



DIGITAL SIGNAL PROCESSING LAB

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Experiment Number	06
Date of Experiment	17/02/2021
Date of Submission	24/02/2021
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Section	ETC - 06

Aim of The Experiment :-

To design FIR, LPF, HPF & BPF using windowing techniques

Software Required :-

- MATLAB R2018a

Theory :-a) **FIR:**

- Finite Impulse Response
- It is a filter whose impulse response is of finite period, as a result of it settles to zero in finite time
- Used to implement almost any sort of frequency digitally.

b) **LPF:**

- Low pass filter
- It passes signals with a frequency lower than a selected cutoff frequency and attenuates signals with a frequency higher than cutoff frequency
- Filters noise from a circuit.

c) **HPF:**

- High pass filter
- It allows the signals with frequency higher than a certain cutoff frequency and attenuates signals with a lower than the cut off frequency.

d) **BPF:**

- Band pass filter
- A device that passes frequency within a certain range and alternative frequency outside that range.

Cut-off frequencies of the filters ($\times \pi \text{ rad/samples}$)

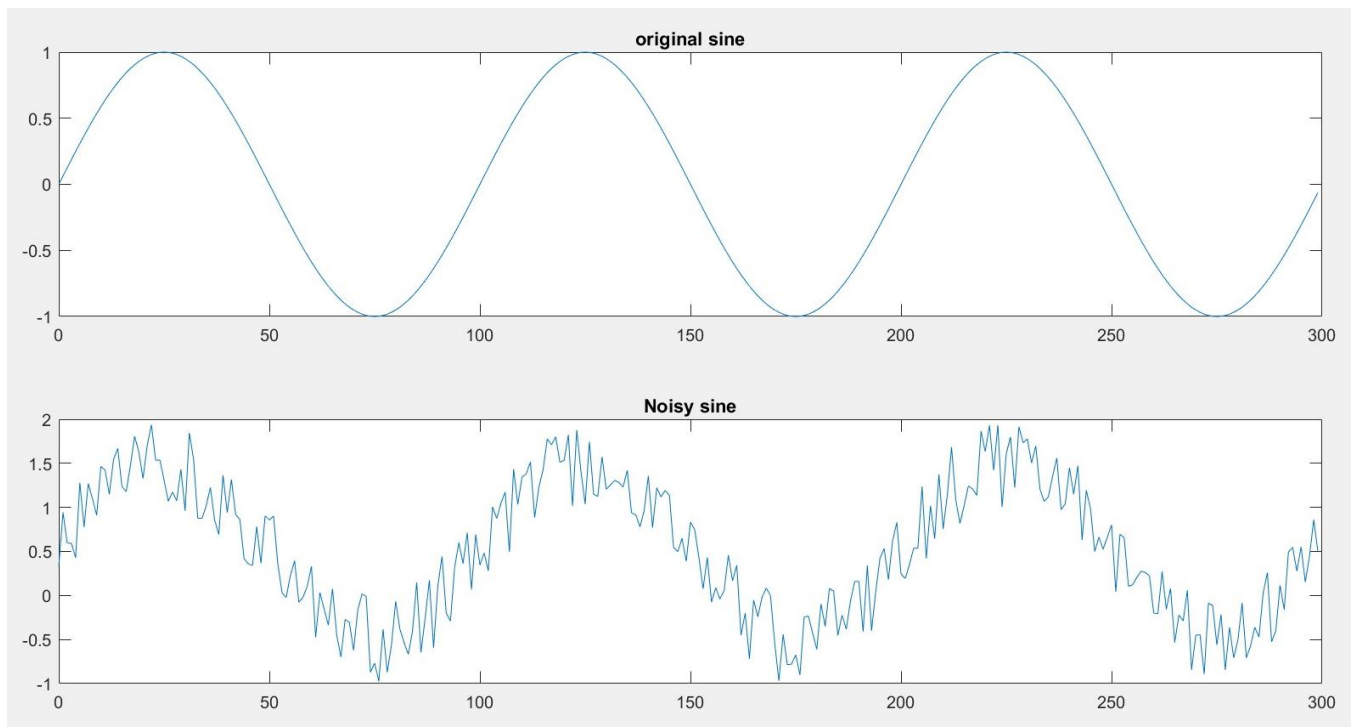
	Rectangular Window	Triangular Window
Low Pass	0.3	0.3
High Pass	0.6	0.6
Band Pass	0.2, 0.5	0.2, 0.5

Code :-

```

%Main code for designing FIR Filter
%written by Debagnik Kar 1804373
clear all
close all
clc
prompt0 = input('Select window [Rect(1)/tri(2)]: ')
prompt1 = input('select filter type [LP(1)/HP(2)/BP(3)]: ')
N = 50
switch prompt0
    case 1
        win = rectwin(N+1)
    case 2
        win = triang(N+1)
    otherwise
        win = []
        disp('error')
end
switch prompt1
    case 1
        fil = "low"
        cut = 0.3
    case 2
        fil = "high"
        cut = 0.5
    case 3
        fil = "bpf"
        cut = [0.3 0.5]
    otherwise
        disp('error 2')
end
fs = 1000
N1 = 300
n = 0:N1-1
%generation and adding noise
xn = sin(20*pi*n/fs)
figure(1)
subplot 211
plot(n,xn)
title("original sine")
rn = xn+rand(size(xn))
subplot 212
plot(n,rn)
title('Noisy sine')
%Filtering
fxn = fir1(N,cut,fil,win)
yn = filter(fxn,1,rn)
figure(2)
subplot 313
freqz(fxn)
figure(3)
plot(n,yn)

```

Graph/Output :-*Fig 6.1: Input signals*

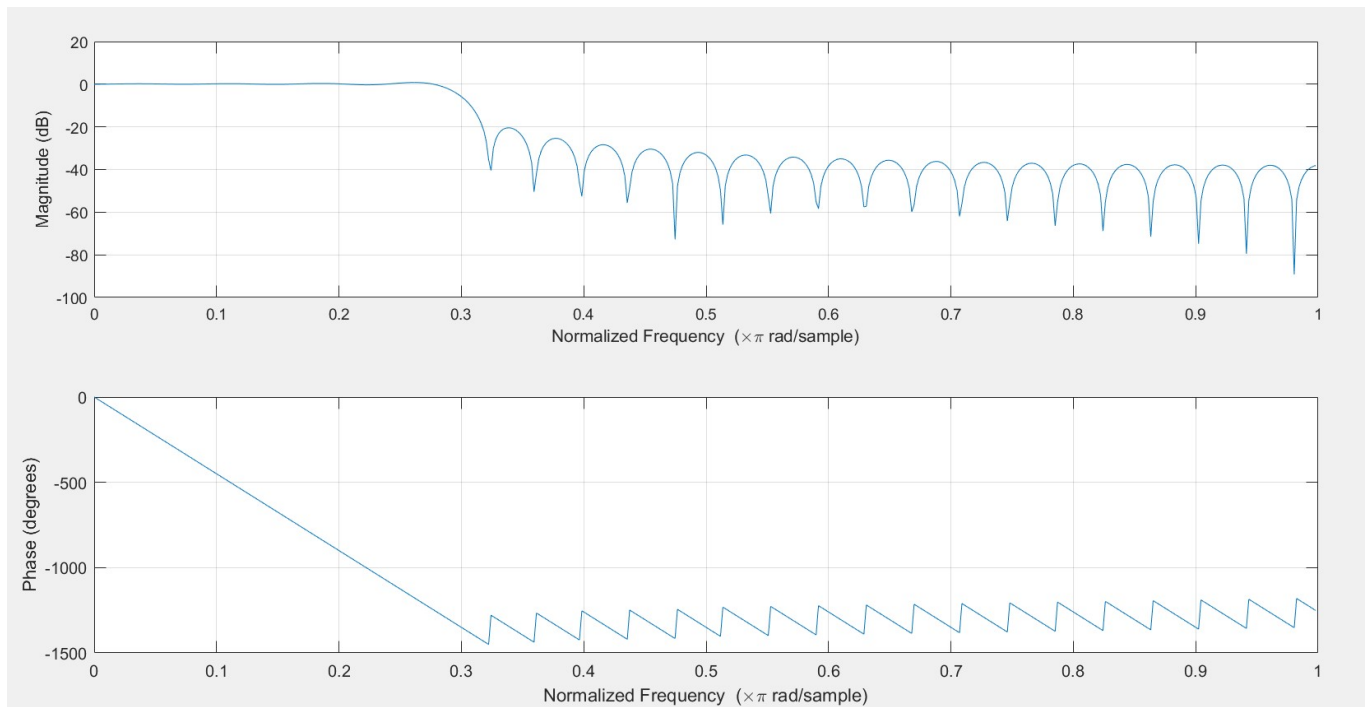


Fig 6.2: frequency response of the low-pass FIR filter with rectangular window

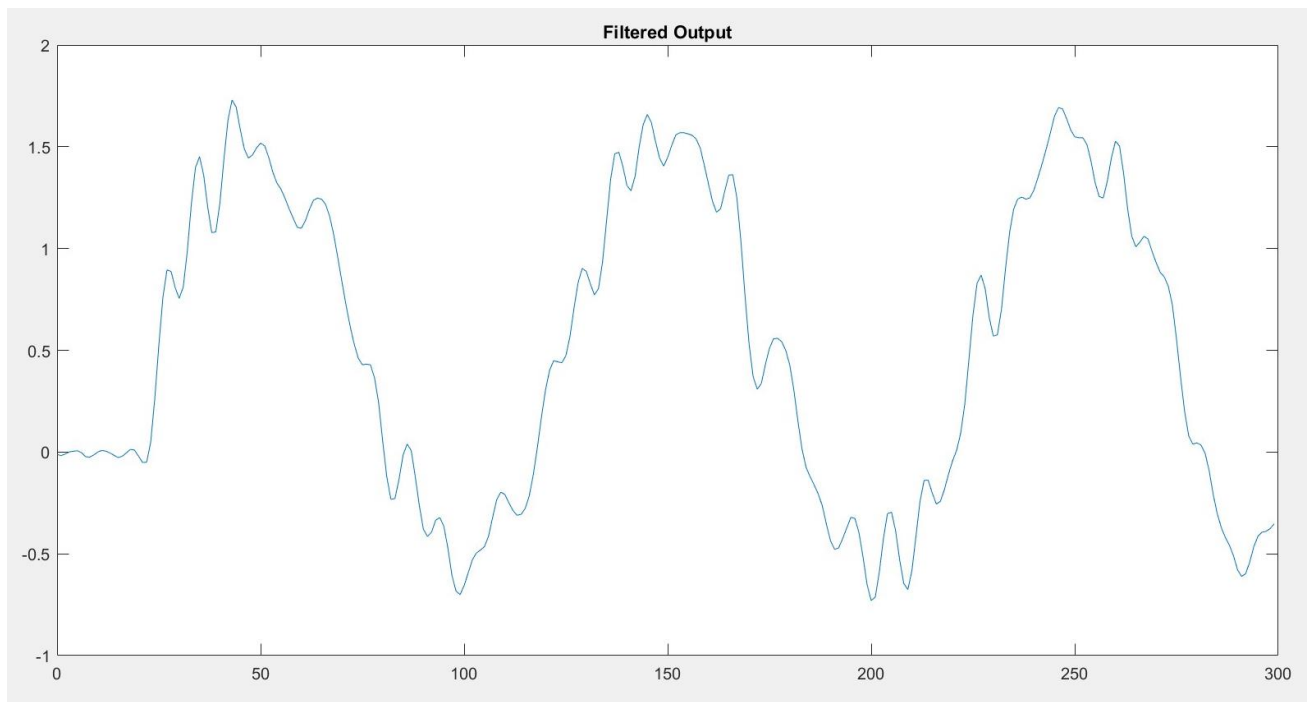


Fig 6.3: filtered output. (Low pass – rectangular window)

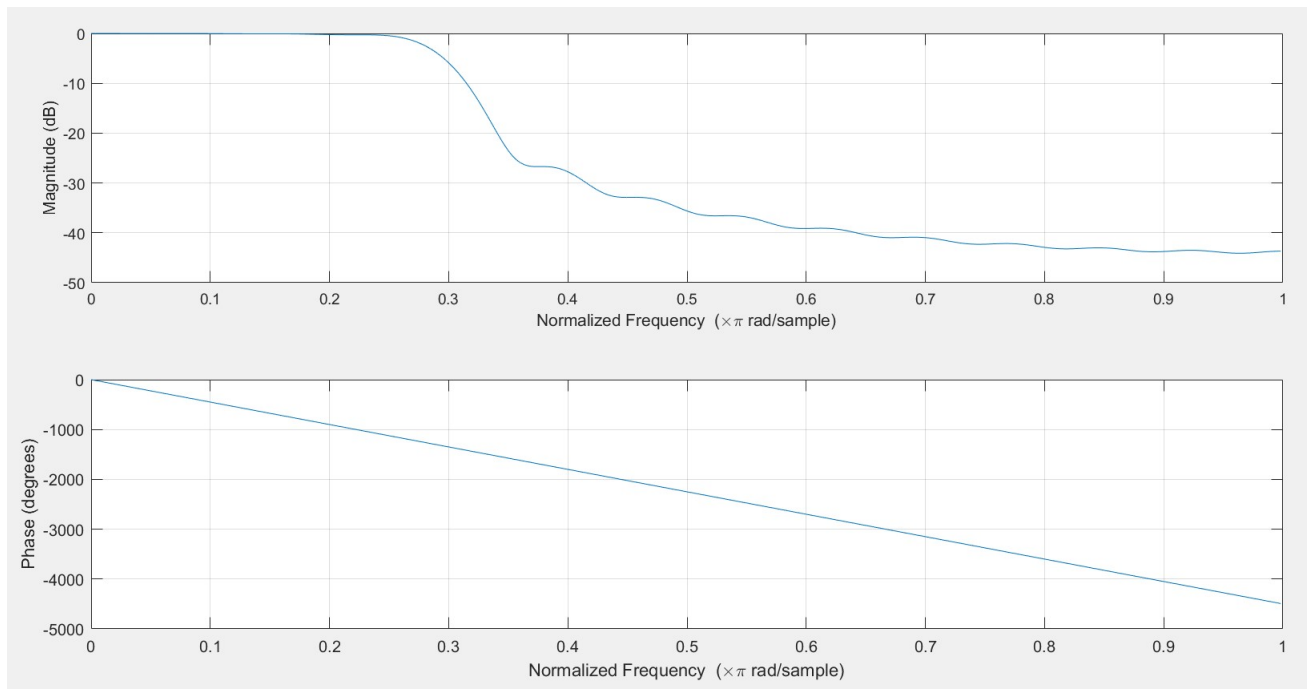


Fig 6.4: frequency response of lowpass FIR filter with triangular window

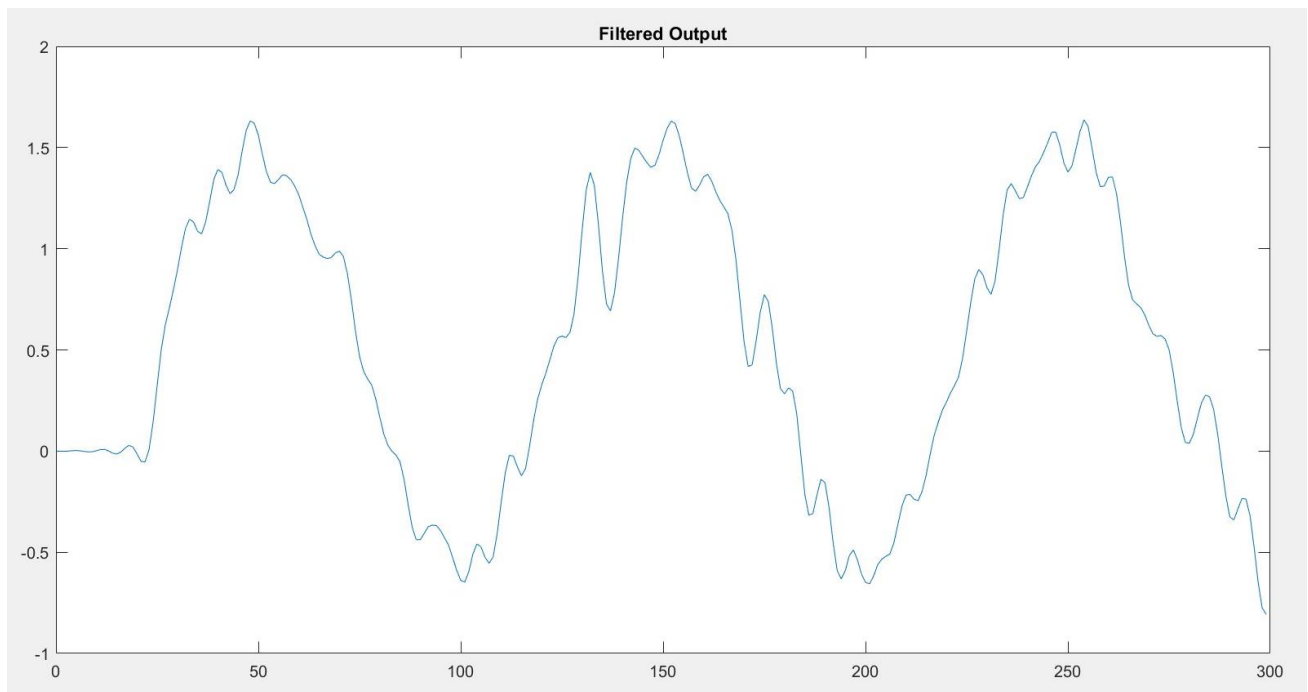


Fig 6.5: filtered output. (Low pass – triangular window)

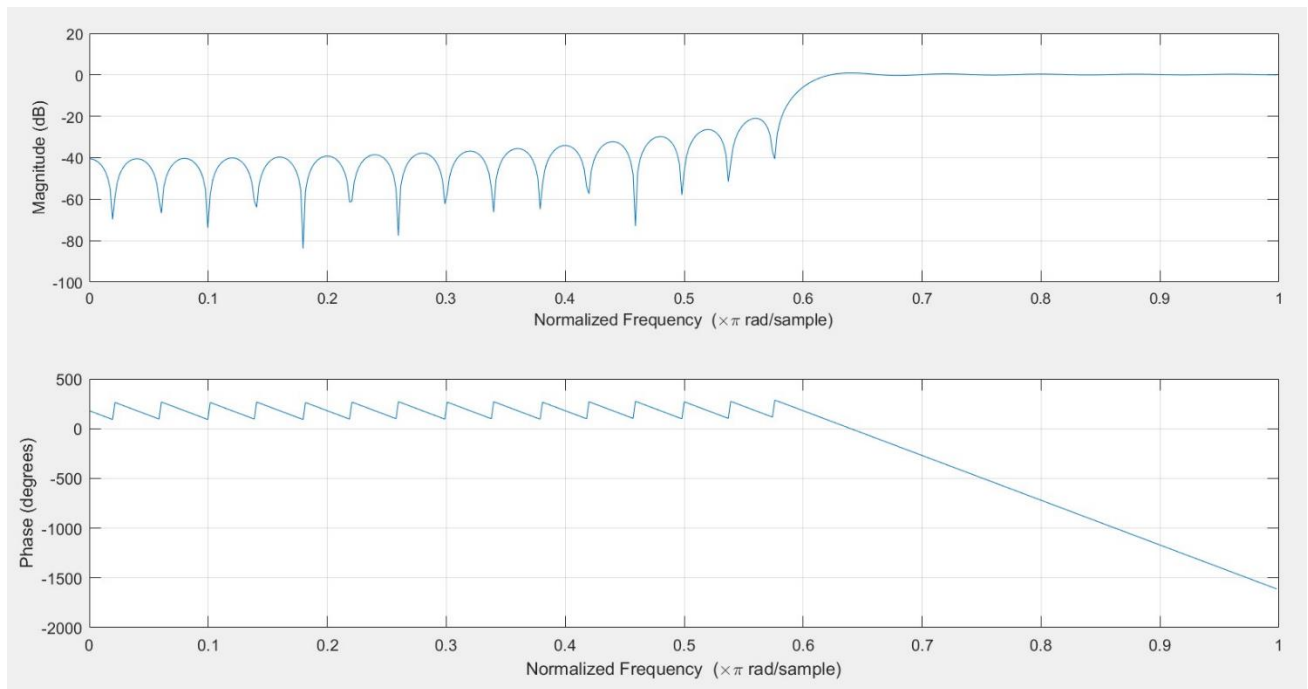


Fig 6.6: frequency response of high pass FIR filter with rectangular window

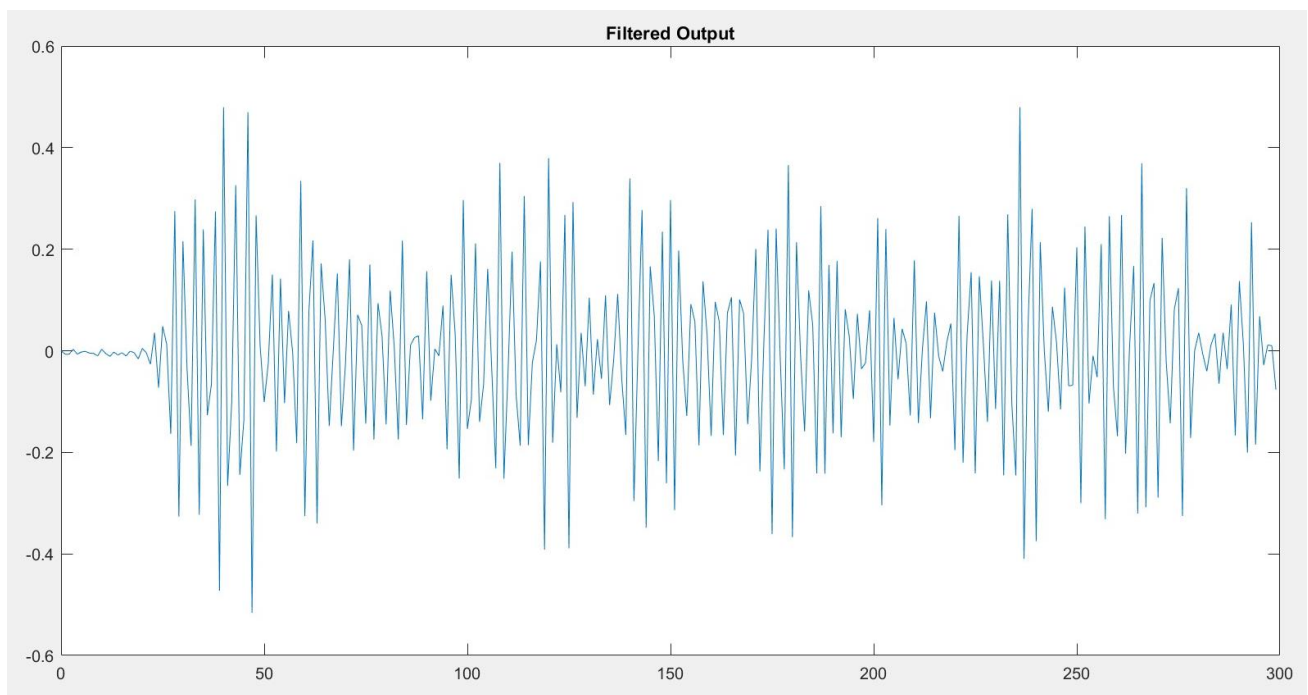


Fig 6.7: filtered output for high pass FIR filter with rectangular window

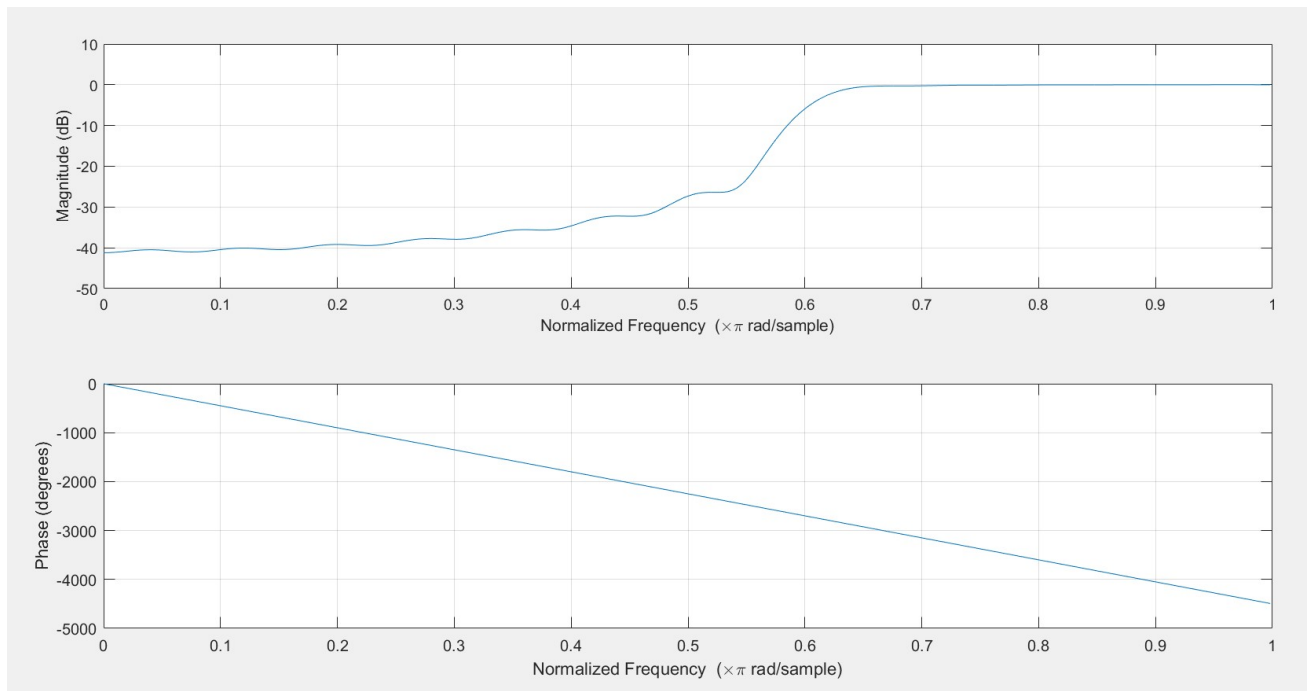


Fig 6.8: frequency response of high pass FIR filter with triangular window

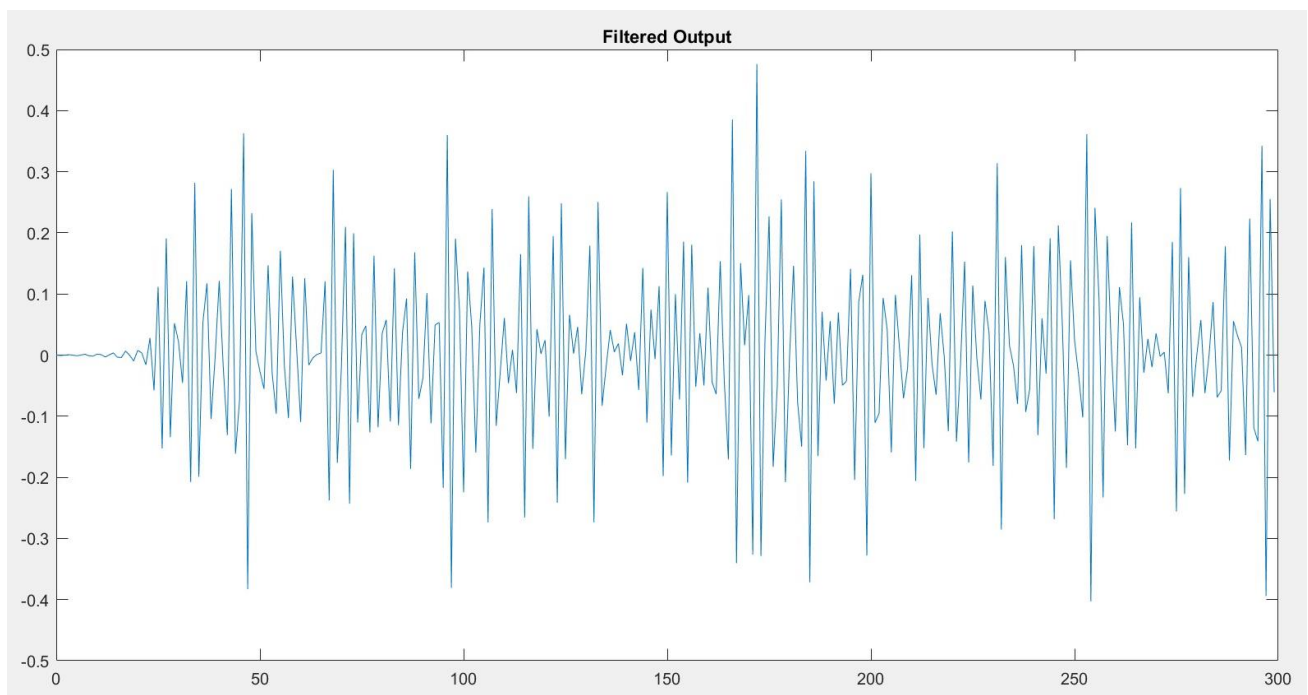


Fig 6.9: filtered output for high pass FIR filter with triangular window

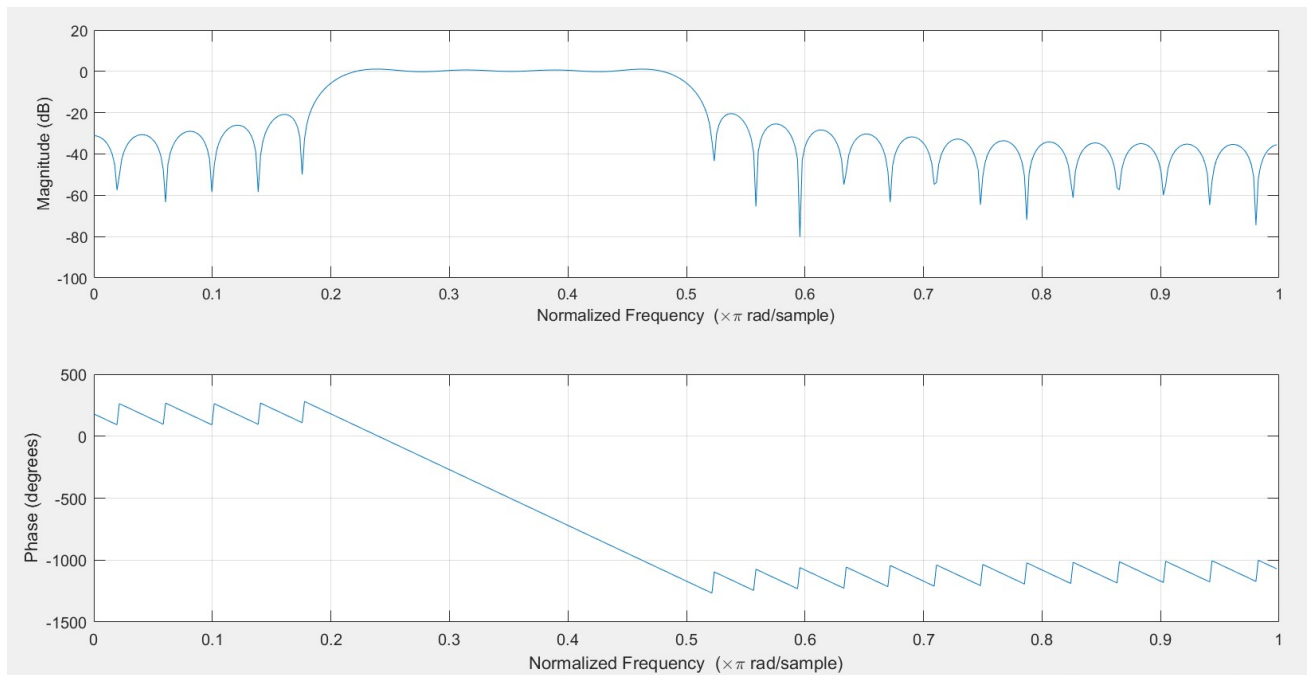


Fig 6.10: frequency response of band pass FIR filter with rectangular window

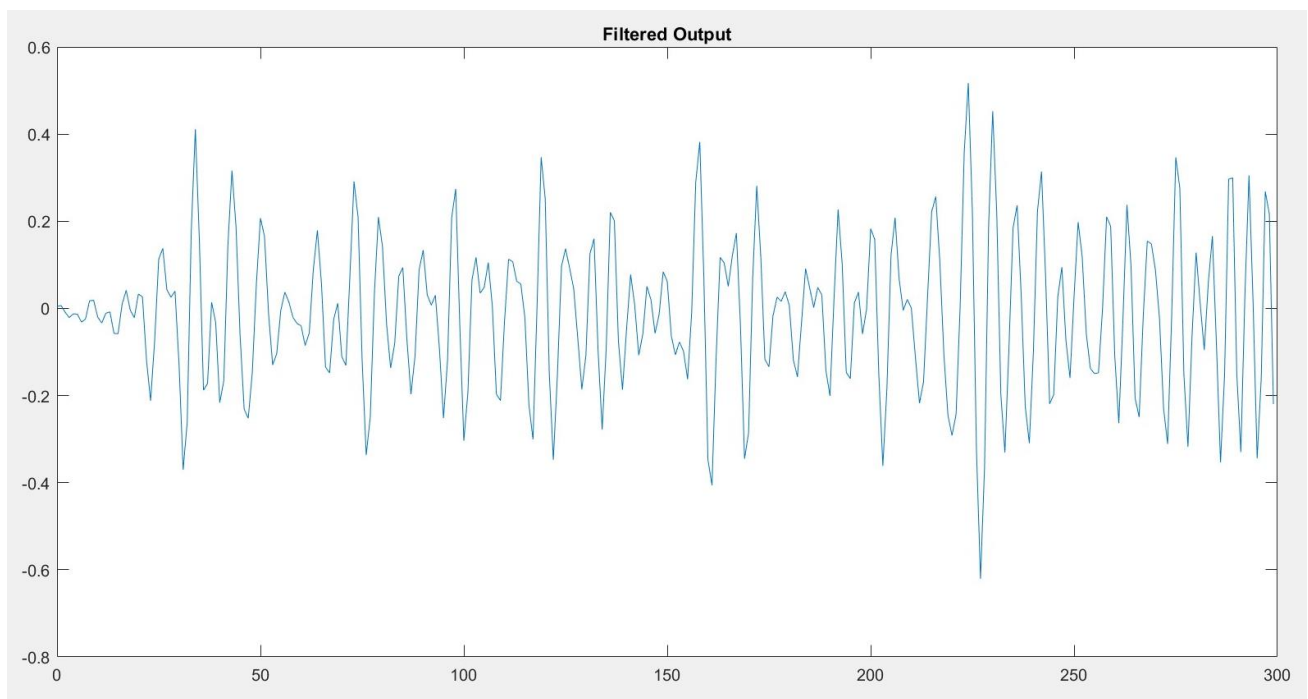


Fig 6.11: filtered output for band pass FIR filter with rectangular window

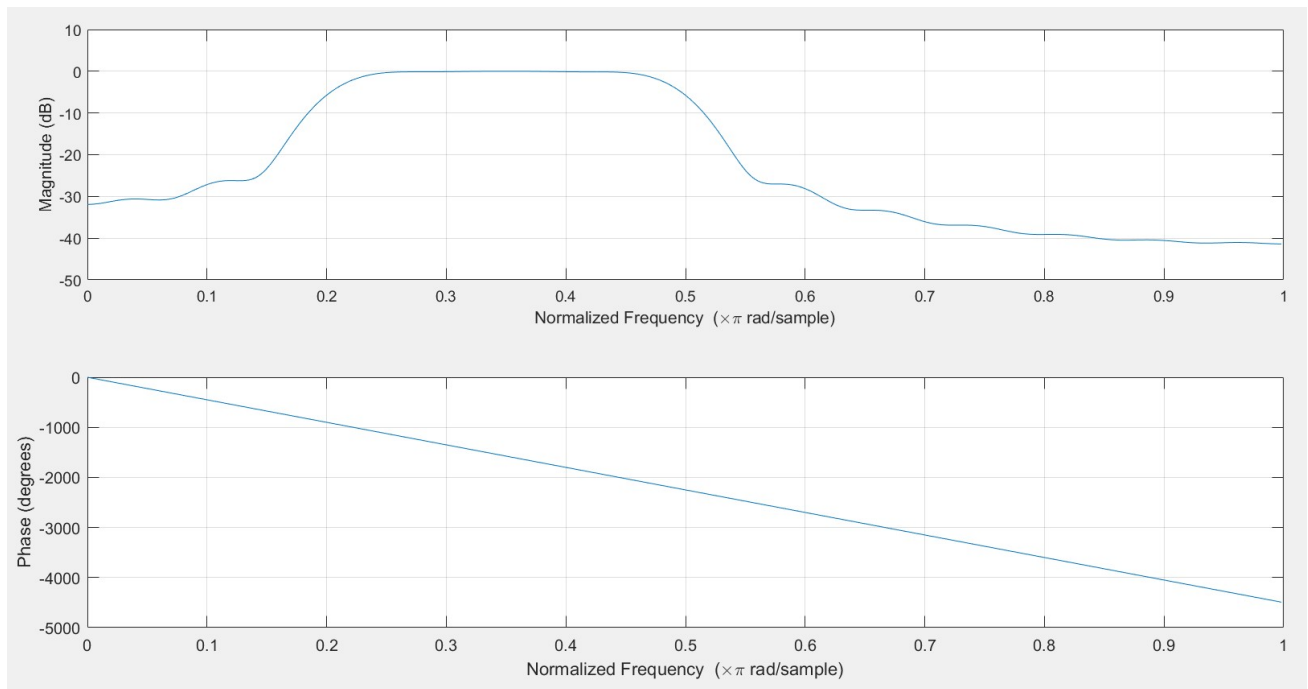


Fig 6.12: frequency response of band pass FIR filter with triangular window

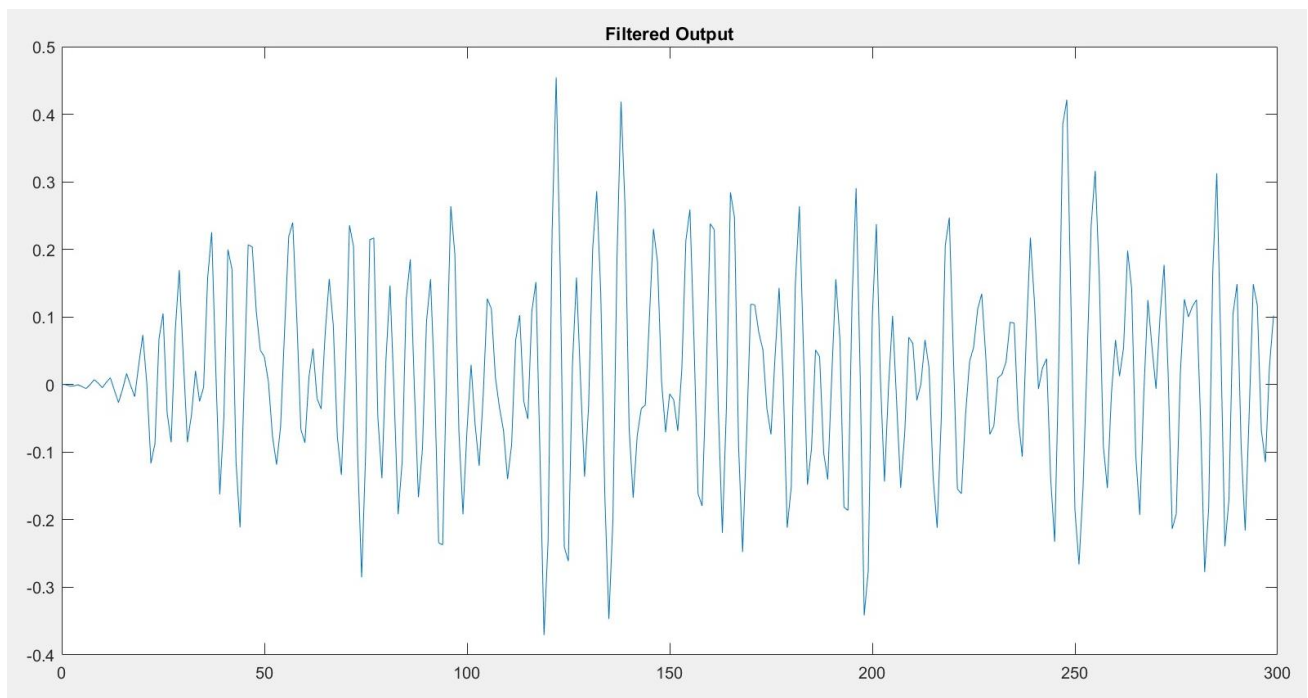


Fig 6.13: filtered output for band pass FIR filter with triangular window

Discussion/Inference of the experiment :-

In this experiment we designed FIR filters using rectangular and triangular window for lowpass, high pass, and bandpass by simulation in MATLAB.

For windows we used `rectwin()` and `triang()` functions. We generated a sinusoidal message signal to it. Then created the FIR filter by using the `fir1()` functions with the appropriate parameters for high, low or bandpass filters and also designed assigned the cut-off frequency accordingly. Then used the `filter()` function and the frequency responses using `freqz()`.

Conclusion :-

We designed and simulated a lowpass/high pass/bandpass FIR filter successfully using MATLAB using windowing techniques.