DSP Lab
Assignment

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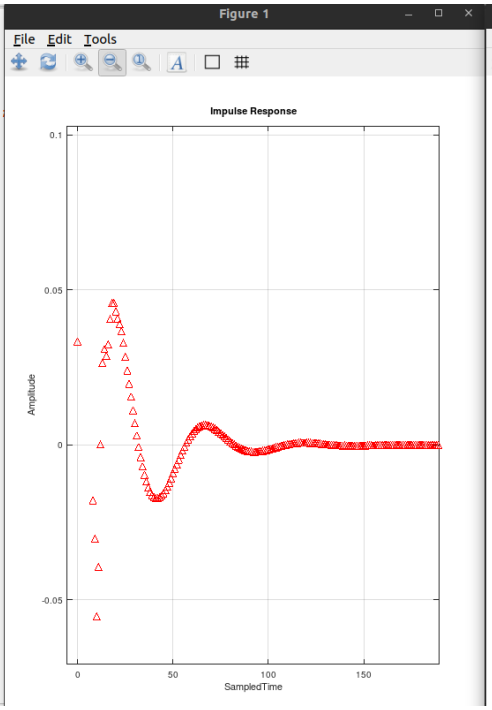
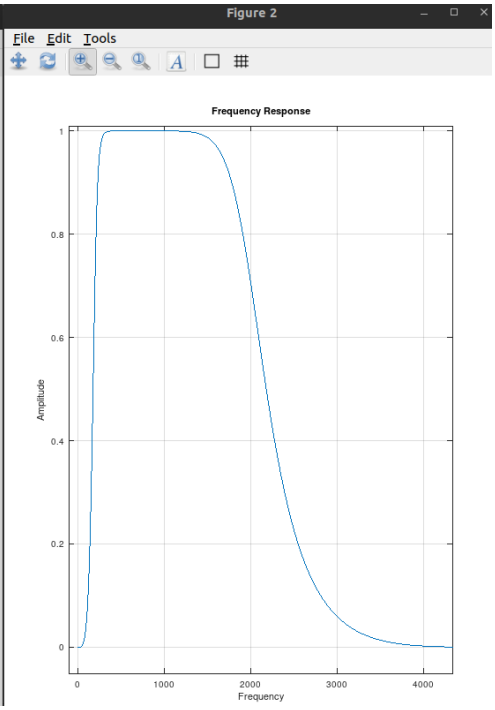
السكشن : 2

Q1:

When n = 4

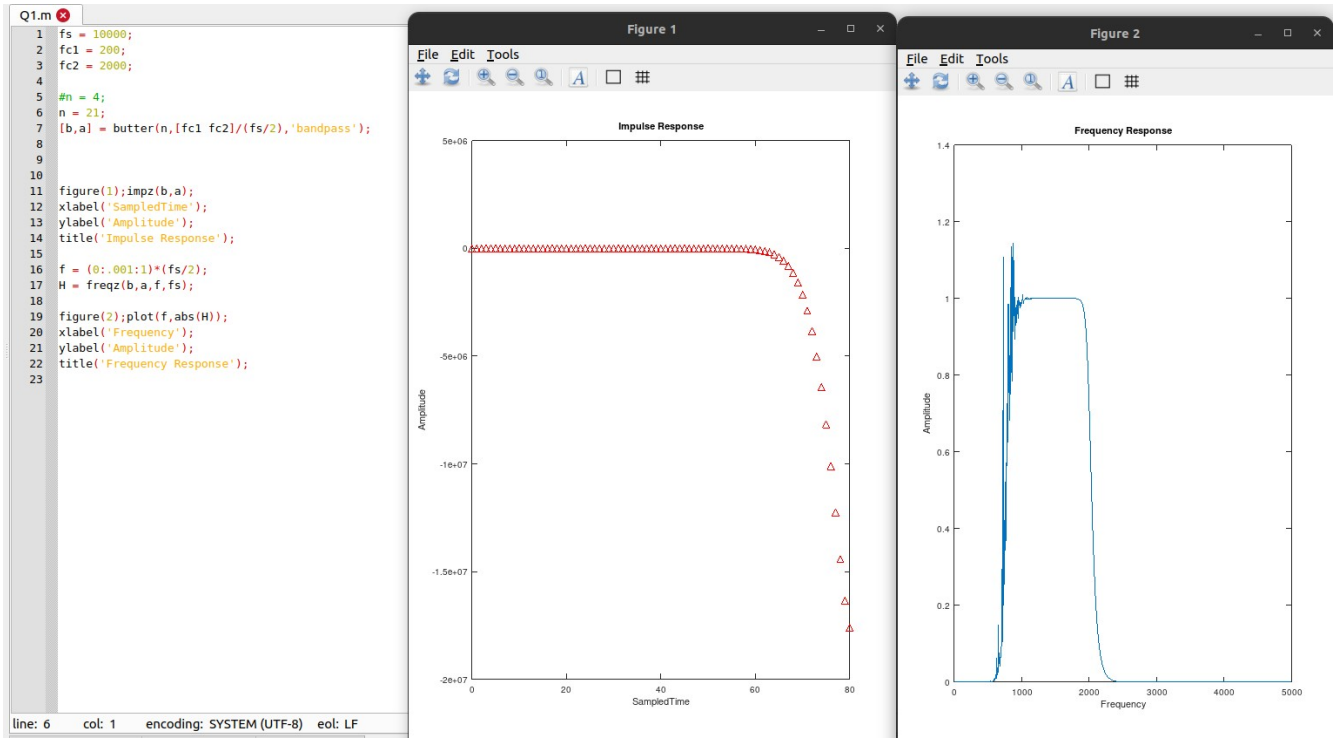
```
fs = 10000;
fc1 = 200;
fc2 = 2000;

n = 4;
#n = 21;
[b,a] = butter(n,[fc1 fc2]/(fs/2),'bandpass');



figure(1);impz(b,a);
xlabel('SampledTime');
ylabel('Amplitude');
title('Impulse Response');

f = (0:.001:1)*(fs/2);
H = freqz(b,a,f,fs);

figure(2);plot(f,abs(H));
xlabel('Frequency');
ylabel('Amplitude');
title('Frequency Response');

```





System is stable

When n = 21



System is unstable

Q2:

1- Read the file into MATLAB, specify #samples and time of recording in sec.

Q2.m

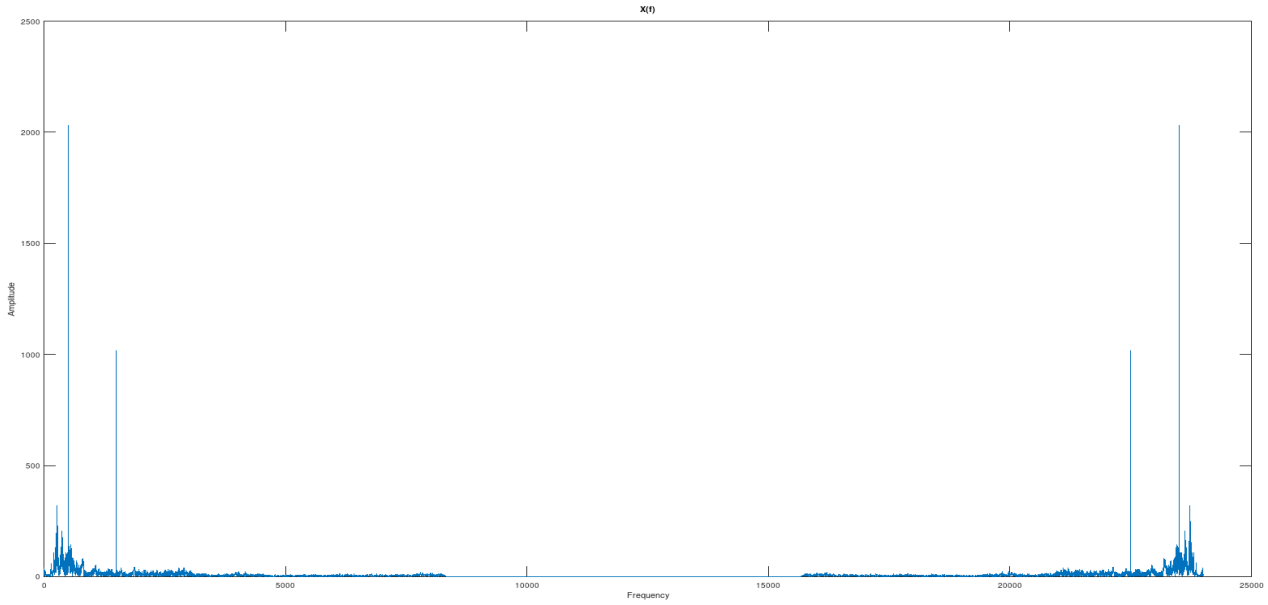
```
1  [xn,fs] = audioread('../sound/whistle.wav');
2
3  # 1- Read the file into MATLAB, specify #samples and time of recording in sec.
4  N = length(xn);
5
6  time = N/fs;
```

#samples = 41472
time = 1.7280 sec

```
>> N
N = 41472
>> time
time = 1.7280
```

2- Plot the frequency spectrum of signal x, do you notice the peaks?

```
8  # 2- Plot the frequency spectrum of signal x, do you notice the peaks?
9
10 xk = fft(xn);
11 f = linspace(0,fs,N);
12
13 figure(1);plot(f,abs(xk));
14 xlabel('Frequency');
15 ylabel('Amplitude');
16 title('X(f)');
17
```



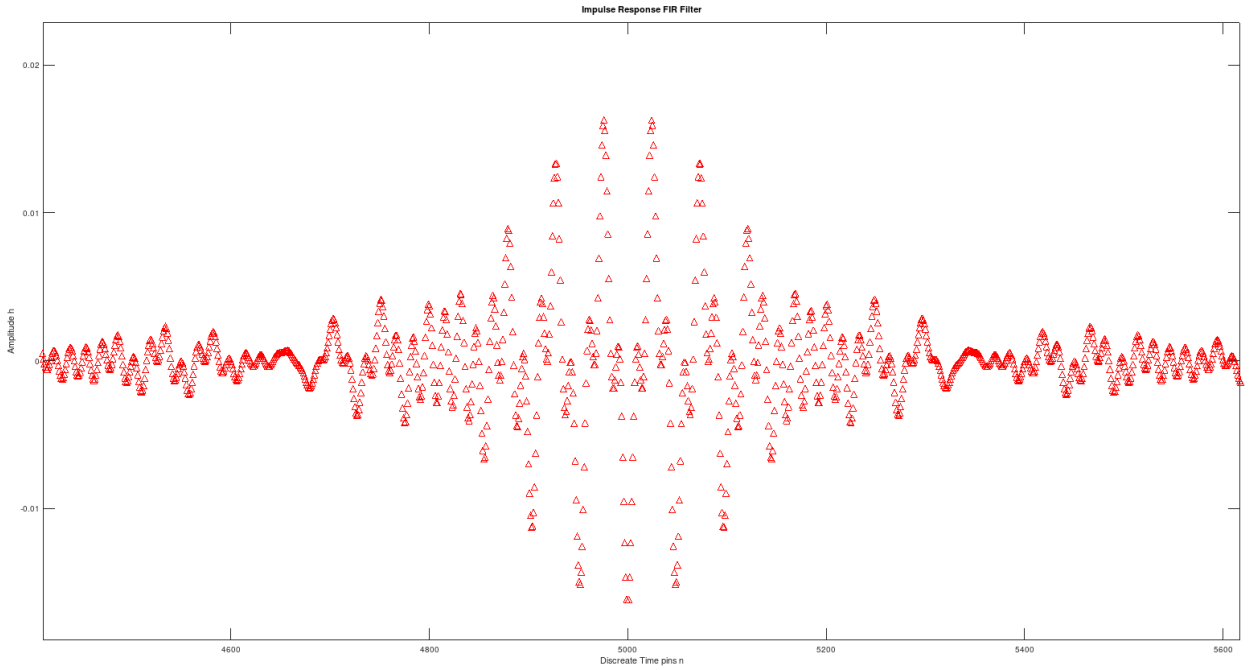
3- Design a filter to reject the sinusoidal signals from signal x.

```
# 3- Design a filter to reject the sinusoidal signals from signal x.

n = 10000;
#first filter
fc1 = 1460;
fc2 = 1530;

a = 1;
b = fir1(n,[fc1 fc2]/(fs/2),'stop');

#second filter
fc3 = 420;
fc4 = 550;

c = 1;
d = fir1(n,[fc3 fc4]/(fs/2),'stop');

#compining them
bd = conv(b,d,'same');
ac = 1;
```

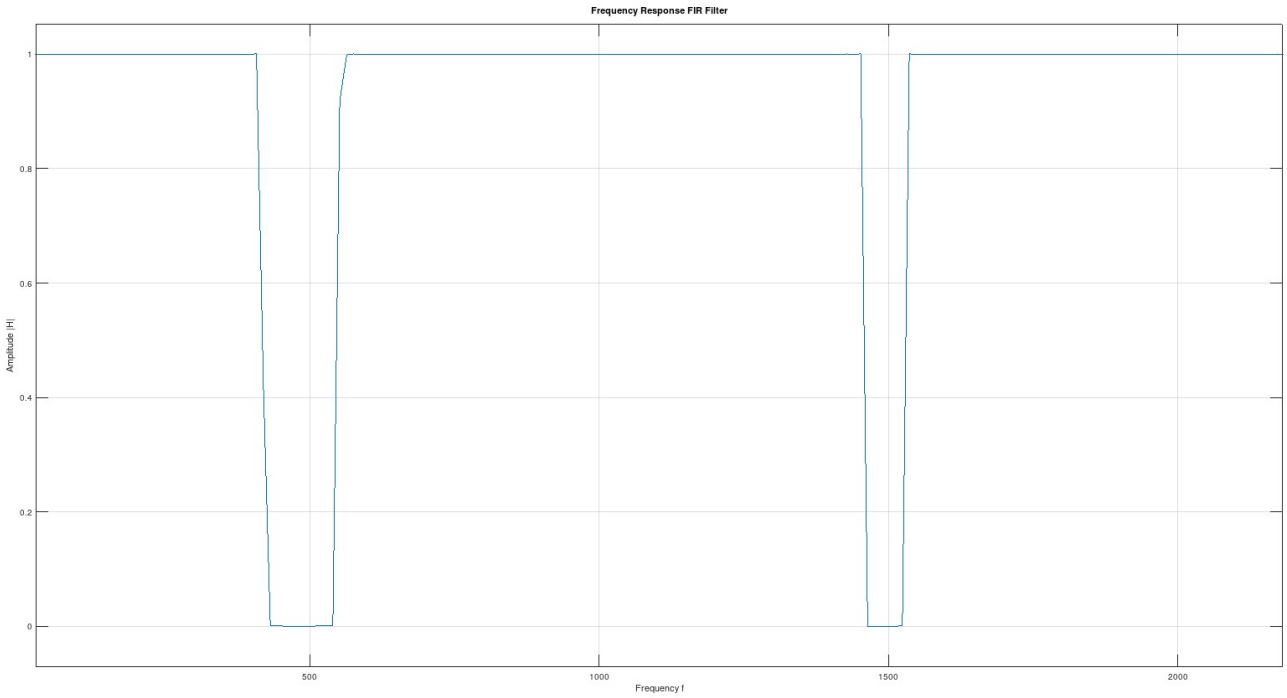
4- Plot frequency response, impulse response of the designed filter. Is the filter stable?

```
# 4- Plot frequency response, impulse response of the designed filter. Is the filter stable?

figure(2); impz(bd,ac);
xlabel('Discreate Time pins n');
ylabel('Amplitude h');
title('Impulse Response FIR Filter');

f = (0:.001:1)*(fs/2);
H = freqz(bd,ac,f,fs);

figure(3); plot(f,abs(H));
xlabel('Frequency f');
ylabel('Amplitude |H|');
title('Frequency Response FIR Filter');
```

Impulse Response:



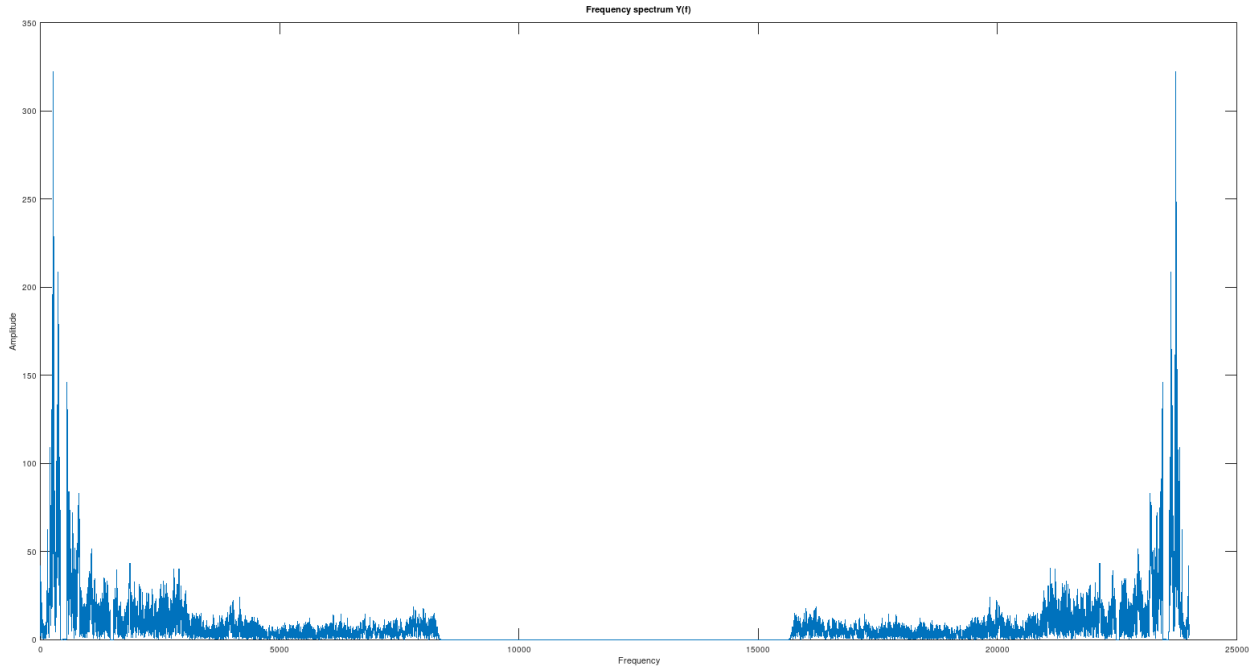
Frequency Response:



Yes Filter is Stable

5- Plot the frequency spectrum of signal y (the output of the filter).

```
# 5- Plot the frequency spectrum of signal y (the output of the filter).
yn = filter(bd,ac,xn);

yk = fft(yn);
f = linspace(0,fs,N);

figure(4);plot(f,abs(yk));
xlabel('Frequency');
ylabel('Amplitude');
title('Frequency spectrum Y(f)');
```



6- Play the output signal is the whistle still there?

```
65  # 6- Play the output signal is the whistle still there?
66  sound(yn,fs);
67
```

No

7- Calculate the energy for the original signal and the filtered signal.

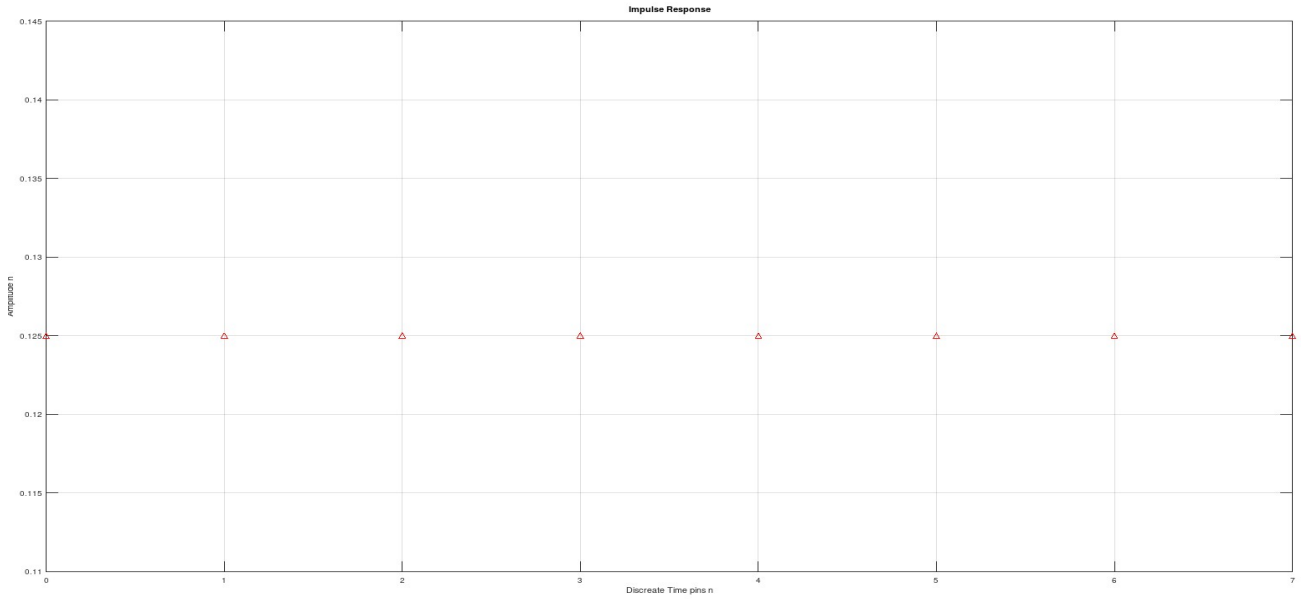
```
ex = sum(abs(xn) .^2);
ey = sum(abs(yn) .^2);
>> ex
ex = 585.82
>> ey
ey = 285.23
>> Q2
```

Q3: For each of the following filters plot frequency responses, impulse responses:

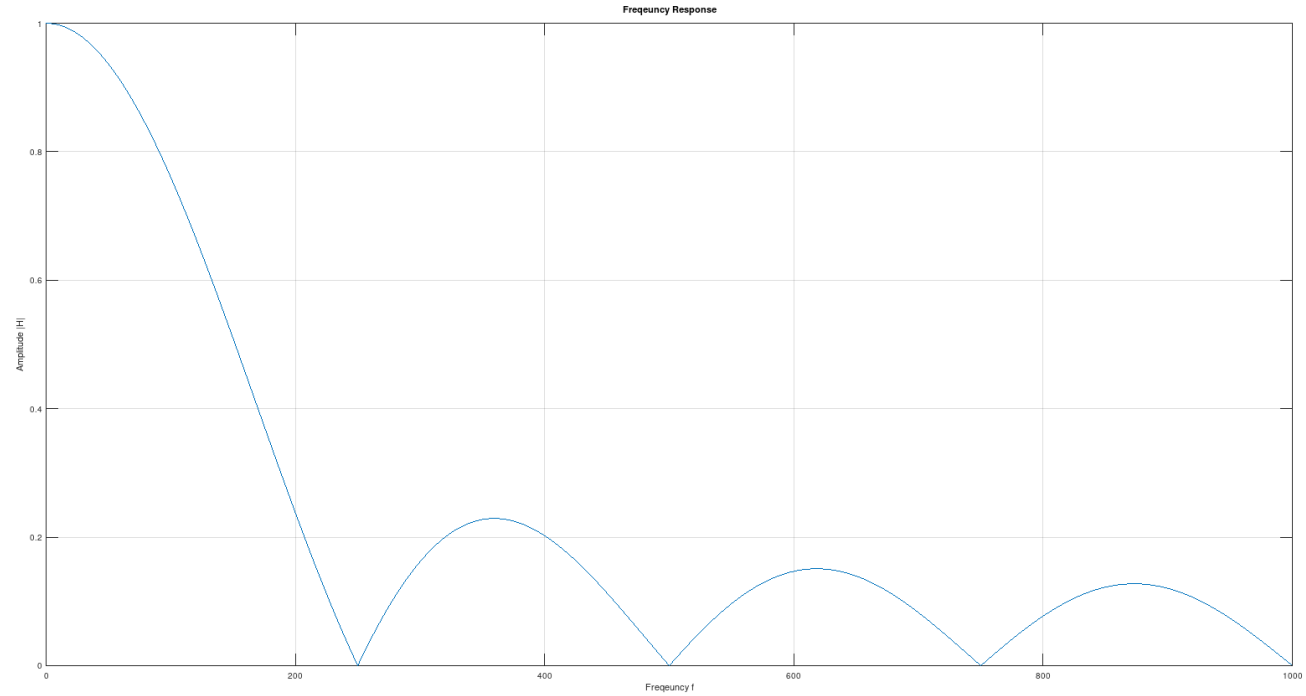
1- y[n] =1/8 * (x[n] + x[n − 1] + x[n − 2] + x[n − 3] + x[n − 4] +x[n − 5] + x[n − 6] + x[n − 7])

```
#3.

#1 y[n] =1/8 * (x[n] + x[n - 1] + x[n - 2] + x[n - 3] + x[n - 4] +x[n - 5] + x[n - 6] + x[n - 7])
num = (1/8) * ones(1,8);
denum = 1;

figure(1);impz(num,denum);
xlabel('Discreate Time pins n');
ylabel('Amplitude h');
title('Impulse Response');

fs = 2000;
f = (0:.001:1)*(fs/2);
H = freqz(num,denum,f,fs);

figure(2);plot(f,abs(H));
xlabel('Freqeuncy f');
ylabel('Amplitude |H|');
title('Freqeuncy Response');
```

Impulse Response:



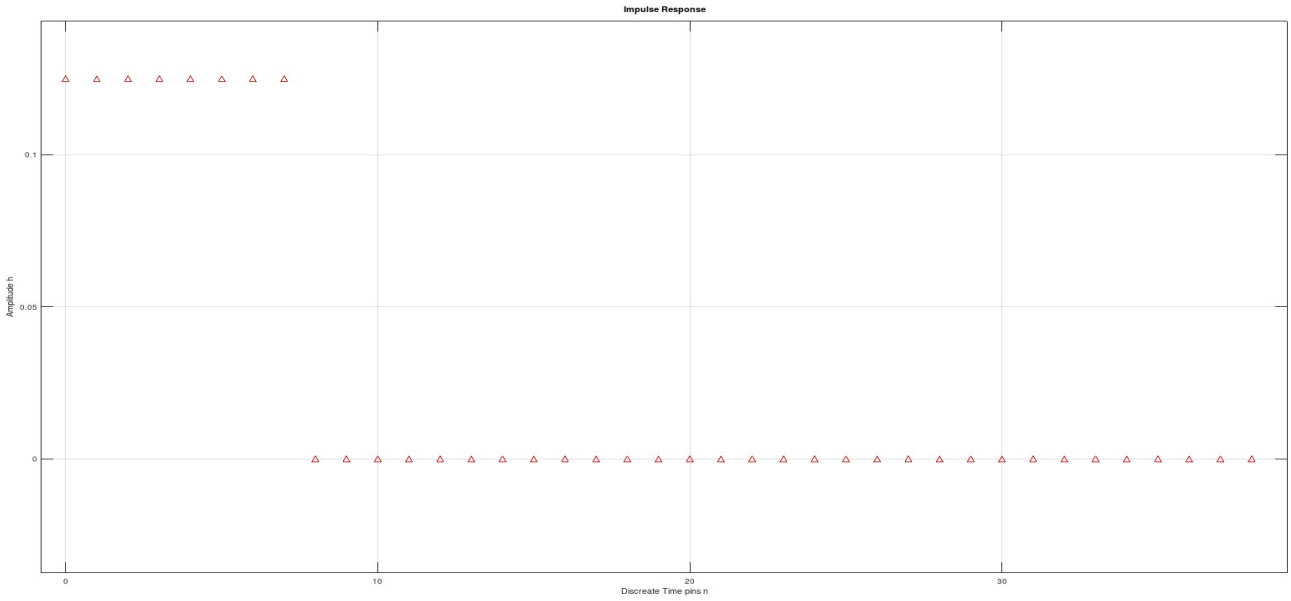
Freq Response:



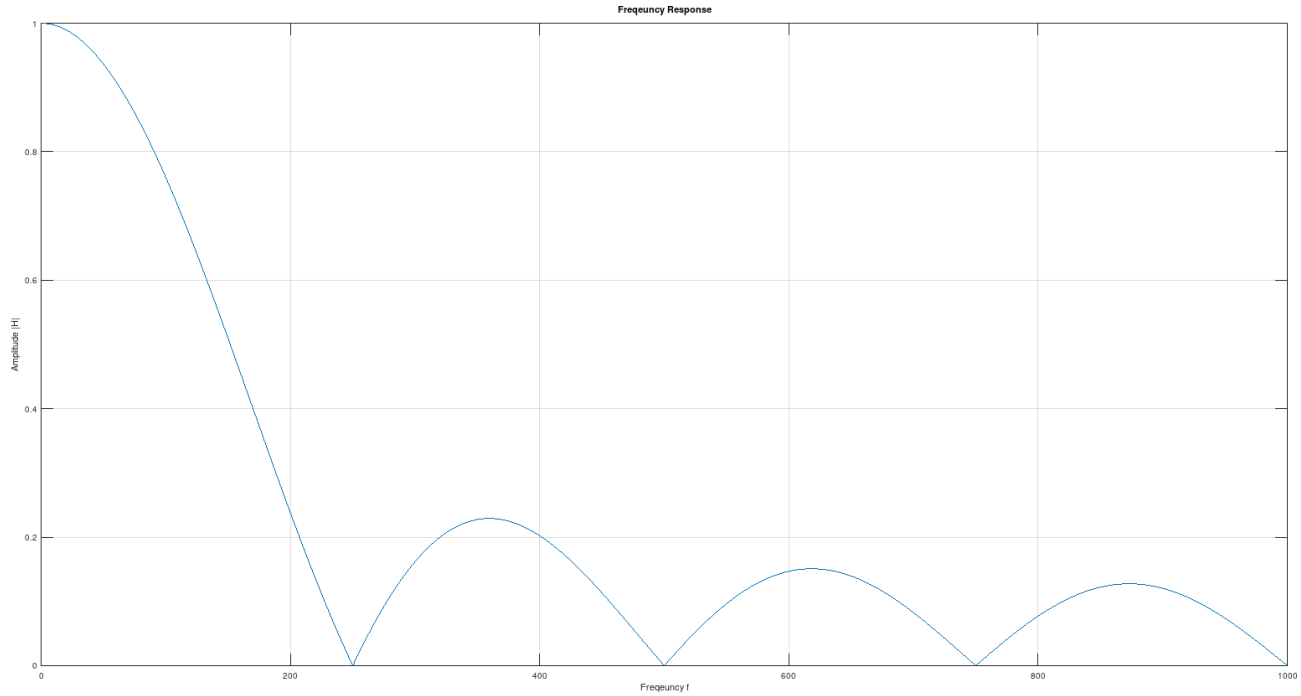
2- y[n] =1/8 * (x[n] − x[n − 8]) + y[n − 1]

```
22
23  #2 y[n] =1/8 * (x[n] - x[n - 8]) + y[n - 1]
24
25  num2 = (1/8) * [1 zeros(1,7) -1];
26  denum2 = [1 -1];
27
28  figure(3);impz(num2,denum2);
29  xlabel('Discreate Time pins n');
30  ylabel('Amplitude h');
31  title('Impulse Response');
32
33  H2 = freqz(num2,denum2,f,fs);
34
35  figure(4);plot(f,abs(H2));
36  xlabel('Freqeuncy f');
37  ylabel('Amplitude |H|');
38  title('Freqeuncy Response');
```

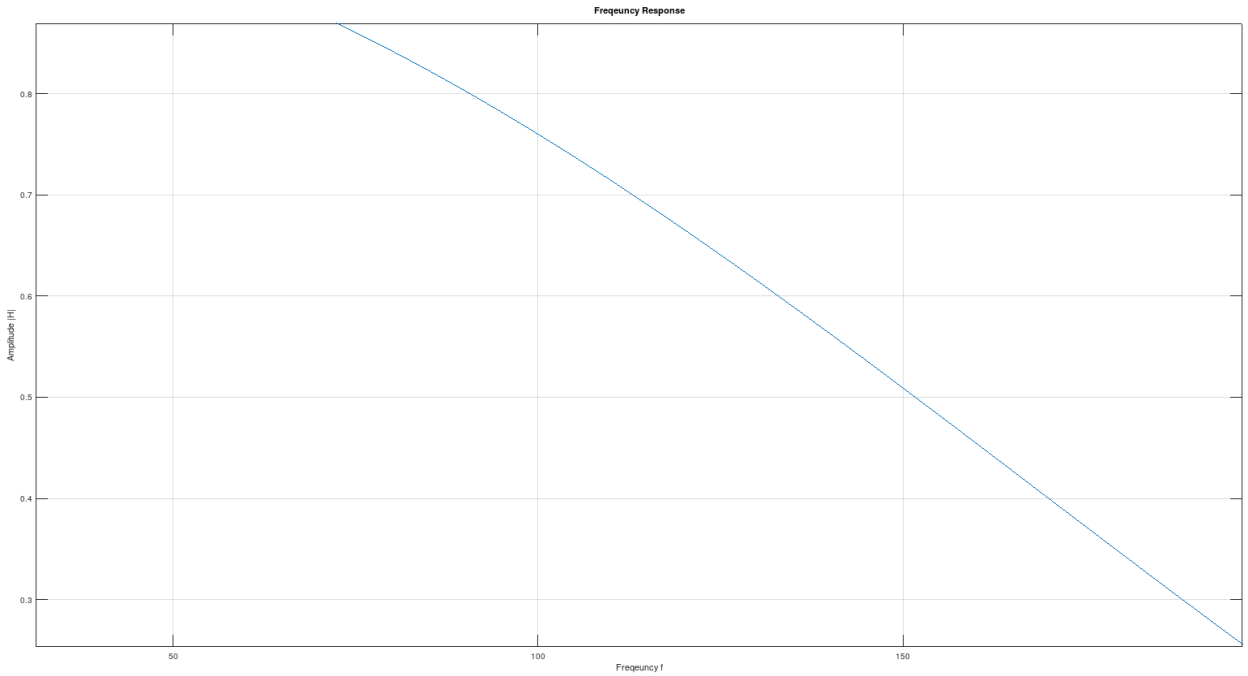
impulse Response



Freq Response:



Comment
Both Filter Systems Have the Same Impulse and Frequency Response with CutOff Freq = 150 Hz



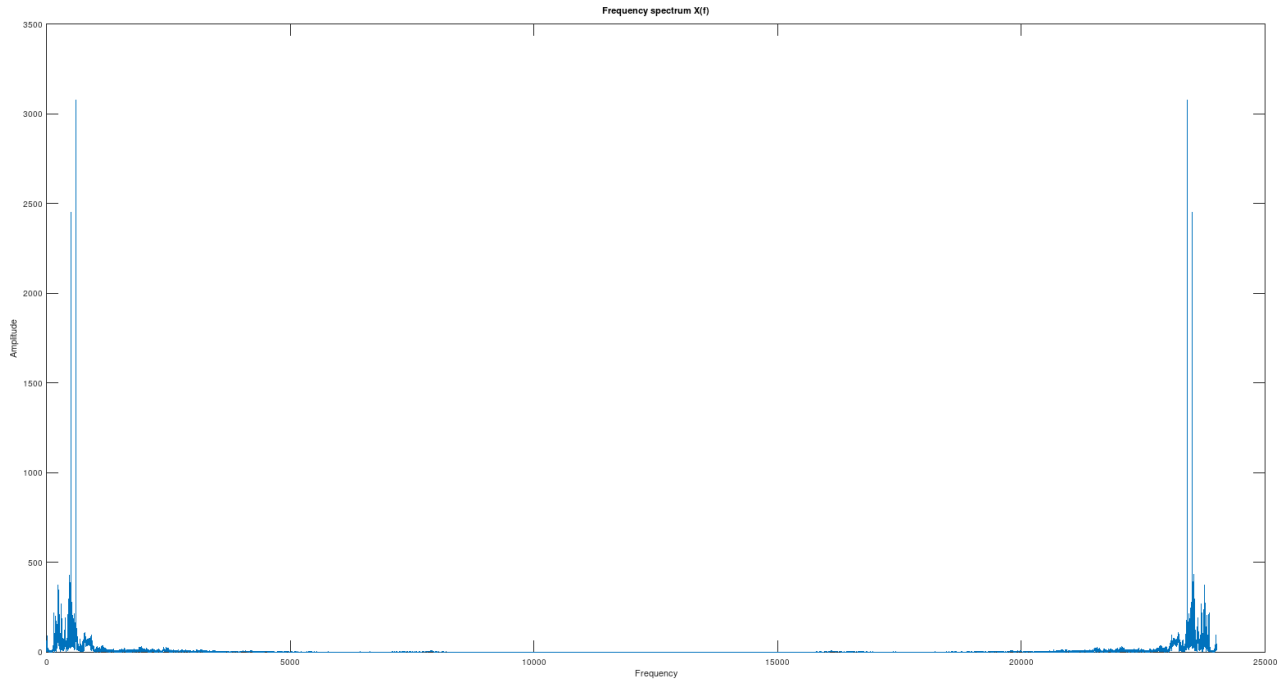
Q4: Filter File1.wav

it’s same code as Whistle Question but with CutOff Frequencies [480 520] and [590 610]

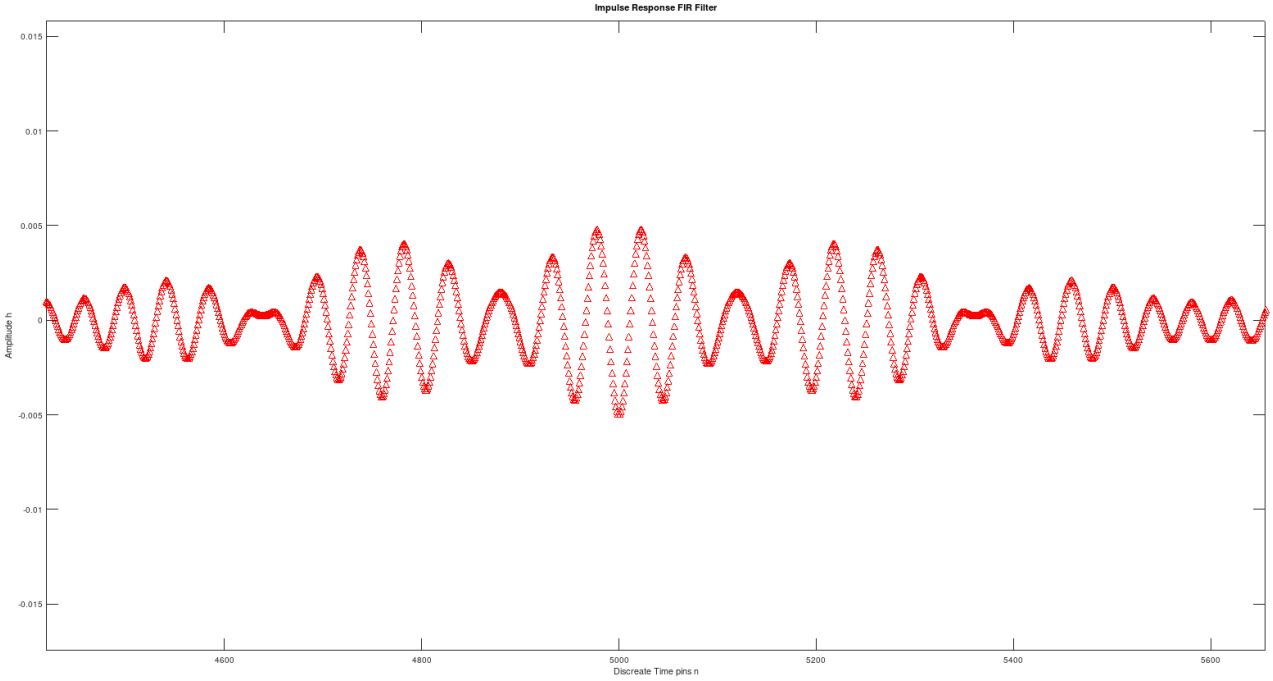
Q4.m

```
[xn,fs] = audioread('../sound/file1.wav');

# 1- Read the file into MATLAB, specify #samples and time of recording in sec.
N = length(xn);

time = N/fs;

# 2- Plot the frequency spectrum of signal x, do you notice the peaks?

xk = fft(xn);
f = linspace(0,fs,N);

figure(1);plot(f,abs(xk));
xlabel('Frequency');
ylabel('Amplitude');
title('Frequency spectrum X(f)');

# 3- Design a filter to reject the sinusoidal signals from signal x.

n = 10000;
#first filter
fc1 = 480;
fc2 = 520;

a = 1;
b = fir1(n,[fc1 fc2]/(fs/2),'stop');

#second filter
fc3 = 590;
fc4 = 610;

c = 1;
d = fir1(n,[fc3 fc4]/(fs/2),'stop');

#compining them
bd = conv(b,d,'same');
ac = 1;

# 4- Plot frequency response, impulse response of the designed filter. Is the filter stable?

figure(2); impz(bd,ac);
xlabel('Discreate Time pins n');
ylabel('Amplitude h');
title('Impulse Response FIR Filter');

f = (0:.001:1)*(fs/2);
H = freqz(bd,ac,f,fs);

figure(3); plot(f,abs(H));
xlabel('Frequency f');
ylabel('Amplitude |H|');
title('Frequency Response FIR Filter');

# 5- Plot the frequency spectrum of signal y (the output of the filter).
yn = filter(bd,ac,xn);

yk = fft(yn);
f = linspace(0,fs,N);

figure(4);plot(f,abs(yk));
xlabel('Frequency');
ylabel('Amplitude');
title('Frequency spectrum Y(f)');

# 6- Play the output signal is the whistle still there?
sound(yn,fs);

# 7- Calculate the energy for the original signal and the filtered signal.

ex = sum(abs(xn).^2);

ey = sum(abs(yn).^2);


```

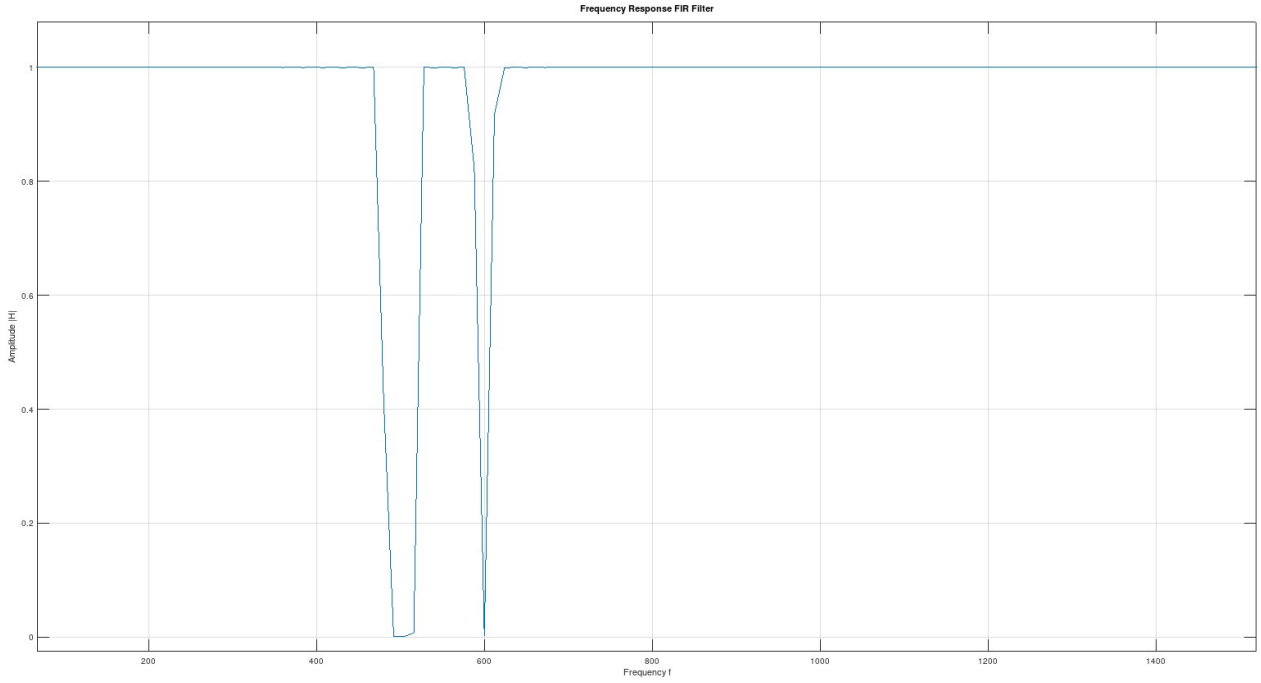
Plotting input Signal in freq domain:



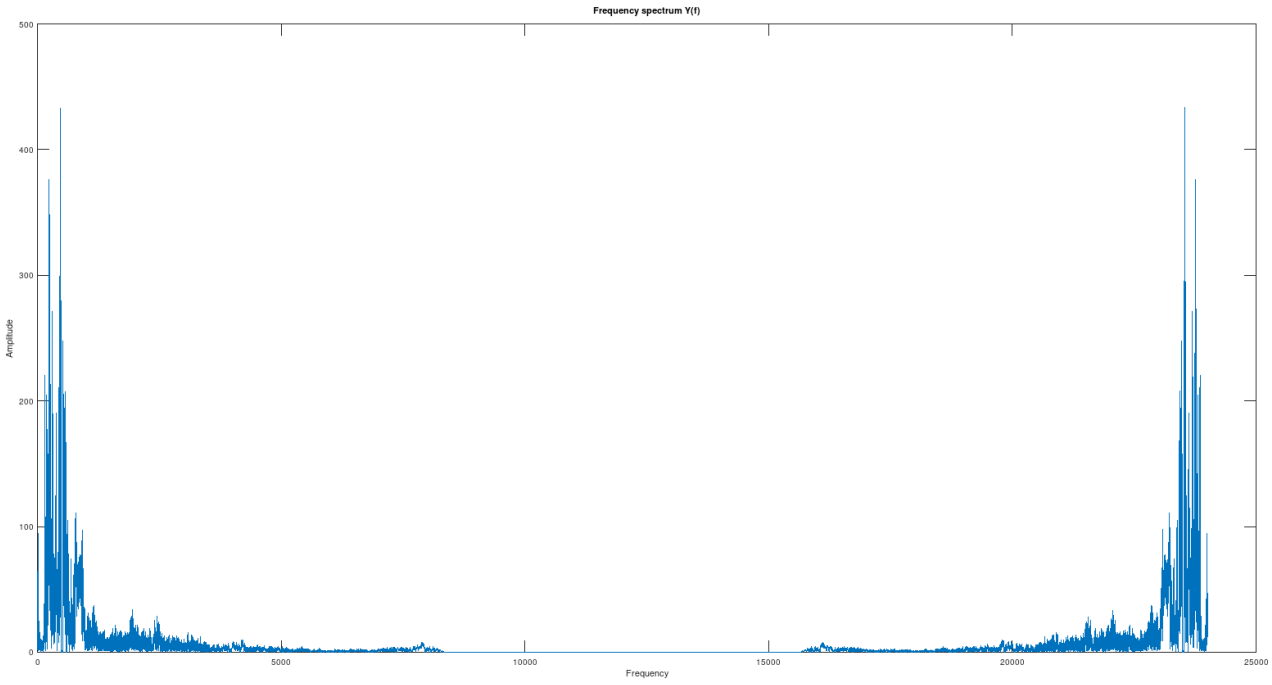
Impulse Response of Band Stop filter



Freq Response



Output Signal



Noise has been Removed

Energies of Both:

```
>> ex = sum(abs(xn).^2);

ey = sum(abs(yn).^2);
>> ex
ex = 1506.8
>> ey
ey = 504.00
>>
```