EEM 401 LABORATORY 3

Question 1.

We have shown that if the input and output of a causal LTI system satisfy the difference equation

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

then the impulse response of the system is $h[n] = a^n u[n]$.

(a) For what values of a is this system stable?

(b) Consider a causal LTI system for which the input and output are related by the difference equation

$$y[n] = a\,y[n-1] + x[n] - a^N x[n-N],$$

where *N* is a positive integer. Determine and sketch a plot of the impulse response of this system. Hint: Use linearity and time-invariance to simplify the solution.

(c) Is the system in part (b) an FIR or an IIR system? Explain.

(d) For what values of a is the system in part (b) stable? Explain.

(e) Write two brief MATLAB programs (really just single statements) that implement the system in part (b) for $a = 0.8$. One program should use `filter( )` and the other should use `conv( )`. Test your programs with an impulse input to verify that they produce the same impulse response.

Question 2.

Use the built-in functions `filter( )` and `freqz( )` of MATLAB to compute 51 samples of the impulse response and frequency response of the system defined by the difference equation

$$y[n] = 1.7163\,y[n-1] - 1.1724\,y[n-2] + 0.2089\,y[n-3]$$
$$+ 0.5264\,x[n] - 1.5224\,x[n-1] + 1.5224\,x[n-2] - 0.5264\,x[n-3]$$

(To compute the impulse response, make an input vector for `filter( )` consisting of one unit sample followed by 50 zero samples). Hand in a `stem( )` plot of the impulse response. Use `subplot( )` and `plot( )` to make a two panel plot of the magnitude and phase of the frequency response.

Question 3.

Use the built-in functions `filter( )` and `freqz( )` of MATLAB to compute 51 samples of the impulse response and frequency response of the system defined by the difference equation

$$y[n] = 1.556\,y[n-1] - 1.272\,y[n-2] + 0.398\,y[n-3] + 0.0798\,x[n] + x[n-1] + x[n-2] + x[n-3].$$

(To compute the impulse response, make an input vector for `filter( )` consisting of one unit sample followed by 50 zero samples.) Hand in a `stem( )` plot of the impulse response. Use `subplot( )` and `plot( )` to make a two panel plot of the magnitude and phase of the frequency response.