Indian Institute of Space Science and Technology
AV336 - Digital Signal Processing Lab
Department of Avionics

Labsheet 8

For this labsheet, whereever you are asked to plot the magnitude response of low pass filters, you should plot the magnitude normalized with the gain at discrete frequency 0 in dB scale.

1. Suppose one desires to design the following low pass filter (this is a specification of the desired response $H_d(e^{j\omega})$.

$$|H_d(e^{j\omega})| \text{ is } \begin{cases} \in [1-0.01, 1+0.01], \text{ for } 0 \leq |\omega| \leq 0.25\pi, \\ \in [0, \delta], \text{ for } |\omega| > 0.3\pi. \end{cases}$$

   (a) Obtain a complete specification of $H_d(e^{j\omega})$ so that we have a filter with linear phase response

   (b) Design filters which meets the above specifications using the frequency sampling method for the cases $\delta = 0.01$ and $\delta = 0.001$.

   (c) Plot the desired magnitude plot along with the magnitude plot of the filter that you have designed and comment on the differences.

   (d) For each δ above, plot separate magnitude plots of the filters that you have obtain if you apply circular shifts of $M/4$ and $M/2$ to the $h[n]$. What do you observe?

   (e) Suppose we need to design a filter with $\delta = 0.001$. Using two frequency samples in a "transition band" is it possible to obtain a $\delta = 0.001$? What should be the values of those two frequency samples? Is there a tradeoff between δ and M?

2. Study what the Matlab inbuilt functions "fir2" and "firls" do. Go through the design examples which are shown in Matlab's help for these two functions.

3. Study what the Matlab inbuilt function "firpm" (or "remez") does. Use firpm to design a linear phase equiripple filter meeting the requirements in Task 1.

4. Matlab also provides filter design tools such as "filterbuilder" and "fdatool". Explore how these tools can be used to design FIR filters.