MAT 320 Homework 5
Fall 2020

Due date: Thursday, Nov 12

You can use SciLab, or write a program to help in calculations, for any part of this homework.

Impulse reponse always refers to the output y_t of a filter given input $x_t = \delta_t = (1, 0, 0, \ldots)$. You may also assume that unless otherwise stated, the values of a signal at negative sample indices are always zero.

1. Follow the recipe on page 92, using sampling frequency $44,100$ Hz, to design a reson filter with the specified bandwidth B and resonant frequency ψ. Write the filter equation and compute the first three values y_0, y_1, y_2 of the impulse response. Do all of this in two different ways: 1) with $B = 2\phi$, where $\cos\phi = 2 - \frac{1}{2}(R + \frac{1}{R})$ and 2) with $B = 2(1 - R)$. Note: Choose R to be less than 1.
   (a) $B = 10$Hz, $\psi = 1000$Hz
   (b) $B = 20$Hz, $\psi = 5000$Hz

2. Suppose a reson filter has impulse response given by:
$$y_t = \sqrt{2}(0.99^t)\sin(\frac{\pi}{4}(t+1)).$$
   What is the filter equation? (Hint: see formula 6.6)

3. Chapter 5, Problem 1 (Hint: think power series)

4. Chapter 5, Problem 3a,b (Note: by *peak frequency* the author means the frequency at which the magnitude response reaches its peak. This is the frequency labeled ψ on page 91.)

5. (a) Magnify the graph in Figure 8.1 so that you can choose values of the poles and zeros to two decimal places.
   (b) Write the transfer function.
   (c) Compute the magnitude response at each of the values on the graph in Figure 8.2 from 0.18 to 0.36, at each dot along the horizontal axis.