**Lab: 4 Windowing**

FFT windows reduce the effects of leakage but cannot eliminate leakage entirely. In effect, they only change the shape of the leakage. The spectrum is affected by each type of window in a slightly different way.

the highest side-lobe level is the most important parameters in Window Weighting Characteristics in FFT Analysis.

Lower level is better and increase detectability is the worst-case processing loss.

**Comparison between Hamming and Hanning window**

* Both windows are good for random signals. Their frequency resolutions are good. They have fair enough amplitude accuracy.
* The Hanning and Hamming window are quite similar.
* However Hamming window also has the disadvantage of being discontinuous at the edges which leads to clearly visible artifacts in the images.
* For the Hamming window, the side-lobes nearest the main lobe have been strongly shaped by the optimization.
* While the Hanning window has the shape of one cycle of a cosine wave with 1 added to it so it is always positive.
* the Hamming window is also one period of a raised cosine. However, the cosine is raised so high that its negative peaks are above zero, and the window has a discontinuity in amplitude leaving the window. This makes the side-lobe roll-off rate very slow.
* While the Hanning window does a good job of forcing the ends to zero, it also adds distortion to the wave form being analyzed in the form of amplitude modulation
* Amplitude Modulation in a wave form results in sidebands in its spectrum.
* Whereas in the case of the Hanning window, these sidebands, or side lobes as they are called, effectively reduce the frequency resolution of the analyzer by 50%.

**Blackman**

Blackman is good for random or mixed signals. Its frequency resolution is poor. It has good amplitude accuracy.

Blackman is more complex than Hamming window. he Blackman window has good characteristics for audio work.

**Triangular window**

In triangular window, Main lobe is twice as wide as that of a rectangular window of length. And also First side lobe is twice as far down as rectangular case It is Often applied implicitly to sample correlations of finite data.

Triangular is good for random or mixed signals. Its frequency resolution is poor. It has good amplitude accuracy. But compared to hamming window, hamming window performs better. It has simple equation.

**Rectangular window**

Length has no effect on the height of the side lobes. As length increases, the main lobe narrows.

A phase term arises when we shift the window to make it causal, while the window transform is real in the zero-phase case ex. centered about time 0.

It is the simplest window possible.