ECE-486 Test 1
March 8, 2000

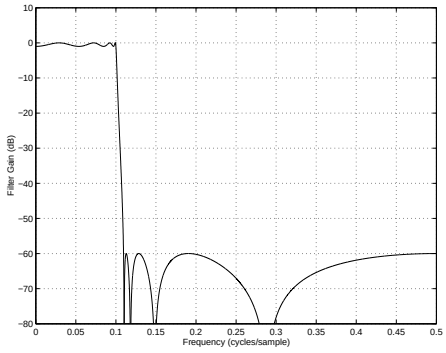
1. The transfer function of a discrete-time system is given below. Evaluate the impulse response of the system, and determine whether or not the system is stable.

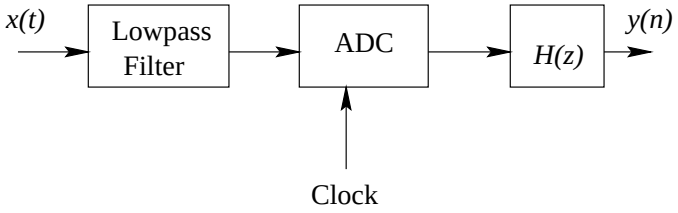
$$H(z) = z^2 + \frac{z}{z+.75} + \frac{1}{z-2} + \frac{4z^2+2.5z}{(z-0.5)(z+4)} \qquad 0.75 < |z| < 2$$

2. A discrete-time lowpass filter has been designed and has the magnitude response illustrated below. The filter is to be used as part of a system which samples and filters an audio continuous-time signal $x(t)$. The signal $x(t)$ may have significant energy throughout the audio band ($|f| < 20$ kHz). It is desired that the system output $y(n)$ be samples of the low-frequency ($|f| < 300$ Hz) portion of the analog signal $x(t)$, with all terms above 350 Hz attenuated by at least 60 dB.

   (a) If the available discrete-time filter is to be used, find the required sample-rate for the system. Specify the requirements of the analog lowpass filter, including the passband, stopband, and stopband attenuation.

   (b) A block of 4096 samples of the system output $y(n)$ are collected for analysis. Let $Y(k)$, $k = 0, \ldots, 4095$, denote the DFT of the data block. Identify all DFT indices k which are expected to have significant energy (containing signals in the passband of the discrete-time filter).





3. A discrete-time system is described by the difference equation given below.

$$y(n) + 3y(n-1) + 4y(n-2) = 5x(n)$$

(a) Is this system time invariant? (justify)

(b) Is this system causal? (justify)

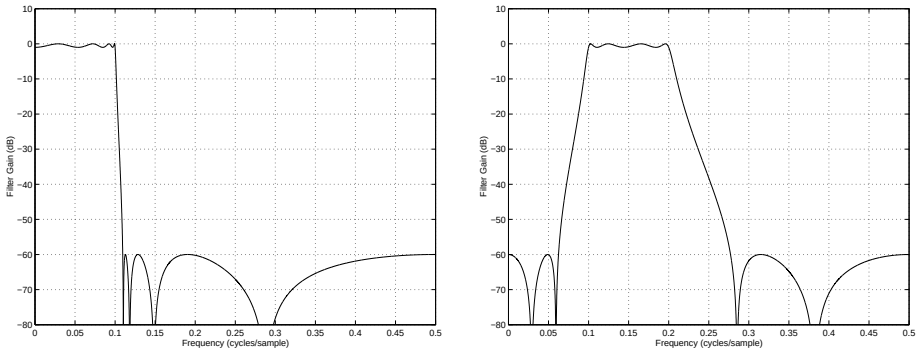
(c) Is this system stable? (justify)

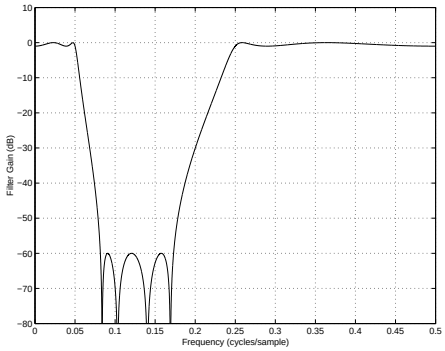
(d) Find the z-transform of the system output for system input $x(n) = 0.5^n u(n)$, and initial conditions $y(-1) = 1$, $y(-2) = 2$. (Do not solve for $y(n)$)

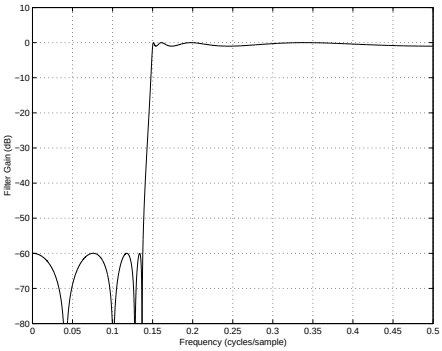
(e) Find the transfer function of the system (specify the ROC of your result)

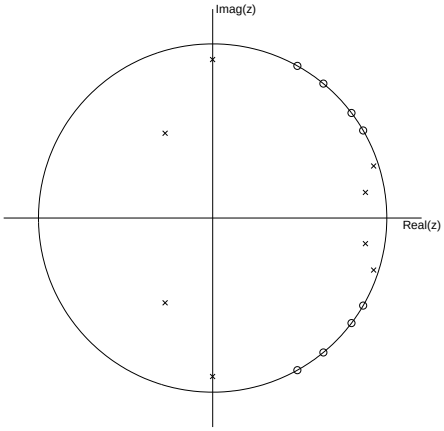
(f) Find the first two samples of the impulse response of the system, $h(0)$ and $h(1)$.

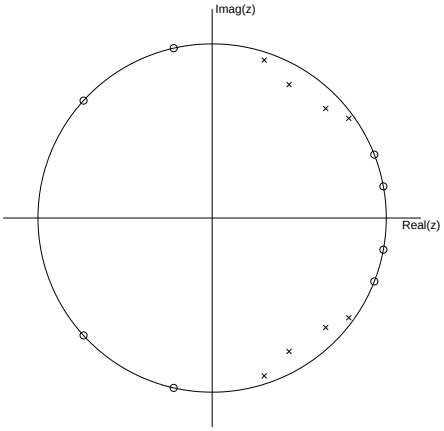
4. The figures shown below illustrate the frequency characteristics for lowpass, bandpass, bandstop, and highpass filters. The corresponding pole-zero diagrams (in a confused order) are also illustrated. Indicate which pole-zero diagram is appropriate for each of the filter characteristics.

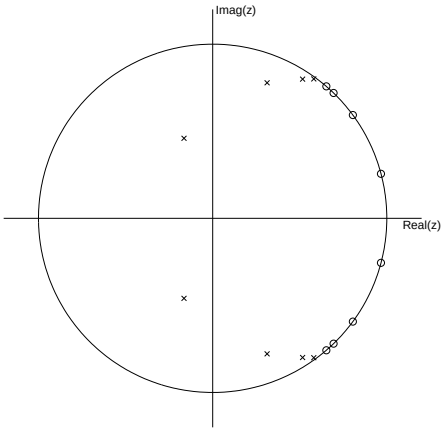


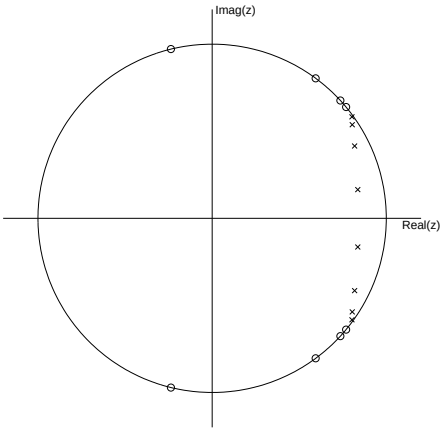












5. A block diagram of a discrete time system is illustrated below.

   (a) Find and plot the magnitude frequency response of the system, $|H(\omega)|$.

   (b) Is this an IIR or FIR system? (justify)

   (c) Is this a stable system? (justify)