \left(\frac{1}{4} + \frac{z^{-2}}{2} + \frac{1}{4}z^{-4} \right) \right]$$

$$H(z) = \left(\frac{1}{4} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-4} \right) = \frac{1}{4} \left(\frac{1+z^{-2}}{2} \right)^2 \quad \left[\text{using } (a+b)^2 = a^2 + b^2 + 2ab \right]$$

for Lth order system

$$\boxed{H(z) = (H_1(z))^3 \Rightarrow \left(\frac{1+z^{-2}}{2} \right)^3} \quad \leftarrow \text{transfer function}$$

(b) We know filter of this type $\frac{1}{2^m} (1+z^{-1})^m$ is cascading
FIR low filter
hence it is FIR low cascading filter

(c) A.T.O $\omega_c = 2 \cos^{-1} (2^{-1/2 \times 6})$

$$= 2 \cos^{-1} (0.94) = \omega_c$$

$$\Rightarrow \omega_c = 0.6738$$

← Cut off frequency

Q3) Inside zip file