EELE 577 Spring 2013 Homework #3

Assigned: Friday 8 March 2013
Due: Wednesday 25 March 2013

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

Task: design two 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:

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

(1) Obtain direct-form coefficients (b, a) for both of the filters and then locate the poles and zeros (for example, 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 show some test results to verify that your filter implementation is performing as desired.