Homework 5

- **Problem 1** 5.43 from the Textbook
- **Problem 2** 5.57 from the Textbook
- **Problem 3**

Load the file prob3.mat to define the following parameters:

$[b, a]$	Filter co-efficients of an eighth order IIR filter
h	a 33-point FIR impulse response
$x1, x2$	narrowband test signals, created using Hamming window

You can use *grpdelay* from Matlab to compute the group delays required.

(a) Group Delay of IIR Filter

(i) Generate and plot the first 150 points of the impulse response of the IIR filter.

(ii) Compute and plot its frequency response magnitude and its group delay.

(iii) Plot the signals $x1$ and $x2$ and their Fourier transforms. Use these plots and the plots from (ii) to estimate the output of running each of these sequences through the IIR filter.

(iv) Verify the estimates in part (iii) by explicitly computing the outputs due to $x1$ and $x2$ using the *filter* function.

(b) Group Delay of FIR Filter

(i) Plot the impulse response of the FIR filter. Generate and plot its frequency response magnitude and group delay. Explain the relation between the impulse response and the fact that the group delay is a constant.

(ii) For the signals $x1$ and $x2$, what outputs would you expect from processing each of these sequences with the FIR filter. Verify your prediction by explicitly computing the outputs using *conv* or *filter* functions.

- **Problem 4**

(a) Low-pass filter using Windows

Design a length-23 linear-phase FIR low-pass filter with a band edge of $|\omega|_0 = 0.3\pi$ using the following windows : Rectangular, Barlett, Hanning, Hamming, Blackman.

(i) Plot the impulse response, amplitude response and the zero locations of the five filters.

(ii) Compare the transition bandwidth of the five filters.

(iii) Compare the amplitude response by computing the Chebyshev error (squared error) with the design specifications.

(a) Band-pass filter using Windows

Design a length-31 bandpass filter with transition bands. Set the lower stopband as $\{0 \leq |\omega| \leq 0.08\pi\}$, the passband as $\{0.1\pi \leq |\omega| \leq 0.3\pi\}$ and the upper stopband as $\{0.4\pi \leq |\omega| \leq \pi\}$. Apply the five windows : Rectangular, Barlett, Hanning, Hamming, Blackman. Compare their transition bandwidths and amplitude response as in (a).