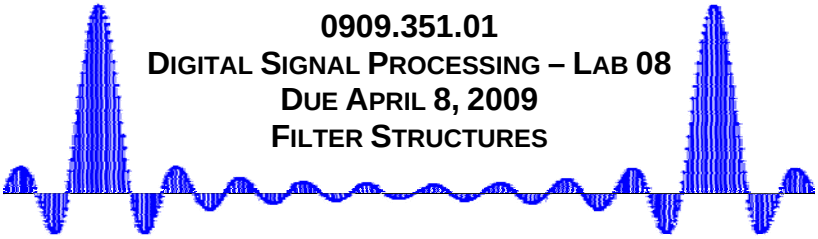

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DIGITAL SIGNAL PROCESSING – LAB 08
DUE APRIL 8, 2009
FILTER STRUCTURES

1. Consider the following simple CCLDE

$$y[n] = x[n-1] - 1.2x[n-2] + x[n-3] + 1.3y[n-1] - 1.04y[n-2] + 0.222y[n-2]$$

   a. Determine what kind of a filter is this (lowpass/highpass, etc. and FIR vs. IIR)
   b. Implement this filter using Simulink in
      i. Direct form I structure
      ii. Direct form II structure
   c. Using the following signal, sampled at 2000Hz, determine the spectrum of the signal at the input and output of this filter

$$x(t) = \sin(2\pi 150t) + \sin(2\pi 295t) + \sin(2\pi 455t)$$

      Does the output spectrum represent what you would expect based on your answer in (a)?

2. Using the Digital Filter Design block in Simulink, design the following bandpass filter as an IIR as well as an FIR filter f_{stop1}=500Hz, f_{pass1}=700Hz, f_{pass2}=1400Hz, f_{stop2}=1600Hz. Stopband attenuation; 25dB
   a. What order filter did you get in each case?
   b. For FIR filter, you will notice that Matlab designed this filter as "Direct-Form FIR." For IIR type, it is designed as Direct Form II structure using 2nd order blocks. Click on the "Realize Model" button on the left side, and Simulink will realize the filter using those structures and place a block in your model workplace. Using this block, add appropriate input/output blocks to demonstrate that the filter works as intended on the following test signal $x(t) = \sin(2\pi 200t) + \sin(2\pi 1000t) + \sin(2\pi 1820t)$ sampled at 4kHz.
   c. Plot the realized filters in each case. You can see these structures simple double clicking on the design filter block.
   d. If you wanted to realize the IIR filter in direct form II structure, but not as a cascade of 2nd order filters, how would you implement it? Show your Simulink implementation. Make sure that you check your design on the same test signal to ensure that your design works as intended.