

ECE 111 - Homework #14

ECE 343 Signals & Systems & Filters
Due Monday, April 28th. Please submit via email or on BlackBoard

Filter Analysis

1) A filter has the following transfer function

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

- 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.

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

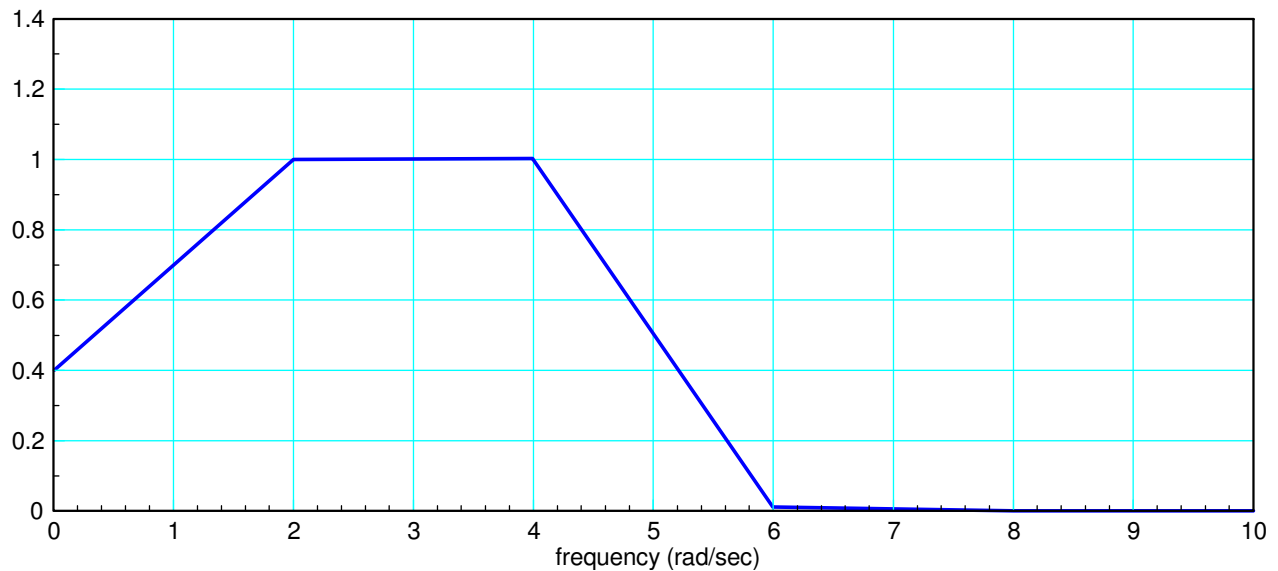
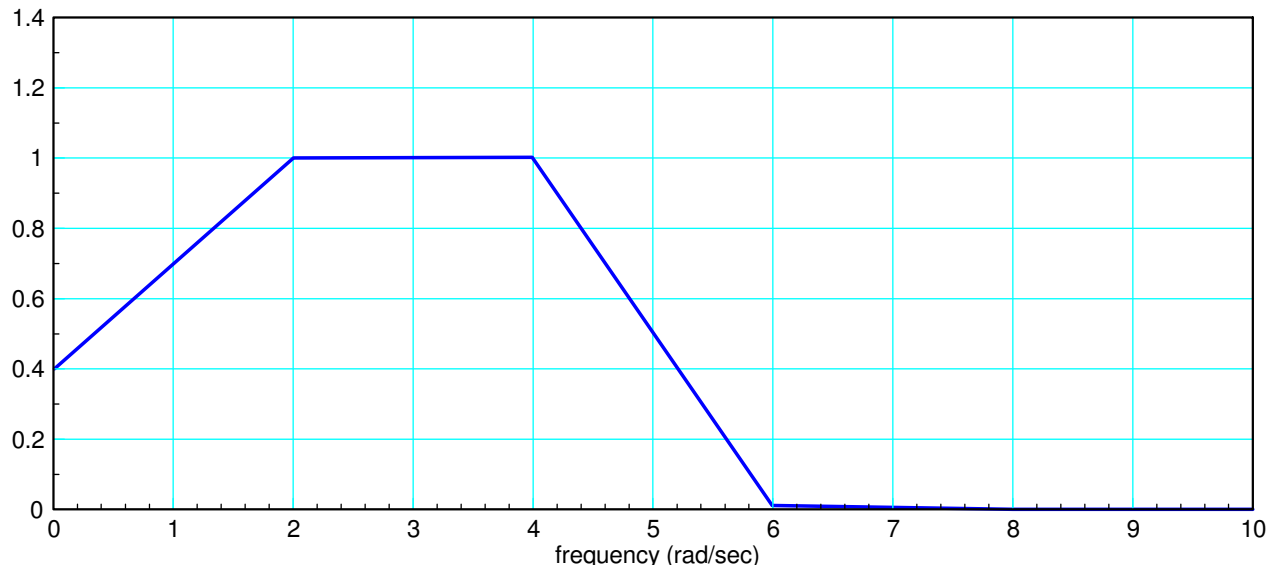
3) Plot the gain vs. frequency for this filter from 0 to 30 rad/sec.

$$Y = \left(\frac{100s^2}{(s^2+s+1)(s^2+5s+400)} \right) X$$

Filter Design

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

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



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:

$$G(s) = \left(\frac{a}{(s^2+bs+c)(s^2+ds+e)(s^2+fs+g)} \right) = \left(\frac{72}{(s^2+s+2)(s^2+s+4)(s^2+s+9)} \right)$$

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