ECE 111 - Make-Up Homework #14

ECE 343 Signals & Systems & Filters

Filter Analysis

1) A filter has the following transfer function

$$Y = \left(\frac{100(2s+1)}{(s+3)(s+4)(s+5)} \right) X$$

- 1a) What is the differential equation relating X and Y?
- 1b) Find y(t) assuming $x(t) = 4$
- 1c) Find y(t) assuming $x(t) = 5\sin(6t)$

2) Plot the gain vs. frequency for this filter from 0 to 30 rad/sec.

$$Y = \left(\frac{400(2s+1)}{(s+3)(s+4)(s+5)} \right) X$$

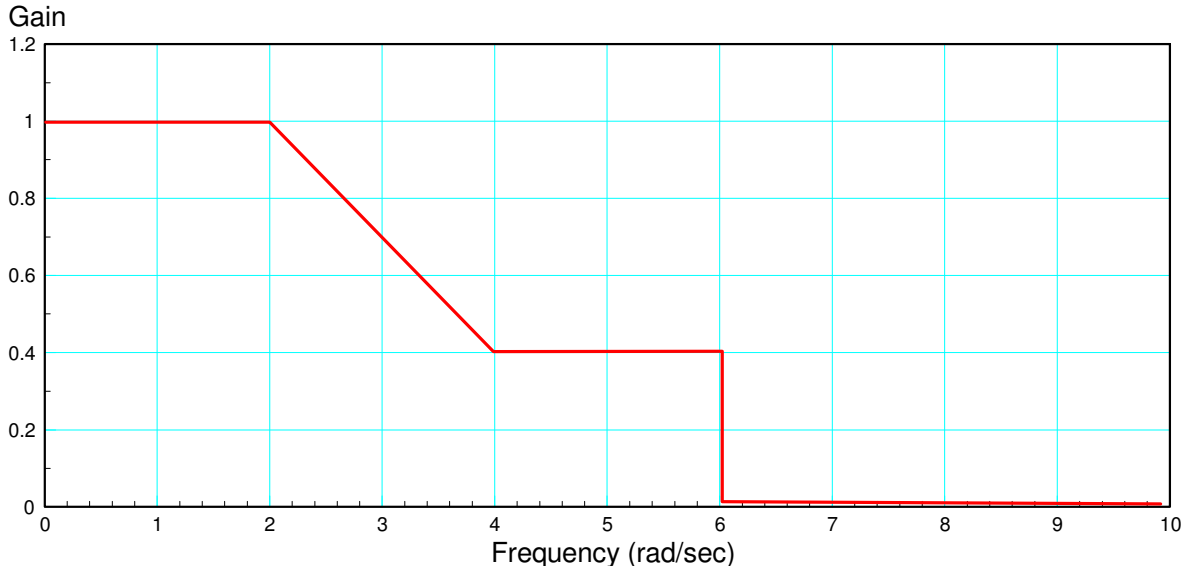
3) Plot the gain vs. frequency for this filter from 0 to 30 rad/sec.

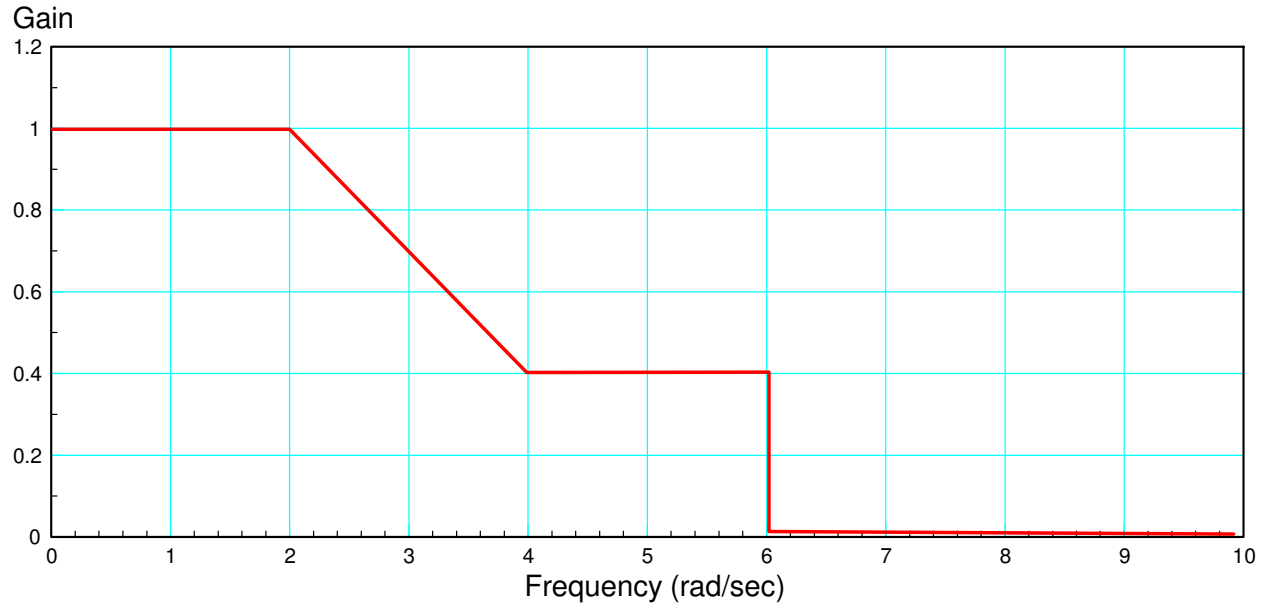
$$Y = \left(\frac{100s^2}{\left(s^2+2s+26\right)\left(s^2+2s+101\right)} \right) X$$

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:

$$G(s) = \left(\frac{a}{(s^2+bs+c)(s^2+ds+e)(s^2+fs+g)} \right) = \left(\frac{3000}{(s^2+2s+5)(s^2+2+17)(s^2+2s+37)} \right)$$

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

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

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