

EE577 Spring 2011

Homework #3

Assigned: Friday 25 March 2011

Due: Wednesday 6 April 2011

In this homework assignment you will use Matlab to investigate some numerical issues with digital filter implementations.

Task: design a pair of band pass filters according to the following specifications.

Sample rate: 48 kHz

Center frequencies: 12.5 Hz and 16.0 Hz

Use 6th-order Butterworth design (see Matlab's `butter()` function, with $N=3$)

Use *one-third octave* filters:

$$F_{low} = F_c \cdot 2^{-\frac{1}{6}} \quad F_{hi} = F_c \cdot 2^{+\frac{1}{6}}$$

(1) Obtain direct-form coefficients (b, a) for both of the filters and then locate the poles and zeros (use `roots()` to find them). Do the resulting filters appear to be stable based on the pole positions? Explain.

(2) Now use `butter()` again, but this time have it generate the poles, zeros and gain scaling factor instead of the direct form polynomial coefficients. Do the resulting pole locations indicate stable filters? Explain.

(3) Using the explicit pole/zero/scale calculations from (2), create a three-stage cascaded 2nd-order section implementation for each filter. Show a verification of the two filters using a plot of gain in dB vs. frequency on a log axis. Overlap the response plots in a single graph.

(4) Finally, write Matlab code that will implement the 2nd-order sections and plot the unit sample response of each filter.

How long is each unit sample response, based on the number of samples before the response envelope is 60 dB below the peak value?