EE524 Homework 2

1. Pole-zero filter design- the goal of this problem is hand-position poles and zeros to reduce or eliminate noise in a signal. If you want to attenuate or eliminate a signal at a given frequency put a zero on the unit circle at the appropriate frequency. Putting a pole right inside this zero gives a nice sharp notch filter.

a. Download the signal whale82000.wav. This is a signal of killer whale calls with some sinusoidal interference at two unknown frequencies. The sampling frequency is 8 kHz. First you need to do a spectral analysis to find the location of the interfering signals. Design a filter with 2 zeros and 2 poles(in conjugate pairs) that eliminates the sinusoidal interference. Turn in the spectral plot of the signal, a pole-zero diagram, and the magnitude response for the filter. Comment on what you hear when you play the signal.

b. Using the signal whale82000chirp.wav. This time the interference is an FM signal that changes frequency in time. Use the spectrum or a spectrogram to see the frequency of this signal. Design a filter using pole-zero placement that has real coefficients which eliminate the interference. Turn in a pole-zero diagram and the magnitude response for the filter. Comment on what you hear when you play the signal.

Matlab Notes:

i. Use *wavread* to read in signals. (*wavwrite* will write a .wav file)

```
>[x,fs]=wavread('whale82.wav');
```

ii. Design the filter in pole-zero form with a vector of poles and a vector of zeros, use *zp2tf* function to convert to a transfer function and *filter* to filter the signal.

iii. Your code should have this form:

```
% read in file
[x,fs]= wavread('whale82.wav');
% define column vectors with poles and zeros, plot results in the complex z-planel
z=[ . . .]'; p=[ . . .]'; zplane(z,p);
% put into transfer function form
[num,den]=zp2tf(z,p,1);
% filter the signal
xf=filter(x,num,den);
```

2. Find and explain the DFT of the following sequences. Comment on the physical and computational resolution and sketch the magnitude response of the DFT (remember: it is

a discrete signal). In this case please work out the derivation in detail for part a (just for practice).

a. $x_a[l] = \cos\left(\frac{3.5\,\pi\, l}{8}\right)$, l=0,1,. . .,15 N = 32.

b. $x_b[l] = \cos\left(\frac{3.5\,\pi\, l}{8}\right)$ l=0,1,. . .,15 N=16

c. $x_c[l] = \cos\left(\frac{3.5\,\pi\, l}{8}\right)$ l=0,1,. . .,15 N=64

3. Problem 4.18 from the textbook
4. Problem 4.34 from the textbook
5. Problem 4.17
6. Problem 4.65