ECE 351 DSP: Practice Problems 4

Instructor: Manuj Mukherjee

1) Consider a cascaded FIR high pass filter of M stages, whose cutoff frequency must be greater than $\frac{2\pi}{3}$.
   a) What is the minimum M needed to achieve this?
   b) Suppose you are using the filter with minimum M. Now, suppose you wish to filter an long input sequence using this filter via overlap-and-save method. Assume you are allowed to do 16 point DFTs. At what length should the input sequence be segmented to enable overlap-and-save method via 16-point DFTs?
2) Identify the filter implemented with lattice reflection coefficients $K_2 = \frac{1}{3}, K_1 = -\frac{1}{2}$, and ladder coefficients $v_0 = \frac{1}{3}, v_1 = -\frac{2}{9}, v_2 = -\frac{1}{3}$. Find its centre/notch frequency (whichever is applicable) and 3-dB bandwidth.
3) Consider the transpose form implementation shown in Figure 1.
   a) Identify the filter type.
   b) Identify its cutoff frequency.
   c) Suppose we build a comb filter using this with $L = 3$. Find all the $\omega \in (-\pi, \pi]$ where the magnitude response is 0.

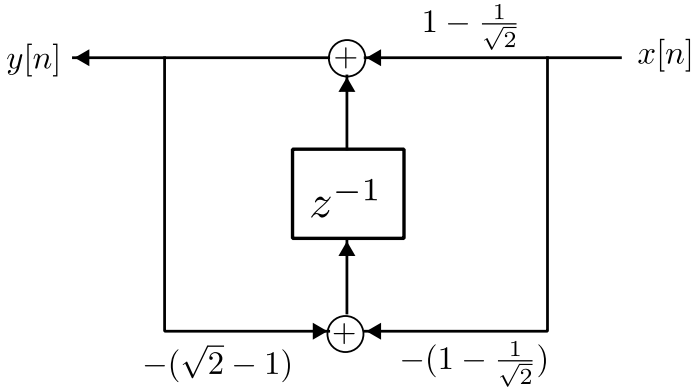

Fig. 1: Figure for Q3.

4) Write down the difference equation for a notch filter with notch frequency $\frac{\pi}{2}$ and 3dB bandwidth $\frac{\pi}{2}$.
5) Can a stable all-pass filter have a stable equalizer? Does a basic IIR band pass filter (as taught in class) have a stable equalizer?

I. Answers

1) a) $M = 3$.

b) 14.

2) IIR Band Pass Filter. Centre frequency $\frac{\pi}{3}$, 3dB bandwidth $\cos^{-1} 0.6$.

3) a) IIR High Pass.

b) $\frac{3\pi}{4}$.

c) $-\frac{2\pi}{3}, 0, \frac{2\pi}{3}$.

4) $y[n] = \frac{1}{2}(x[n] + x[n-2])$.

5) No. No.