ECE 111 - Homework #14

ECE 343 Signals & Systems
Due Monday, November 27th

Filter Analysis

1) A filter has the following transfer function

$$Y = \left(\frac{10(s+2)}{(s+0.5)(s+6)(s+7)} \right) X$$

- 1a) What is the differential equation relating X and Y?
- 1b) Find y(t) assuming $x(t) = 5$
- 1c) Find y(t) assuming $x(t) = 5\sin(2t)$

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

- Low-Pass Filter

$$Y = \left(\frac{50{,}000}{(s+4.8)\left(s^2+11.3s+51.8\right)\left(s^2+4.69s+123\right)} \right) X$$

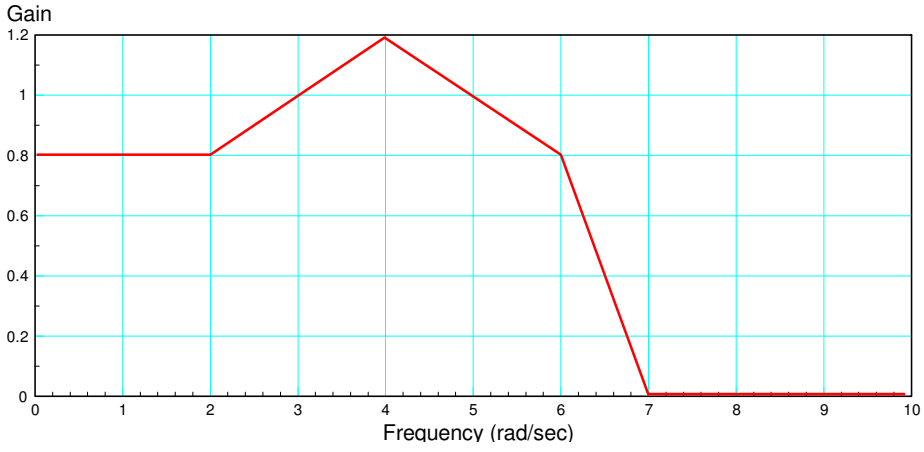
3) Plot the gain vs. frequency for this filter from 0 to 50 rad/sec.

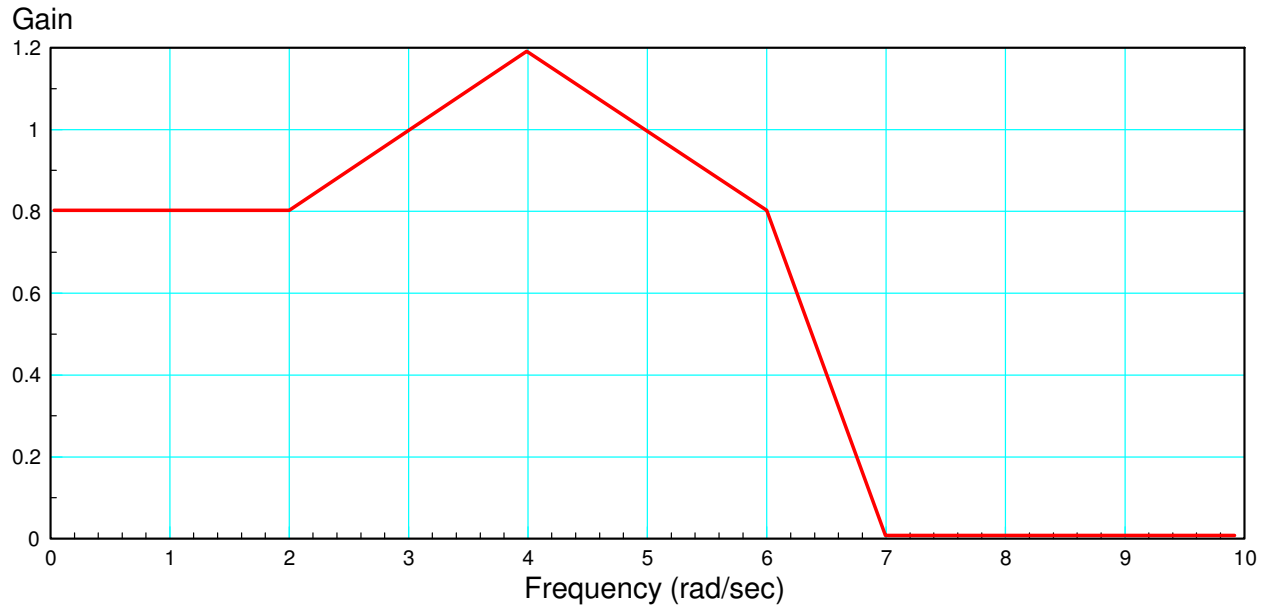
$$Y = \left(\frac{200 \cdot s^2}{(s+1\pm j5)(s+1\pm j15)} \right) X = \left(\frac{200 \cdot s^2}{\left(s^2+2s+26\right)\left(s^2+2s+226\right)} \right) X$$

Filter Design

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

$$G(s) = \left(\frac{a}{\left(s^2+bs+c\right)\left(s^2+ds+e\right)\left(s^2+fs+g\right)} \right)$$





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

- Is passed an array, z, with each element representing (a, b, c, d, e, f, g)
- Computes the gain, G(s) for this value of (a, b, c, d, e, f, g)
- 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:

$$G(s) = \left(\frac{a}{\left(s^2+bs+c\right)\left(s^2+ds+e\right)\left(s^2+fs+g\right)} \right) = \left(\frac{2304}{\left(s^2+s+4\right)\left(s^2+s+16\right)\left(s^2+s+36\right)} \right)$$

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

$$G(s) = \left(\frac{a}{\left(s^2+bs+c\right)\left(s^2+ds+e\right)\left(s^2+fs+g\right)} \right)$$

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

b) Give the resulting filter, and

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