Experiment 6

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1 Aim of the experiment

To familiarise with the concept of Spectral analysis of different windows and FIR filters

2 Results/Graphs

2.1 Question 1

Window generation for rectangular, hamming and hanning windows.

Code : task1.m

Graph

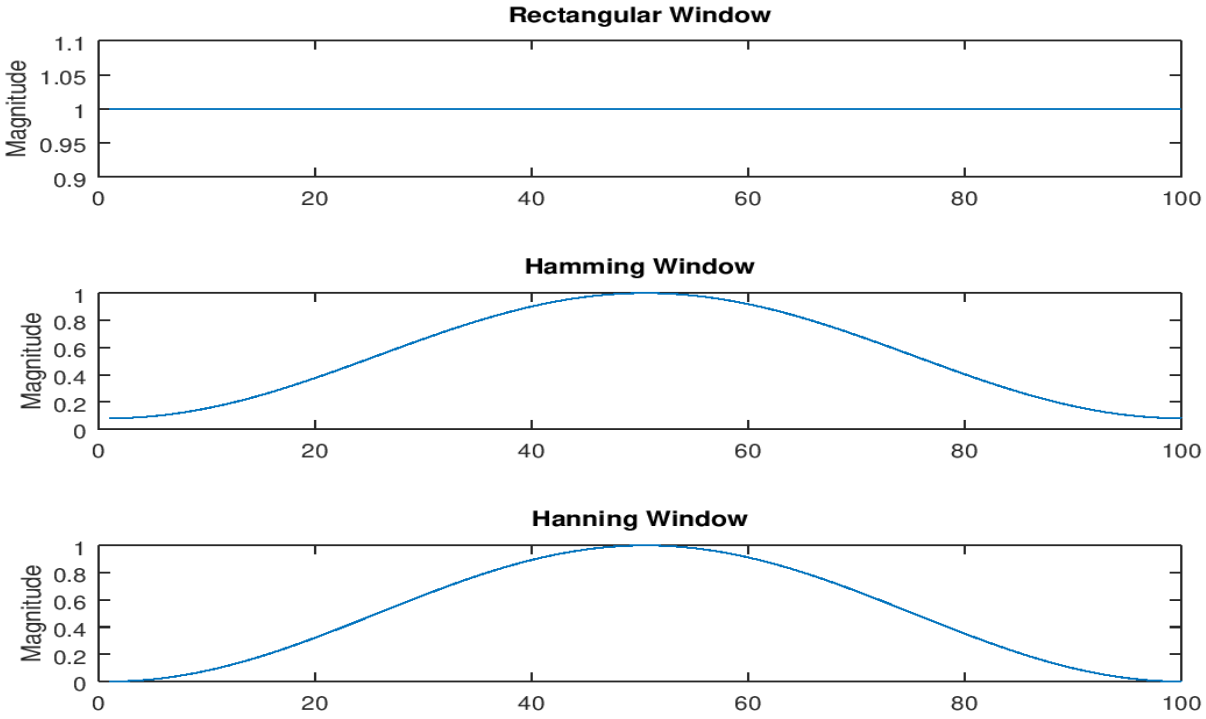

Figure 1: Rectangular, Hamming and Hanning windows

Observations

- Rectangular windowing is same as multiplying the signal by ones. It falls instantaneously to zero outside its range.
- Hamming window is smooth and looks like a raised cosine function. It has a smooth transition from its range of windowing to outside it. It however starts above zero and causes a slight discontinuity.
- Hanning window is similar to Hamming window except for the fact that it starts from exactly zero and thus averts even that slight discontinuity.

Conclusion

- Rectangular Windowing gives sharpest signals. However, if side lobes or noise are present, it cant do anything about them.
- Hanning and Hamming Windows are raised time dilated cosines which progressively attenuate the side lobes. They do however, cause the peaks to become wider, shorter and blunter.
- The only difference between Hanning and Hamming is the discontinuity Hamming has at zero. There is a tradeoff of features between Hanning/Hamming Windowing and Rectangular Windowing.

2.2 Question 2

Frequency analysis by taking a dense DFT.

Code : task2.m

a) Graph

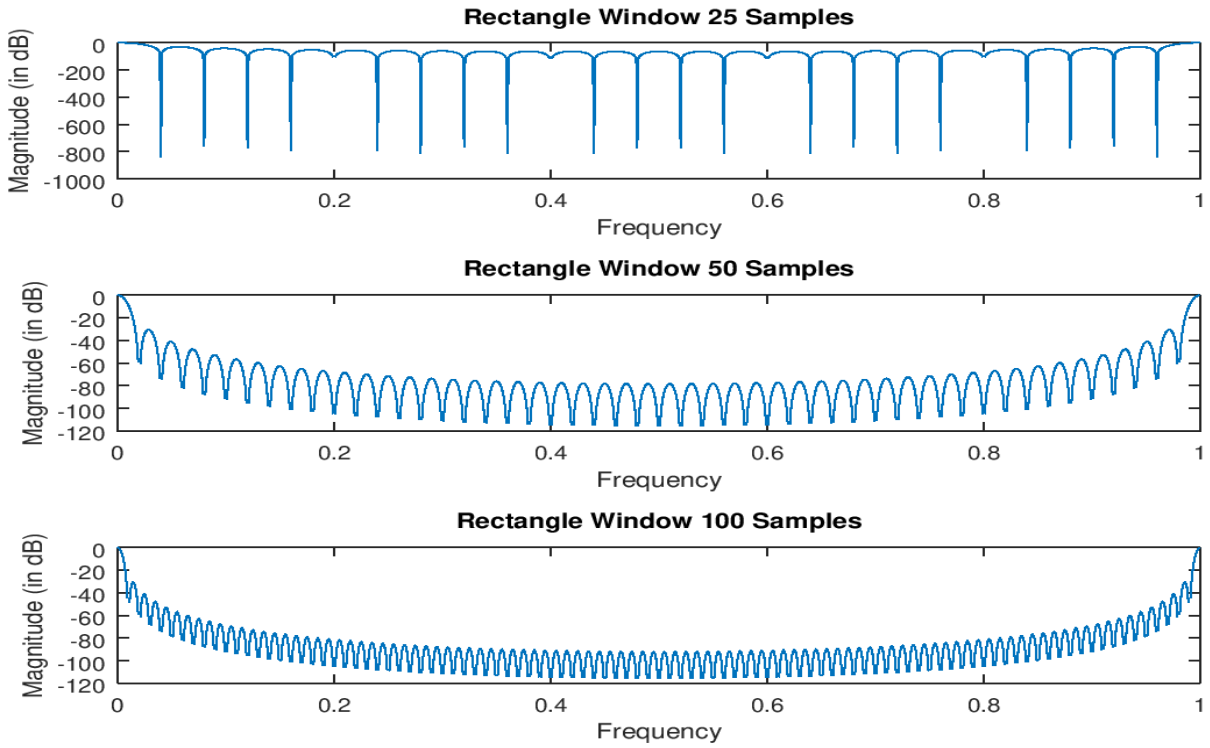

Figure 2: Rectangular Window

b) Graph

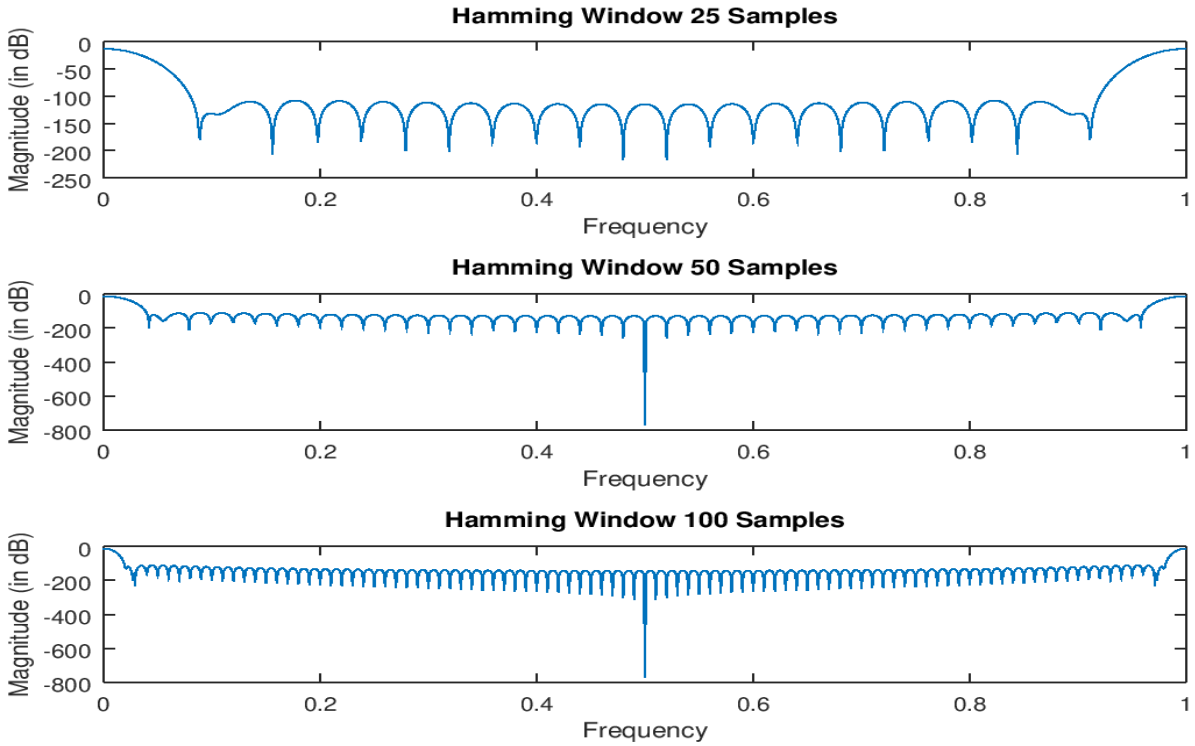

Figure 3: Hamming Window

c) Graph

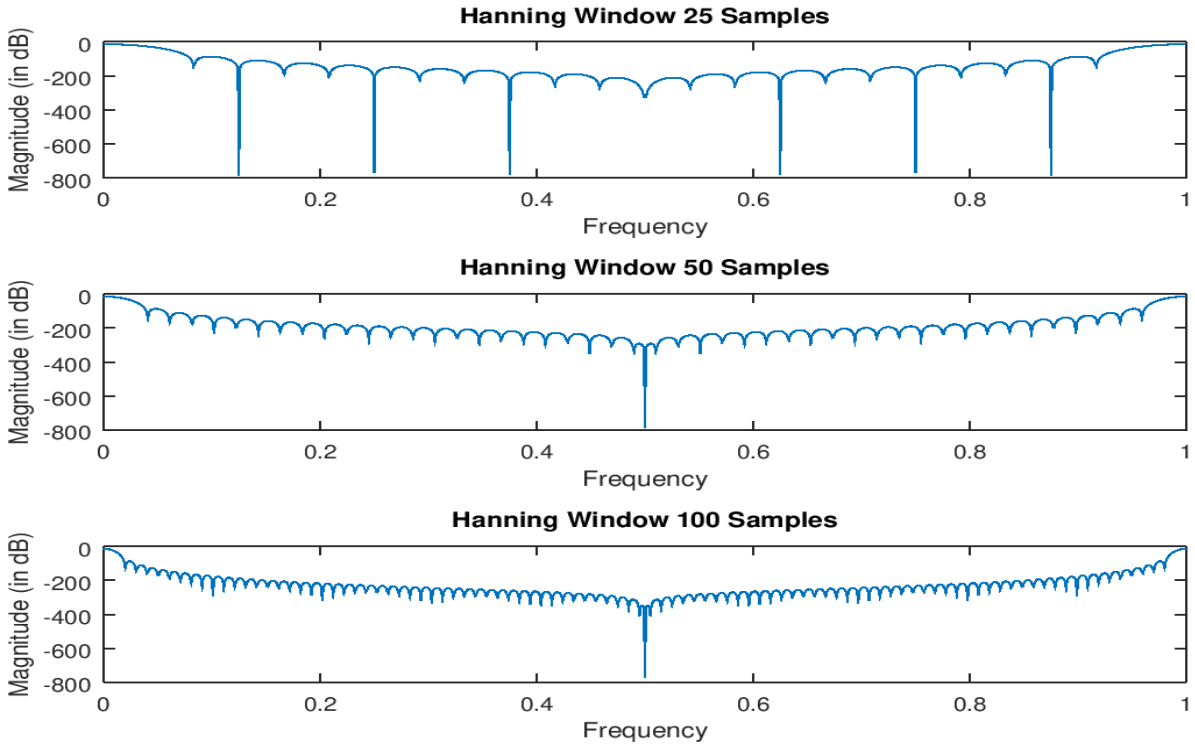

Figure 4: Hanning Window

Observations

- Taking a decibel scale on the y-axis helps enhance the visibility as the crests and troughs become more ostensible.
- The ratio of the height of the DC offset to the second peak is same for all three, m=25, 50 and 100. Here, all three FFTs have been scaled by 25, 50 and 100 respectively so that their gains come in the same range.
- The more the length of the window, more the lobes observed.

Conclusion

- The more the length of the window, better the interpolation of the FFT.
- Also, more the length, faster the transition from one point to the other or from one value of gain to another value of gain-better roll off.
- Wider the window, better the selectivity.

2.3 Question 3

Low pass FIR filter using Rectangular and Hamming windowing function

Code : task3.m

a) Graph

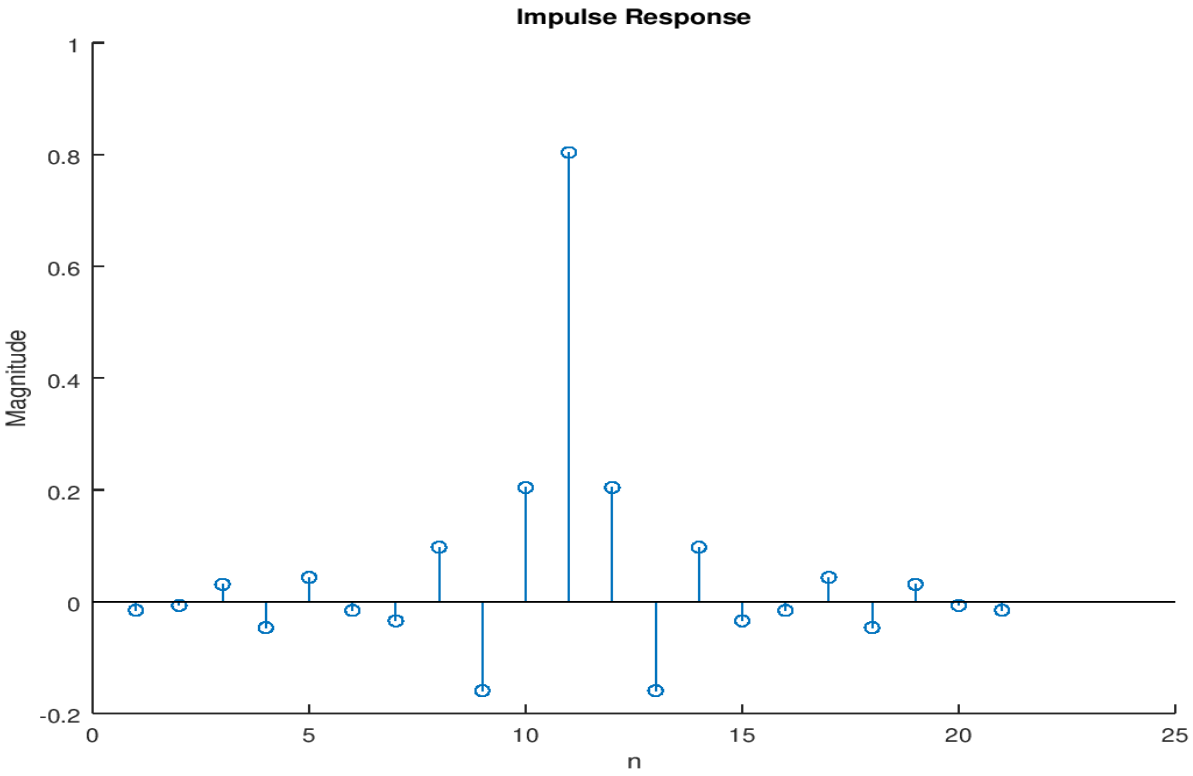

Figure 5: Impulse Response of Rectangular Window

b) Graph

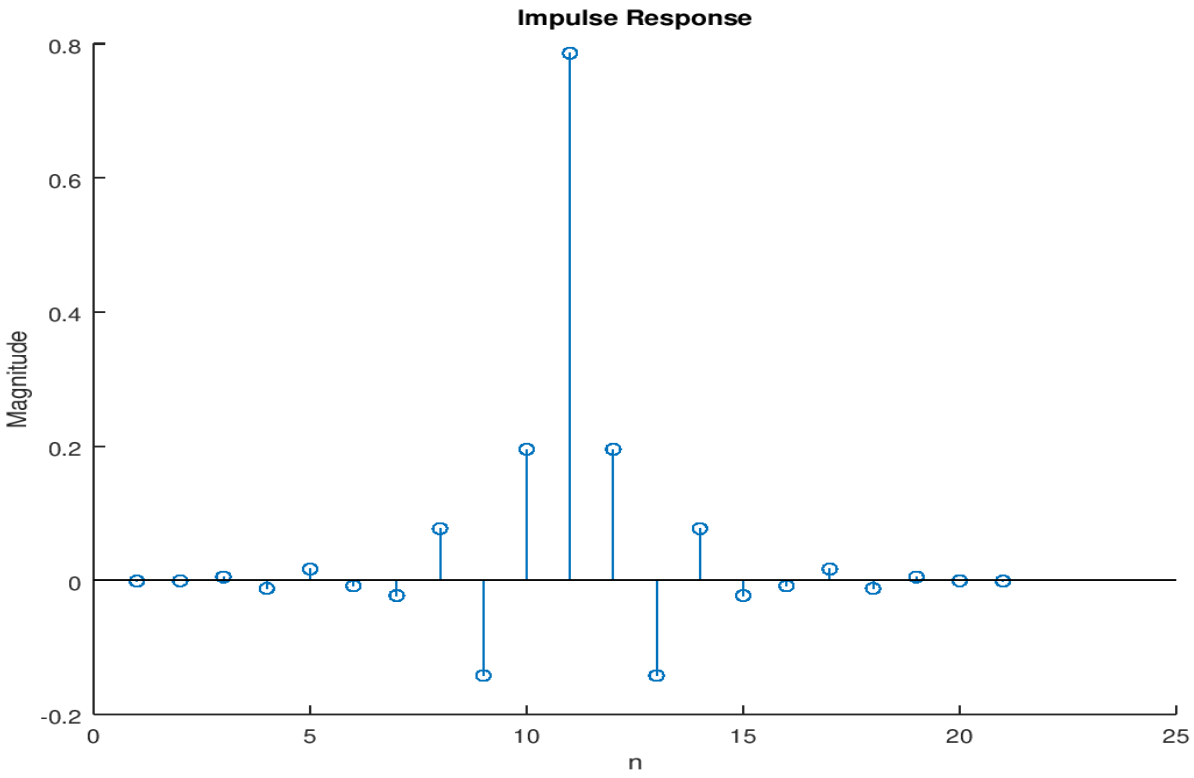

Figure 6: Impulse Response of Hamming Window

c) Graph

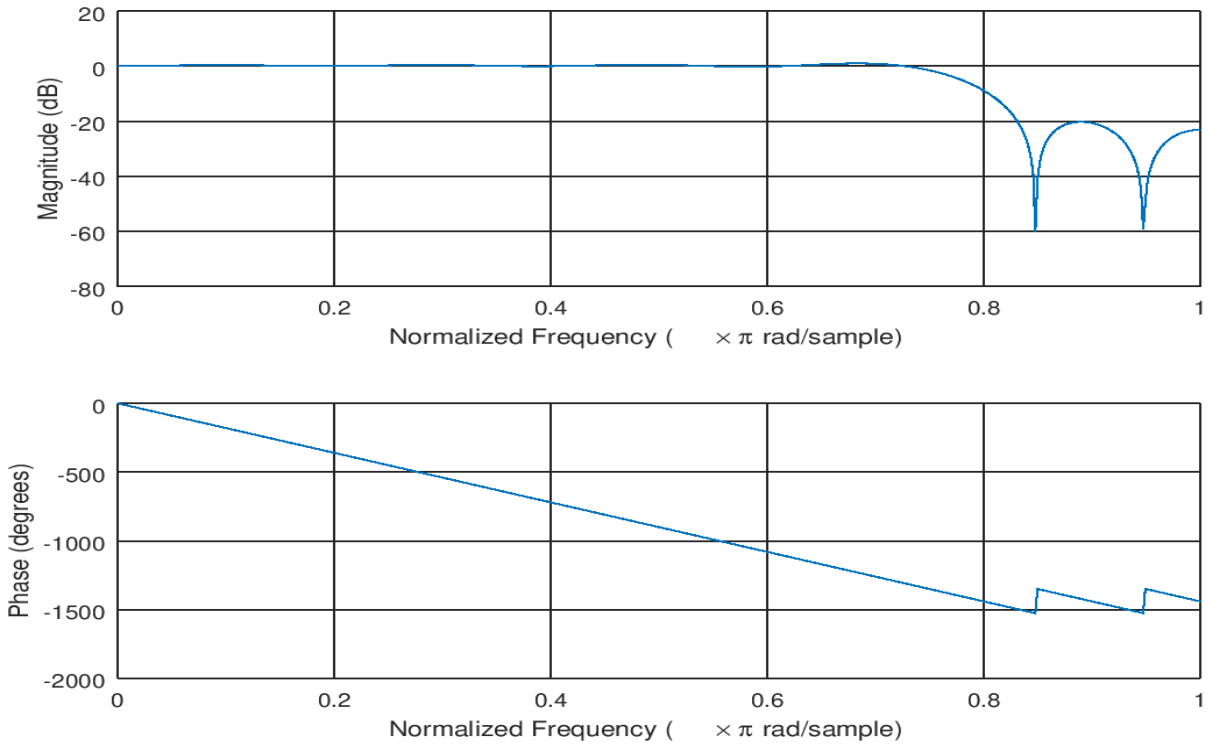

Figure 7: Bode Analysis of Rectangular Window

d) Graph

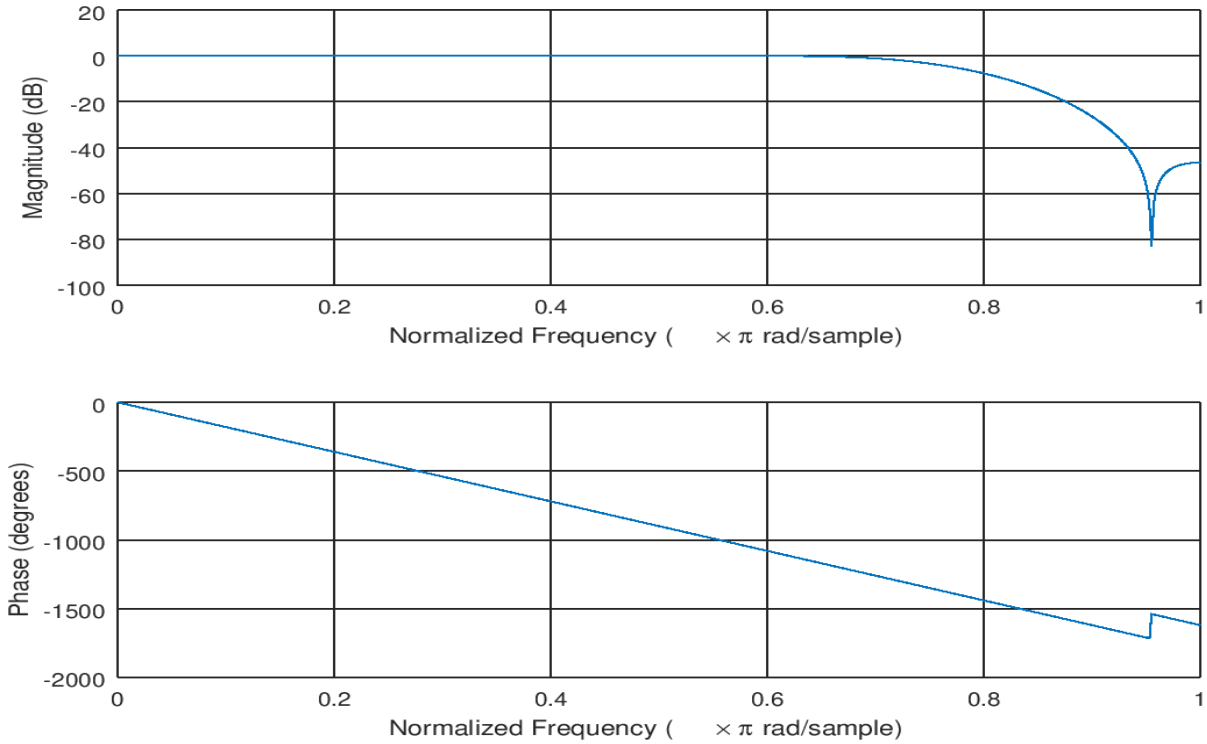

Figure 8: Bode Analysis of Hamming Window

Observations

- The impulse response of the rectangular window has more prominently side lobes than that of the Hamming window.
- The rectangular window filter has faster transition from passband to stopband or faster roll off but lesser attenuation in the stopband.
- The hamming windowed filter has slower transition from passband to stopband or slower roll off but, attenuates the stopband ripples much more.

Conclusion

- The windows act like filters in their own accord. Convolution in time domain is equivalent to multiplication in frequency domain.
- The FFT of the windows show that they act like low pass filters.
- When a signal in its frequency domain is multiplied with the FFT of the windows it would filter the lower frequencies of that signal acting like LPF.