ECE 111 - Homework #10

ECE 343 Signals & Systems- Due Tuesday, March 28th
Please email to jacob.glower@ndsu.edu, or submit as a hard copy, or submit on BlackBoard

Filter Analysis

1) A filter has the following transfer function

$$Y = \left(\frac{10(s+3)}{(s+1)(s+2)(s+5)} \right) X$$

1a) What is the differential equation relating X and Y?

1b) Find y(t) assuming $x(t) = 5$

1c) Find y(t) assuming $x(t) = 5\sin(4t)$

2) Plot the gain vs. frequency for this filter from 0 to 50 rad/sec.

- Low-Pass Filter

$$Y = \left(\frac{20{,}000}{\left(s^2+18.5s+100\right)\left(s^2+7.65s+100\right)} \right) X$$

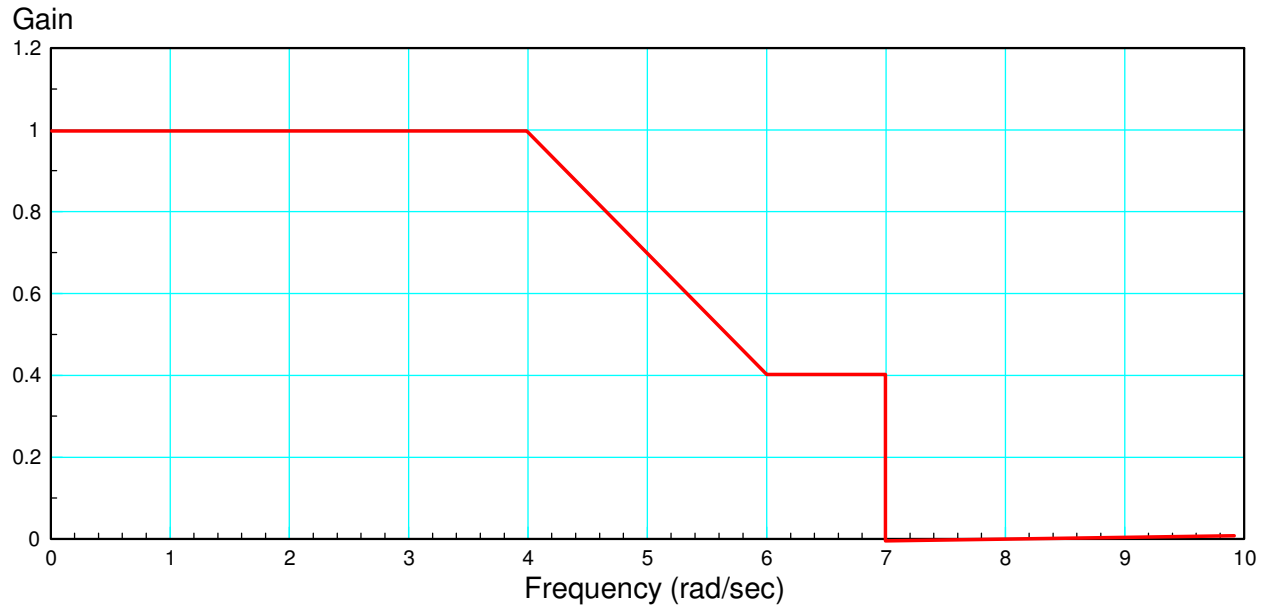
3) Plot the gain vs. frequency for this filter from 0 to 50 rad/sec.

$$Y = \left(\frac{100{,}000 \cdot s^2}{(s+1\pm j10)(s+1\pm j30)} \right) X = \left(\frac{100{,}000 \cdot s^2}{\left(s^2+2s+101\right)\left(s^2+2s+901\right)} \right) X$$

Filter Design

Problem 4-6) Design a filter of the following form so that the gain matches the graph below:

$$G(s) = \left(\frac{a\left(s^2+b\right)}{\left(s^2+cs+d\right)\left(s^2+es+f\right)\left(s^2+gs+h\right)} \right)$$



4) Write an m-file, cost.m, which

- Is passed an array, z, with each element representing (a, b, c, d, e, f, g,h)
- Computes the gain, G(s) for this value of (a, b, c, d, e, f, g,h)
- Computes the difference between the gain, G, and the target (above), and
- Returns the sum-squared error in the gain

5) Use your m-file to determine how 'good' the following filter is:

$$G(s) = \left(\frac{a\left(s^2+b\right)}{\left(s^2+cs+d\right)\left(s^2+es+f\right)\left(s^2+gs+h\right)} \right) = \left(\frac{20\left(s^2+50\right)}{\left(s^2+s+4\right)\left(s^2+s+16\right)\left(s^2+s+36\right)} \right)$$

6) Use fminsearch() to find the 'best' filter of the form

$$G(s) = \left(\frac{a\left(s^2+b\right)}{\left(s^2+cs+d\right)\left(s^2+es+f\right)\left(s^2+gs+h\right)} \right)$$

a) Give the resulting (a, b, c, d, e, f, g,h)

b) Give the resulting filter, and

c) Plot the 'optimal' filter's gain vs. frequency