# Experiment 5

## Windowing and FIR Filters

1. Purpose

   There are two main purpose of this experiment. THe first one is to study the concept of ‘windowing’, along with their effects on the spectrum analysis. The second one is design of Finite Impulse Response (FIR) filters, where the window method is employed.

2. Laboratory Work

   a. Write MATLAB functions to generate the following Windows
      i. Rectangular (also called Boxcar) window ($w = rec(M)$)
      ii. Hamming window ($w = ham(M)$)
      iii. Blackman window ($w = bla(M)$)

      where $M$ is the window length.
      Note: To test the operation of your codes, you may use MATLAB functions boxcar, hamming and blackman.

   b. Using $M = 40$ generate the windows and plot their magnitude spectra in $dB$ by taking a $100$ point FFT. Repeat the procedure for $M = 80$. Compare all spectra (in terms of main lobe width and side lobe level) and state explicitly the effect of the window legth.

   c. Generate signals

   $$x_1[n] = cos(2\pi\, n\, 0.242) + cos(2\pi\, n\, 0.258), n = 0, \dots, 255$$
   $$x_2[n] = cos(2\pi\, n\, 0.25)\, cos(2\pi\, n\, 0.008), n = 0, \dots, 255$$
   $$x_3[n] = cos(2\pi\, n\, 0.29)\, , n = 0, \dots, 127$$

   Compare $x_1[n]$ and $x_2[n]$, in terms of time wavefront and frequency content (magnitude spectrum).

   d. $x_3[n]$ can be thought to be obtained by windowing a sinusoid with a rectangular window. Compare the signal that would have been obtained if the window used were a Hamming window. Plot the magnitude spectra for both windowed signals and comment on the effect of using different type of windows.

   e. Write down the advantage of FIR filters. What is a ‘linear phase filter’? Give an example of what happens if the filter is not linear phase.

f. Compute the impulse response a linear phase $30th$ order lowpass filter with cut-off frequency $w_c = 0.2\pi$. Assume a Hamming window is used. PLot the magnitude and phase response of this filter.

g. Repeat part (f) for a bandpass filter with passband $0.4\pi < w < 0.6\pi$