



## DIGITAL SIGNAL PROCESSING LAB

Debagnik Kar

Roll: 1804373, ETC -06, EC - 3096

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<b>Experiment Number</b>	07
<b>Date of Experiment</b>	24/02/2021
<b>Date of Submission</b>	03/03/2021
<b>Name of the Student</b>	Debagnik Kar
<b>Roll Number</b>	1804373
<b>Section</b>	ETC - 06

**Aim of The Experiment :-**

To Study various parameters required for designing an IIR filter and design LPF, HPF and BPF Butterworth filters for specific cut-off frequencies.

**Software Required :-**

- MATLAB R2018a

**Theory :-****IIR:**

The infinite impulse response (IIR) filter is a recursive filter in that the output from the filter is computed by using the current and previous inputs and previous outputs. Because the filter uses previous values of the output, there is feedback of the output in the filter structure.

**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.

**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.

**BPF:**

Band pass filter

A device that passes frequency within a certain range and alternative frequency outside that range.

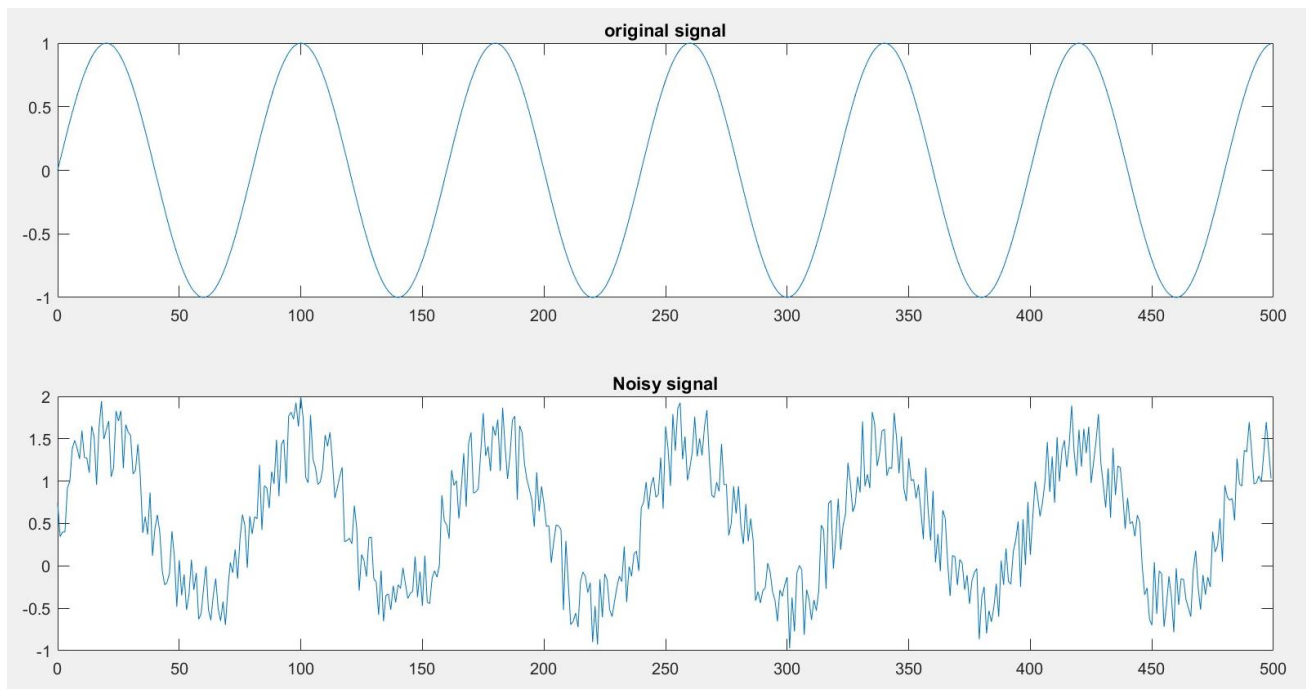
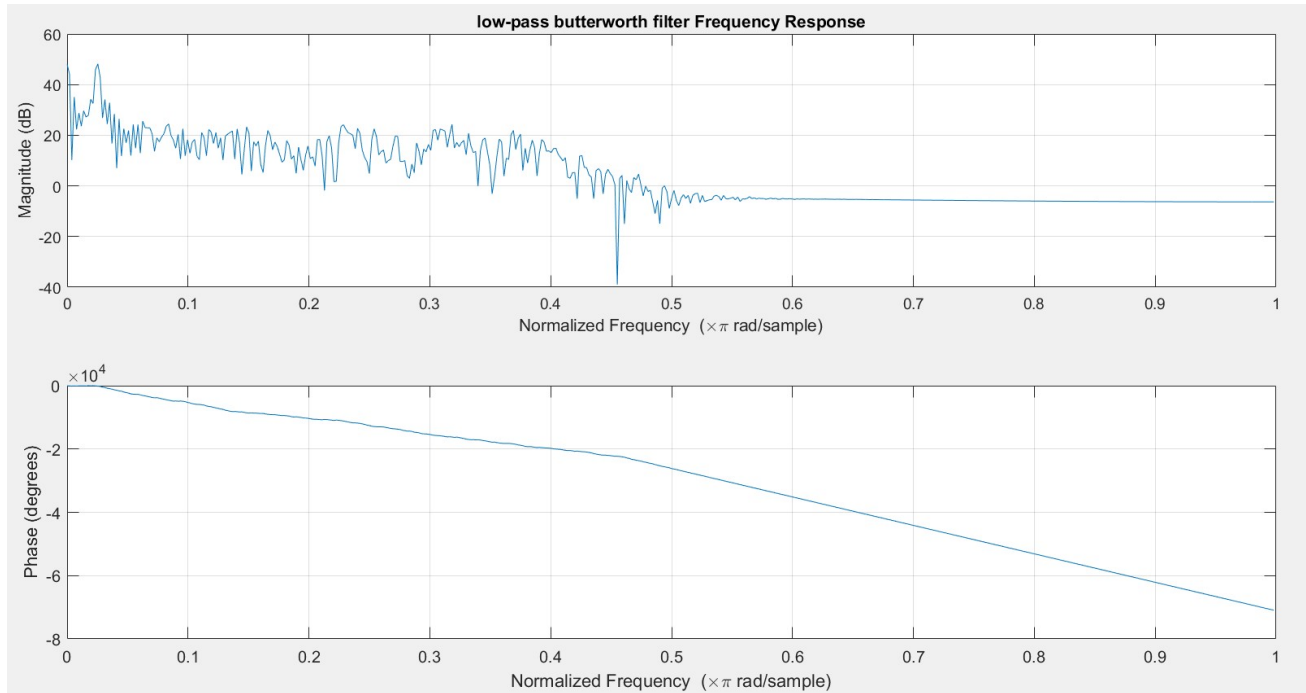
<b>Filter Type</b>	<b>Cutoff Frequency</b>
Low Pass	0.4
High Pass	0.6
Band Pass	0.3, 0.5

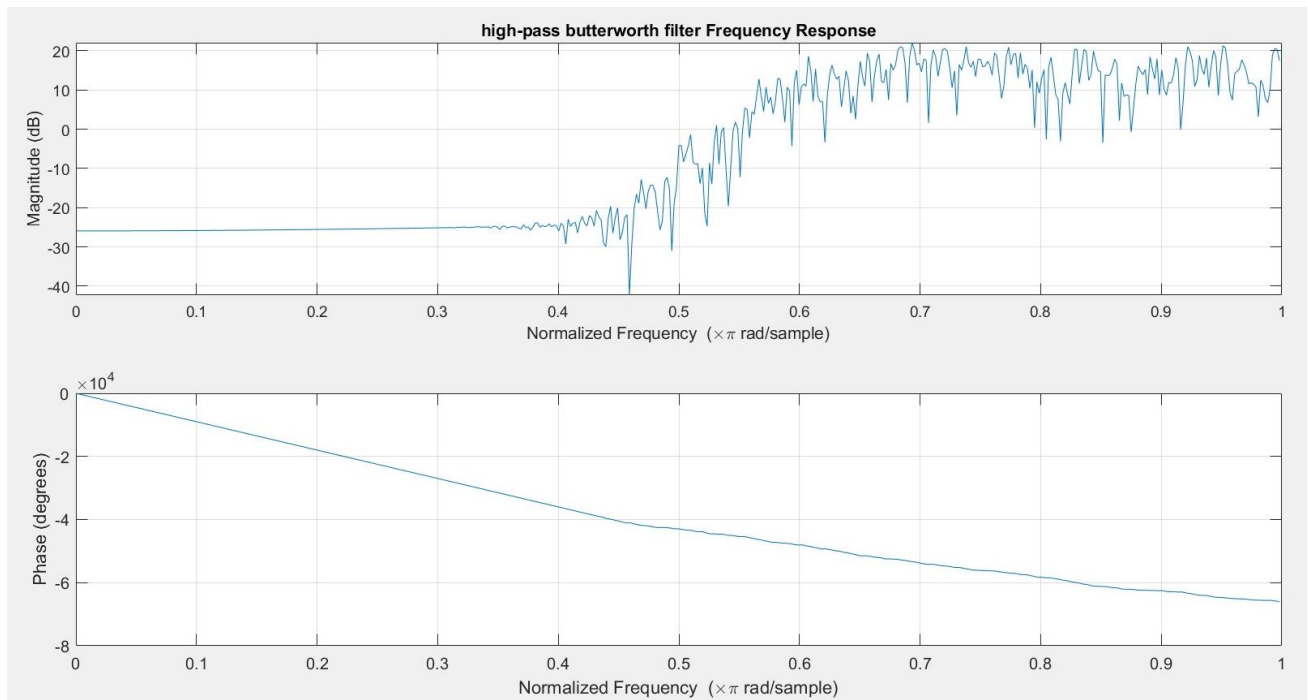
**Code :-**

```

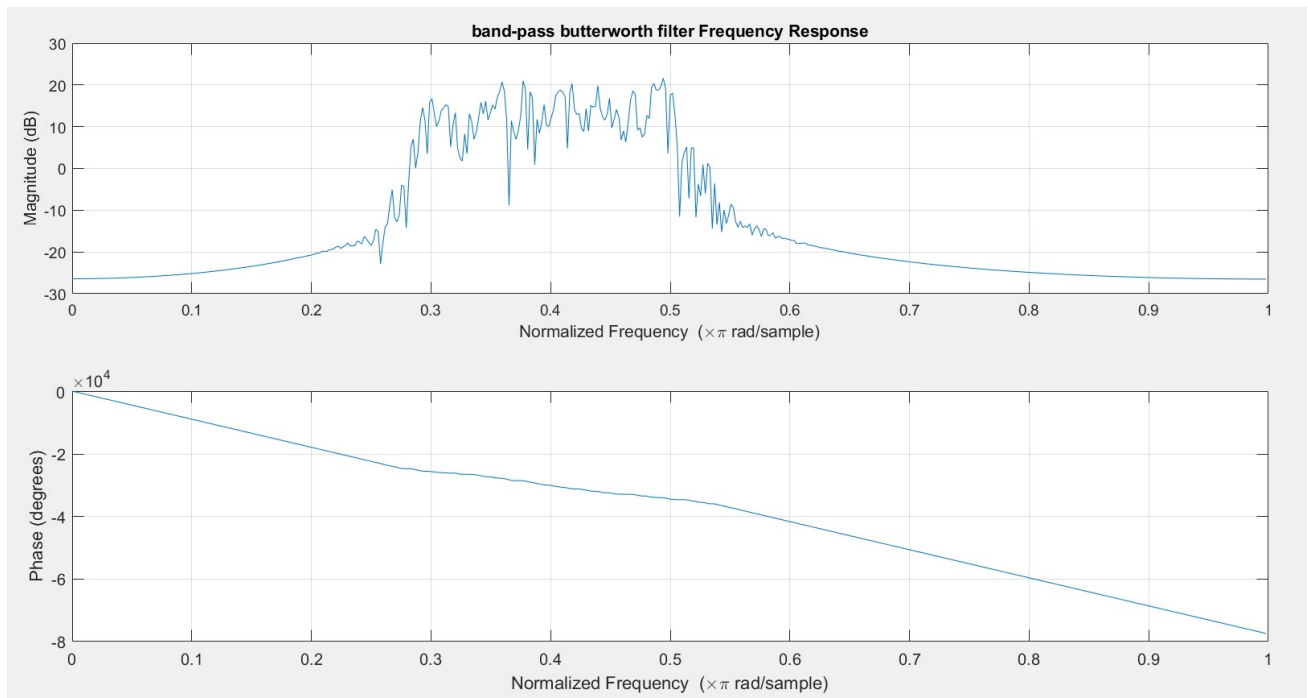
%main.m generates a IIR filter to filter a noisy signal
%Written by Debagnik Kar 1804373
clc
clear all
close all
N = 50
fs = 800
N1 = 500
n = 0:N1-1
prompt0 = input('Select filter (1) Butter (2) chebishev: ')
prompt1 = input('Select filer type (1) LP (2) HP (3) BP: ')
xn = sin(20*pi*n/fs)
figure(1)
subplot 211
plot(n,xn)
title('original signal')
rn = rand(size(n)) + xn
subplot 212
plot(n,rn)
title('Noisy signal')
switch prompt1
    case 1
        fil = 'low'
        Wc = 0.4
        str0 = 'low-pass'
    case 2
        fil = 'high'
        Wc = 0.6
        str0 = 'high-pass'
    case 3
        fil = 'bandpass'
        Wc = [0.3 0.5]
        str0 = 'band-pass'
    otherwise
        exit()
end
switch prompt0
    case 1
        [b a] = butter(10,Wc,fil)
        str2 = 'butterworth filter'
    case 2
        [b a] = cheby2(N,80,Wc,fil)
        str2 = 'chebyshev filter'
end
f = filter(b,a,rn)
str1 = strcat(str0,{' '},str2)
figure(3)
freqz(f)
title(str1)

```

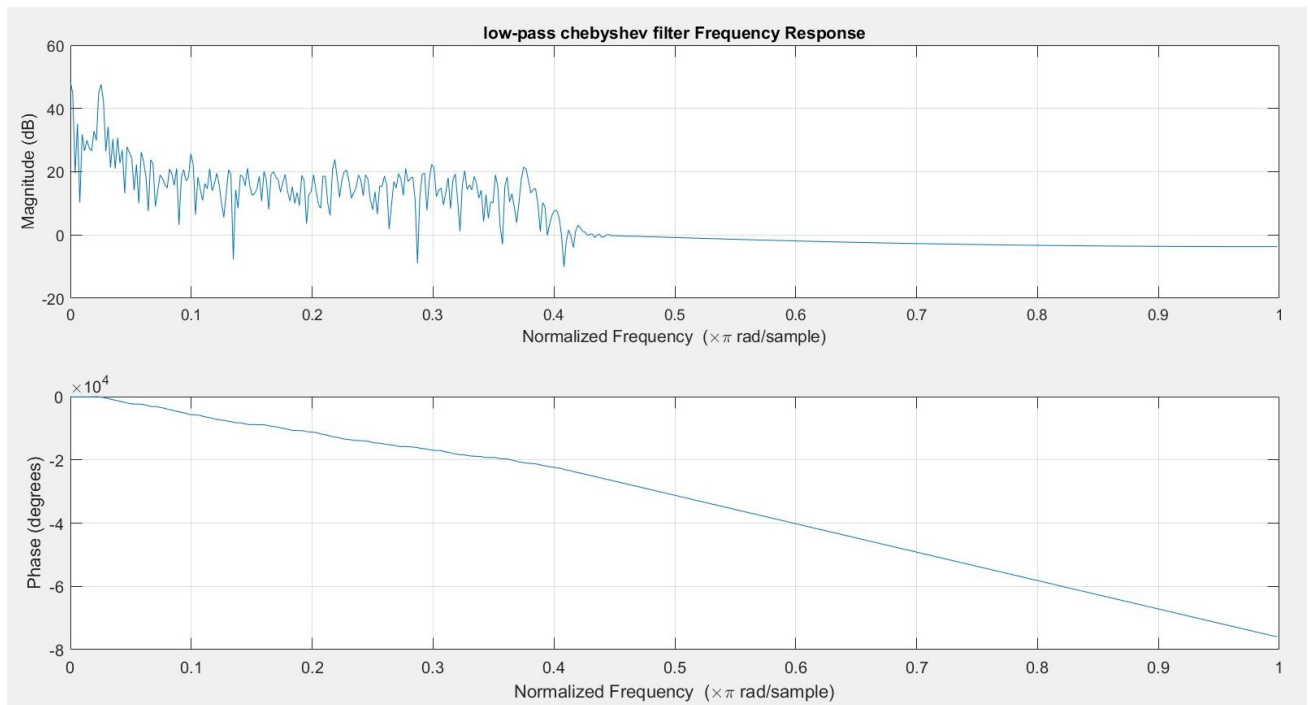
**Graph/Output :-***Fig 7.1: input signal**Fig 7.2: Low Pass Butterworth Filter frequency response*



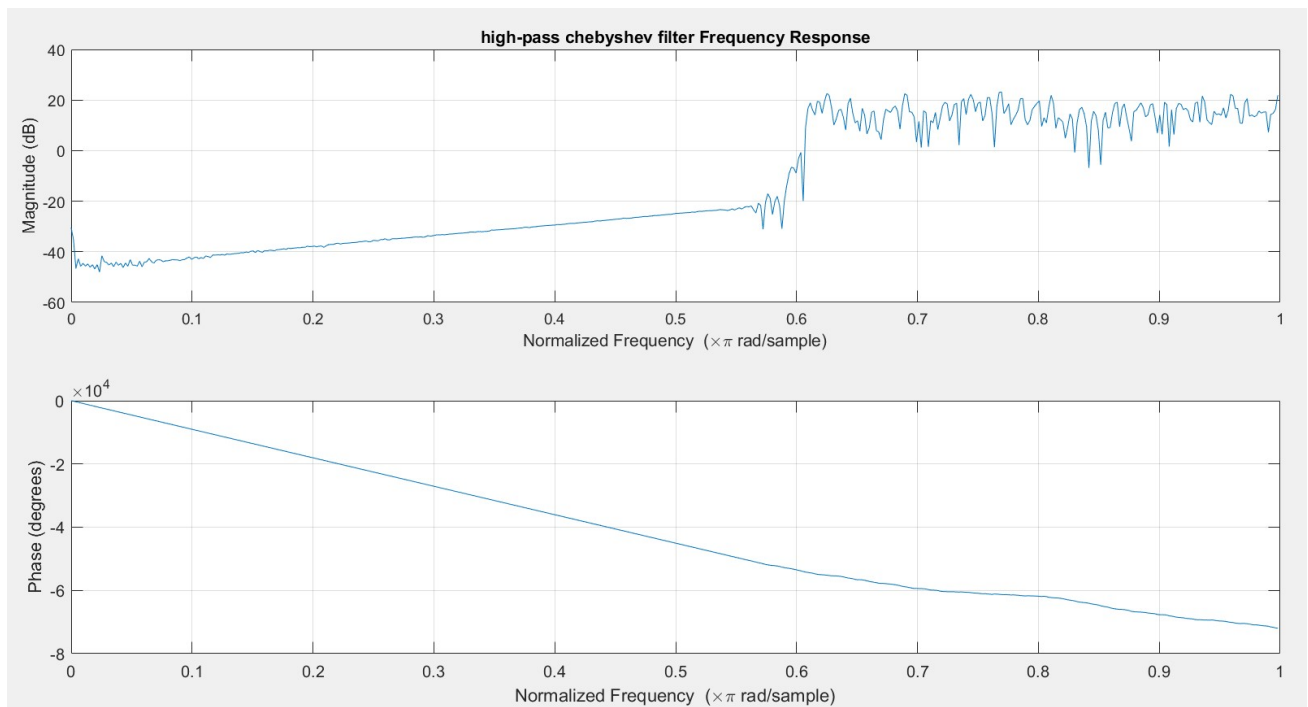
*Fig 7.3: High Pass Butterworth filter frequency response.*



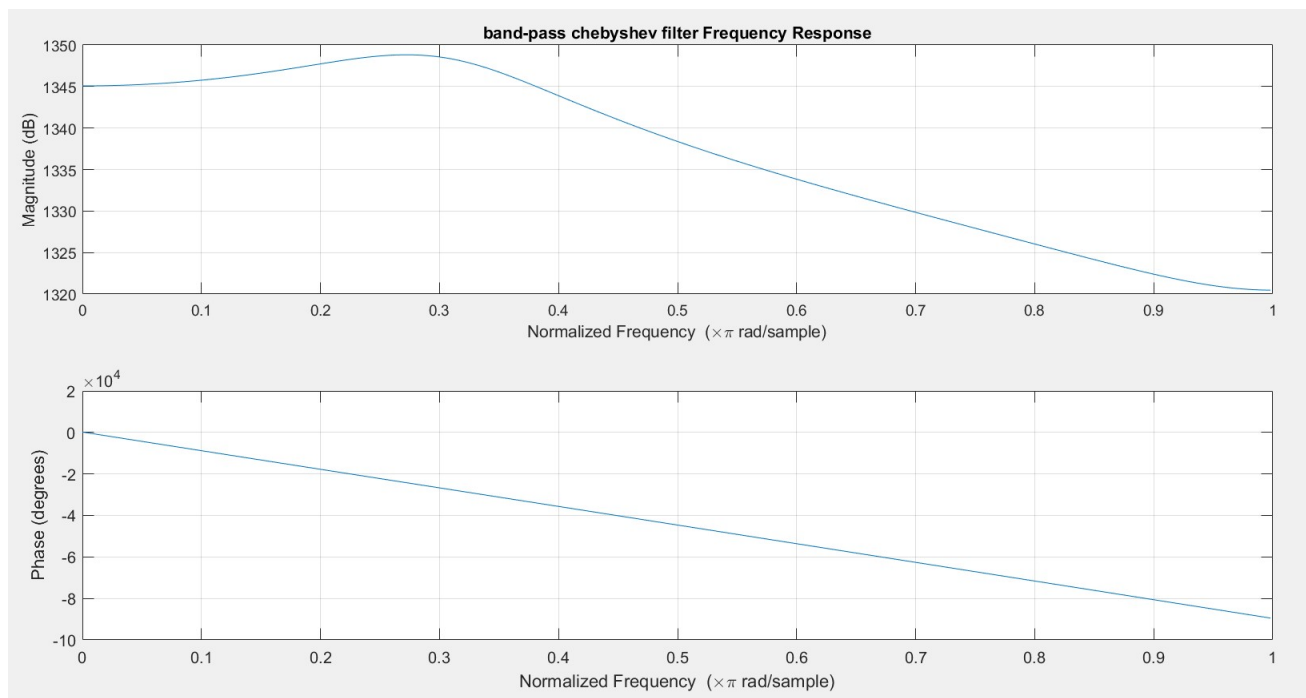
*Fig 7.4: Bandpass Butterworth filter Frequency Response.*



*Fig 7.5: Low Pass Chebyshev filter Frequency Response.*



*Fig 7.6: High Pass Chebyshev filter Frequency Response*



*Fig 7.7: Band-Pass Chebyshev filter Frequency Response.*

### **Discussion/Inference of the experiment :-**

In this experiment we designed Butterworth IIR filters as well as cheby IIR filters for lowpass, high pass, and bandpass by simulating it in MATLAB.

We first generated a sinusoidal message signal and added noise signal to it. Then created the IIR filter by using functions with the appropriate parameters for high, low or bandpass filters and also assigned the cut-off frequency accordingly.

For designing the butterworth filter we used the function `butter()` and for designing the cheby filter we used the function `cheby2()`. Then we used the `filter()` function and the frequency responses were plotted using `freqz()` function.

### **Conclusion :-**

In this experiment we studied various parameters required for designing an IIR filter and designed and simulated LPF, HPF and BPF Butterworth IIR filters successfully using MATLAB for specific cut-off frequencies.