% Tune-Up Tuesday #9 for November 6, 2018

% For the following linear time-invariant (LTI) filter observed for n >= 0,

%

% *y*[*n*] = 0.9 y[*n*-1] + (1/2) x[*n*] + (1/2) x[*n*-1]

%

% We can move the term 0.9 y[*n*-1] to the left-hand side:

%

% y[*n*] – 0.9 y[*n*-1] = (1/2) x[*n*] + (1/2) x[*n*-1]

%

% Take *z*-transform of both sides. All initial conditions are zero to satisfy LTI properties.

%

% Y(z) – 0.9 z^(-1) Y(z) = (1/2) X(z) + (1/2) z^(-1) X(z)

% (1 – 0.9 z-1) Y(z) = (1/2) X(z) + (1/2) z^(-1) X(z)

% Y(z) (1/2) + (1/2) z^(-1) 1 1 + z^(-1)

% H(z) = ---- = -------------------- = - --------------

% X(z) 1 – 0.9 z^(-1) 2 1 – 0.9 z^(-1)

% **i. Plot the poles and zeros in the z domain.**

feedforwardCoeffs = [ 1/2 1/2 ];

feedbackCoeffs = [ 1 -0.9 ];

figure;

zplane(feedforwardCoeffs, feedbackCoeffs);

% ***Answer:*** The transfer function in the z-domain has a zero at z = -1 and pole at z = 0.9.

% The pole has radius 0.9 and angle 0 rad/sample. If the pole were considered by itself,

% then the filter would pass low frequencies (centered at the angle of the pole) and

% attenuate high frequencies. The zero is on the unit circle at angle pi rad/sample,

% which causes more attenuation in high frequencies. ***Lowpass filter***.

% Magnitude response at discrete-time frequency w would be the distance from a point

% on the unit circle at z = exp(j w) to the zero location divided by the distance from the

% point on the unit circle to the pole location, multiplied by the filter gain (1/2).

% **ii. Plot the magnitude response in linear units** **over the interval –pi <= w <= pi.**

% When freqz is called without any return values, it would plot the phase response

% as well as the magnitude response in dB using *A*dB = 20 log10 |*A*|:

% |A| *A*dB |A| *A*dB |A| *A*dB

% 1.0 0dB 0.5 -6dB 0.0 -infinity

% Below, we ask freqz to return the values calculated for the frequency response

% and then plot the magnitude response in linear units instead of using deciBels.

W = -pi : 0.001 : pi;

[H, W] = freqz( feedforwardCoeffs, feedbackCoeffs, W );

figure;

plot(W, abs(H));

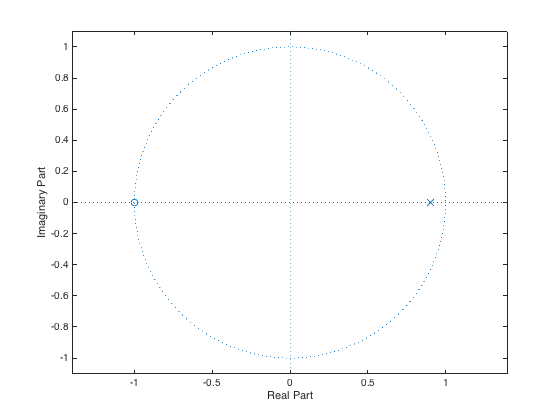
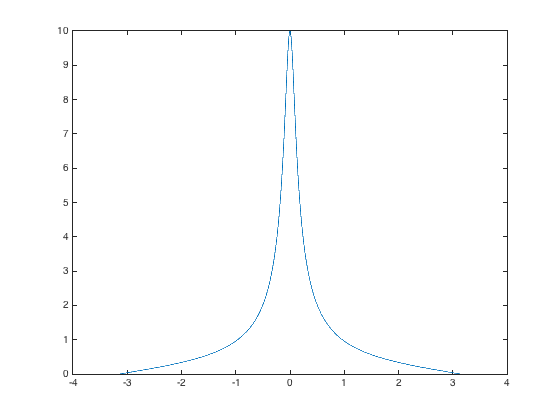
% ***Answer***: Magnitude response peaks at 10 at 0 rad/sample and then decreases

% to zero as the discrete-time frequency increases from 0 to pi. ***Lowpass filter***.

% **iii. Frequency selectivity?**

% Lowpass, highpass, bandpass, bandstop, allpass, notch. ***Lowpass filter***.

% ***Plots are on the next page.***

****