

Key

**EE432 Fall 09 Homework Problem Set 3 (PS03)**

**Assigned: 16 Sep 2009 Due: 25 Sep 2009**

Turn in your code and copy/paste the results from the MATLAB command window as needed.

Fill in the blanks below

1. Find the transfer function  $H(z)$  for a feed forward filter that will remove frequencies from an input signal that occur at  $f_N/2$ . Work this by hand, and show your work. Use *fvtool* to plot the magnitude response.

$$H(z) = \frac{(z - e^{j\pi/2})(z - e^{-j\pi/2})}{z^2} = \frac{(z - j)(z + j)}{z^2} = \frac{z^2 + 1}{z^2}$$

`fvtool([1 0 1], 1)`

2. Using *fvtool*, plot the magnitude response for an inverse comb filter that has 6 zeros with  $R=0.9$ . Also use *fvtool* to plot the pole-zero plot. What is the transfer function for this filter?

$$H(z) = \frac{1 - (0.9)^6 z^{-6}}{z^6} = \frac{z^6 - (0.9)^6}{z^6}$$

`fvtool([1 0 0 0 0 0 - (0.9)^6], [1 0 0 0 0 0 0])`

3. A transfer function is given by:

$$H(z) = \frac{z^2 - z + 1}{z^2 + 1.5556z + 1.21}$$

Use MATLAB to find the poles and zeros.

use "roots": Zeros:  $0.5 \pm 0.866j$

poles:  $-0.7778 \pm 0.7778j$

Is this filter stable? Why or why not?

Magnitude of poles is 1.1. poles not inside unit circle, so NOT stable

Plot the magnitude response with *fvtool*.

If a signal that has been digitized with a sample rate of 192 kHz is input to the filter:

What frequency (in Hz) is most suppressed in the output?

$$\sim \frac{\pi}{3}, \text{ which equates to } \frac{f_s/2}{3} = \frac{192 \text{ kHz}/2}{3} = \boxed{32 \text{ kHz}}$$

What frequency is most amplified?

$$\sim \frac{3\pi}{4} \quad f_s/2 \cdot \left(\frac{3}{4}\right) = \boxed{72 \text{ kHz}}$$

4. A feedback filter has 5 zeros at:

$$z = -1.3 \pm j0.9$$

$$z = 0.1 \pm j0.9$$

$$z = -0.9$$

and 5 poles at

$$z = 0.8 \pm j0.2$$

$$z = -0.8 \pm j0.2$$

$$z = 0.8$$

Using *conv*, determine the numerator and denominator polynomials of the transfer function (positive powers of  $z$ ).

$$H(z) = \frac{z^5 + 3.3z^4 + 4.96z^3 + 4.152z^2 + 3.5188z + 1.845}{z^5 - 0.8z^4 - 1.2z^3 + 0.96z^2 + 0.4624z - 0.3699}$$

Using *fvtool*, generate a plot of the magnitude response of the transfer function, and a pole/zero plot.

Is the filter stable? Why or why not?

Yes - all poles inside unit circle.

If a signal that is input to this filter is digitized with a sample frequency of 20 kHz:

What frequency (in Hz) is most suppressed in the output?

$$\sim 0.46 * f_s/2 = \boxed{4600 \text{ Hz}}$$

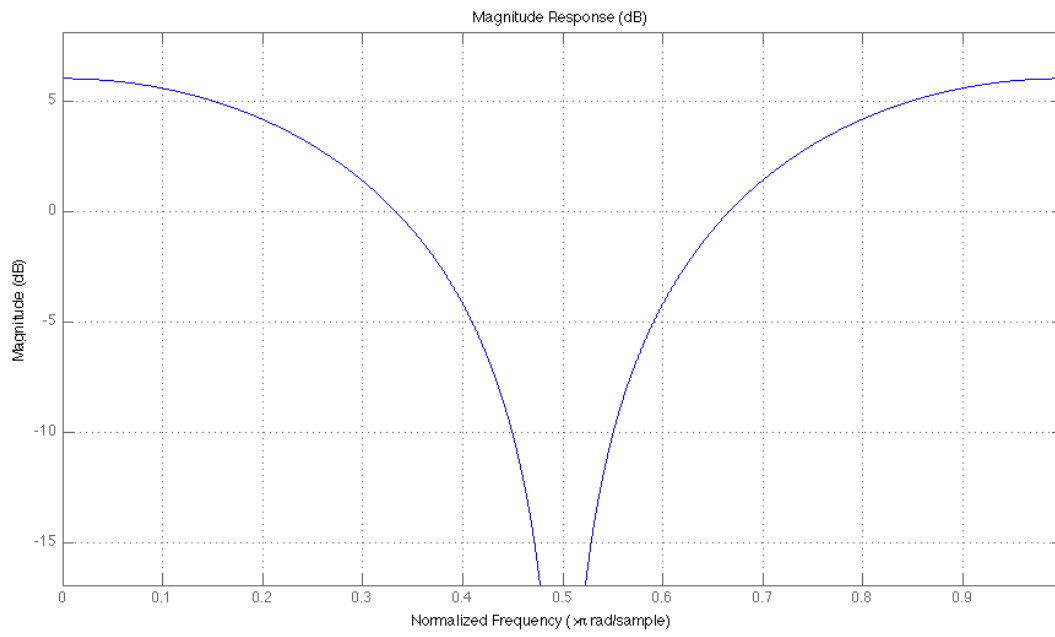
What frequency is most amplified?

$$\boxed{0 \text{ Hz}}$$

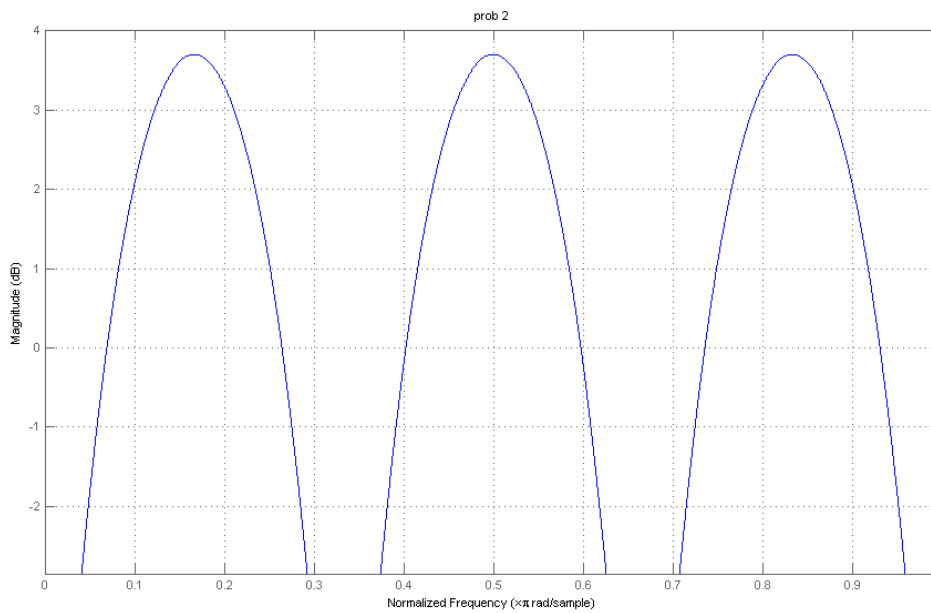
em 1:

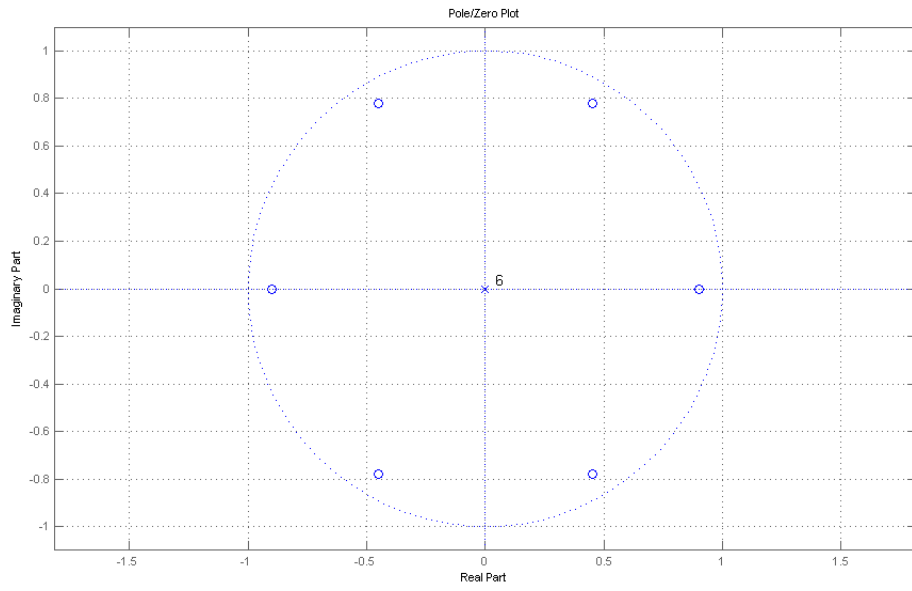
Probl

## Problem 1

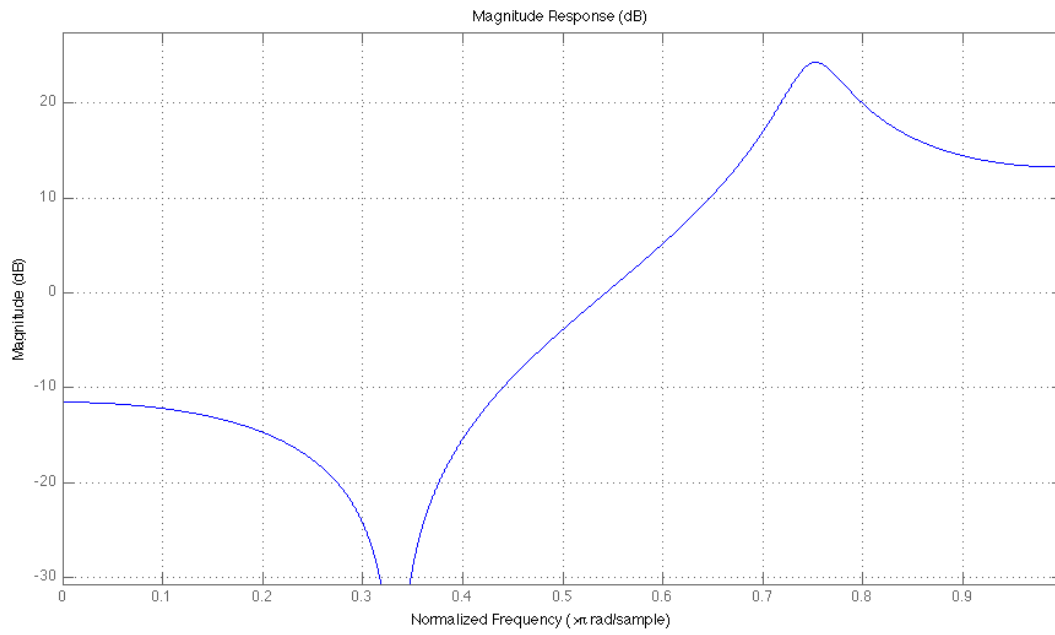


## Problem 2





### Problem 3



# Problem 4

