Lab No.6: DFT and Windowing Effect

Objective
To observe and study the windowing effect on the DFT

Introduction
For finite-length signals, the DFT provides frequency-domain samples of the discrete-time Fourier transform. But, many filtering and spectral analysis applications, the signals do not inherently have finite length. This inconsistency between the finite-length requirement of DFT and reality of indefinitely long signals can be accommodated through the concepts of windowing, and block processing. In this lab we will investigate the windowing effect.

Suggested Reading
MATLAB functions hamming, hanning.

Problem 1
Given two signals as follows:

\[ x[n] = \cos(2\pi \cdot 0.125 \cdot n); \quad 0 \leq n \leq 127 \]
\[ y[n] = \cos(2\pi \cdot 0.123 \cdot n); \quad 0 \leq n \leq 127 \]

a) Compare the 128 point DFT of these two signals. Use trainplot to show it clearly.

b) Compare the 512 point DFT of these two signals.

Observe the differences and explain why is this so.
Problem 2

The strange shape of the DFT in the previous problem is due to the truncation of the cosine wave after 128 points. This truncation is called rectangular windowing because it is equivalent to multiplying a very long cosine wave with a rectangular pulse.

Using $x[n]$ as given in problem 1, compare the differences of 128 point DFTs by using:

a) Rectangular window.

b) Hanning window.

c) Hamming window.

In order to fully understand the windowing effect, examine the frequency response of these three windows.

Note

The windowing effect can be explained using the following diagram.

Where $w[n]$ is the window described above.