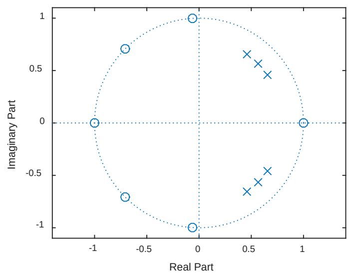
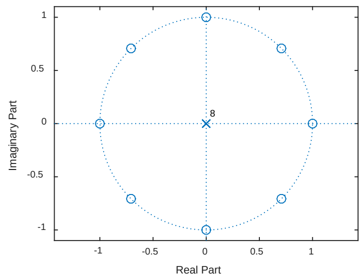
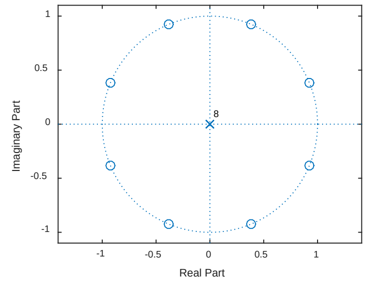
EE 311 **Name____________________**

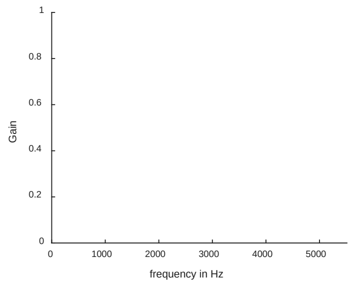
Hour Exam 3 **April 8, 2016**

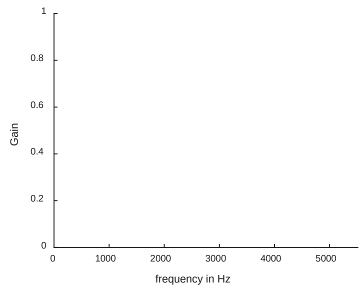
1. For each of the pole/zero plots below use a geometric interpretation of the z-plane to produce a rough plot of the magnitude and phase function.

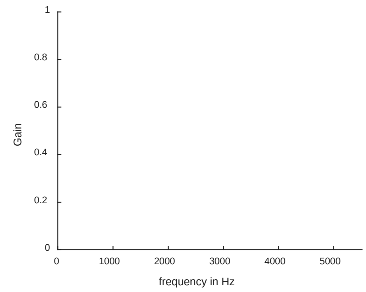












2. For the transfer function given by:

$$H(z)=\frac{(z+1)}{(z^2-1.2z+.52)}$$

Answer the following questions.

(a) Is this filter low pass, high pass, band pass, or band stop?

(b) What is the filter order?

(c) Is this filter stable?

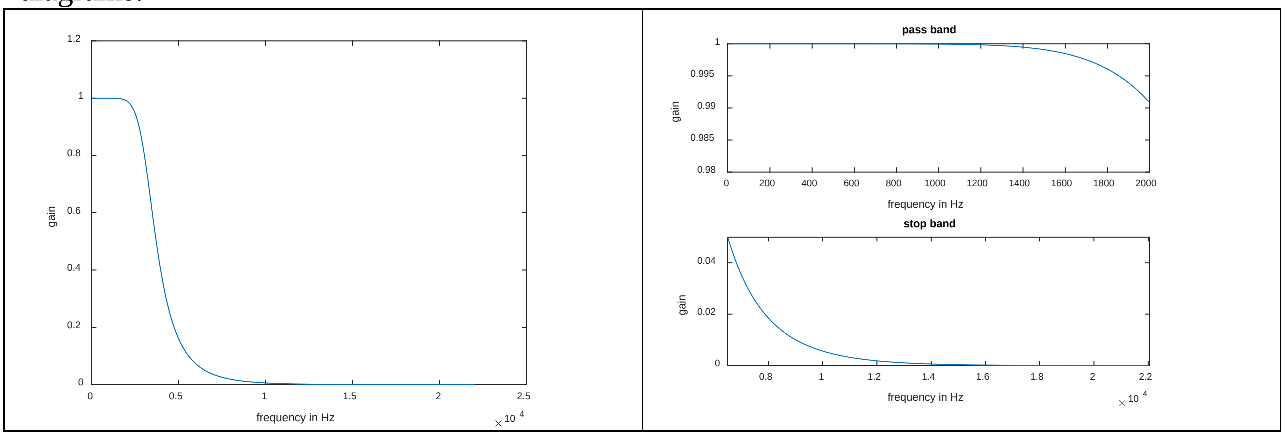
(d) Find the difference equation for the filter.

(e) What will be the final value of the step response for this filter?

(f) What are the first two terms of the impulse response for this filter?

3. A person with which you have had a romantic interlude has sent you a *.wav* file that has music from the South Sea Islands. Unfortunately, it has been corrupted with 60 Hz power line noise. If the signal and the noise ranges from +1 volt to -1 volt in amplitude and you need to reduce the 60 Hz noise so that it is less than 2% of the signal how much decibel reduction is needed in the stop band to preserve this romance.

4. Draw a circle around all of the descriptive terms that apply to the filter whose frequency response is shown below. Circle only those items which can be deduced as being true from the diagrams.



A) FIR	G) Monotonic stop band
B) IIR	H) Not Butterworth
C) Lowpass	I) Not Chebyshev
D) Highpass	J) Not elliptic
E) Bandpass	K) All zeros on the unit circle are at z = -1
F) Band stop	L) Meets specifications

5. A second order resonator filter will have a zero at $z = \pm 1$ and a pole pair at $z = r\angle\theta$

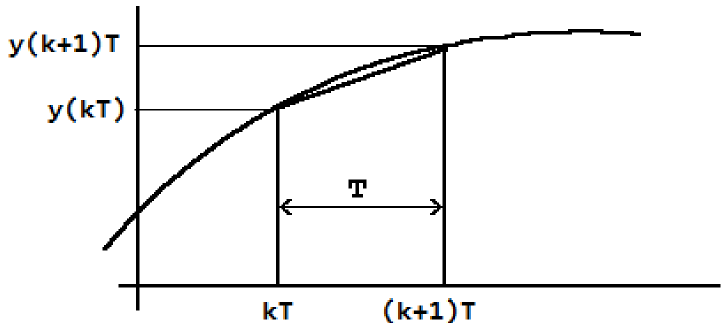
A) Write the second order polynomial for the numerator in terms or r and θ.

B) Write the second order polynomial for the denominator in terms of r and θ.

C) If f_s = 10 KHz, the bandwidth is 20 Hz what is the value for r?

D) If f_s = 10 KHz, the center frequency is 1 KHz what is the value of θ?

6. In class we found a mapping function from s to z by approximating a derivative by using the slope of a straight line between a point at y(kT) and y(k-1)T. You can also approximate the derivative by using the slope of the line from y(k+1)T and y(kT).



Find the mapping function of s to z using the *forward* derivative.

7. An ideal filter has an impulse response given by
h(nT) = {1.0, 0.5, 0.25, 0.125, 0.0625, …} or $h(n) = (1/2)^n$
Pade's method is to be used to design a digital filter with fs = 11025Hz. Take M = N = 7.
Answer the following questions:

A) How many equations are needed?

B) What will be the filter order?

C) What will be the value of b_0?

D) In Pade's method there is a matrix equation of the form $\overline{A} \cdot \overline{x} = \overline{b}$. What is the $\overline{x}$ matrix for this problem?

8. Suppose I want to design a first order unity gain all-pass filter with an approximate mid-band phase shift of -30^o. The transfer function is given by:

$$H(z) = K\frac{z-1/r}{z-r}$$

Find the value of *r* and *K* for this filter.

9. An 8th order analog Butterworth filter has a cutoff frequency of 2,500Hz. What is the gain of the filter at 2,575Hz?