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سكشن / ٤

المادة / Dsp – lap

Assignment

1. Plot frequency response , impulse response for each n = 4,21

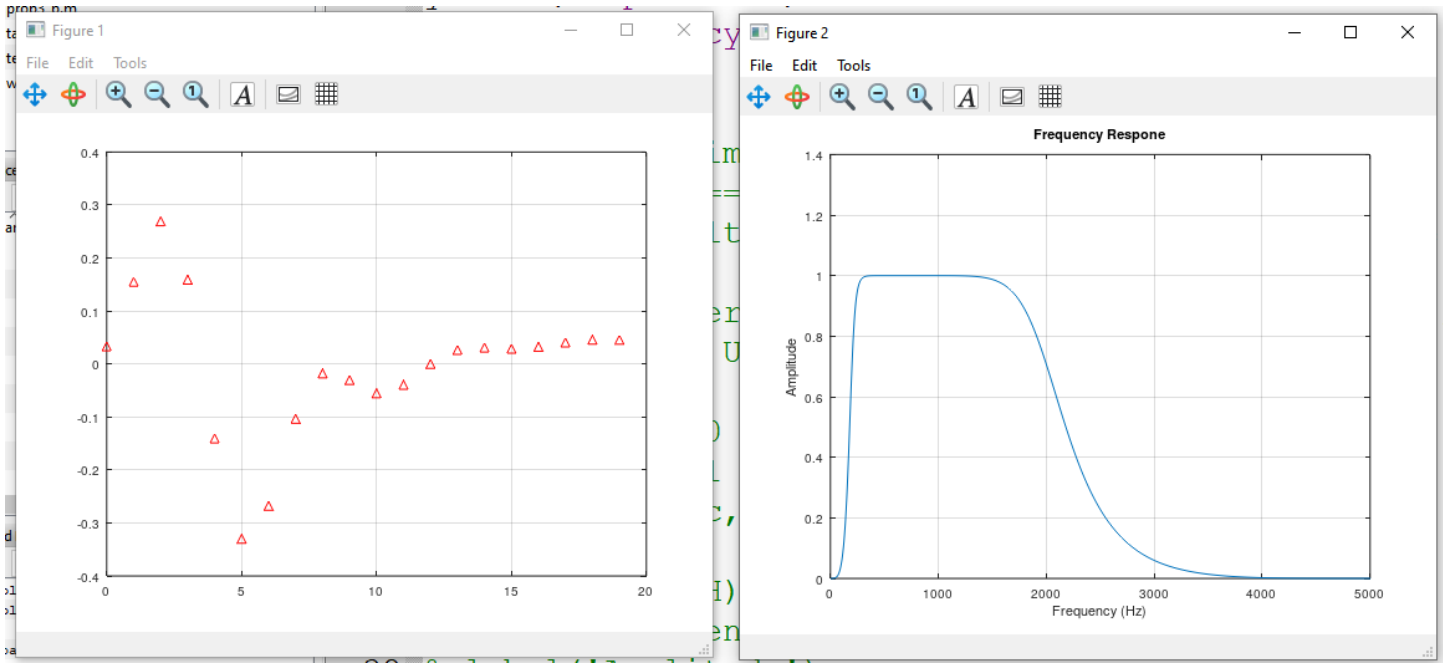
(band pass fc1 = 200, fc2 = 2000)

On octaive program or matlab we will write this code on editor:-

```
% Infinite impluse filter (IIR)  => order =4
Fs = 10000;
n = 4;
[b ,a] = butter(n ,[200 2000]/ (Fs/2) ,'bandpass');
figure; impz( b ,a ,20 );grid;
f = (0 : 0.001 :1)* Fs/2;
H = freqz (b,a,f,Fs);
figure;plot(f , abs(H) );
xlabel('Frequency (Hz)')
ylabel('Amplitude')
title('Frequency Respone')
grid
```

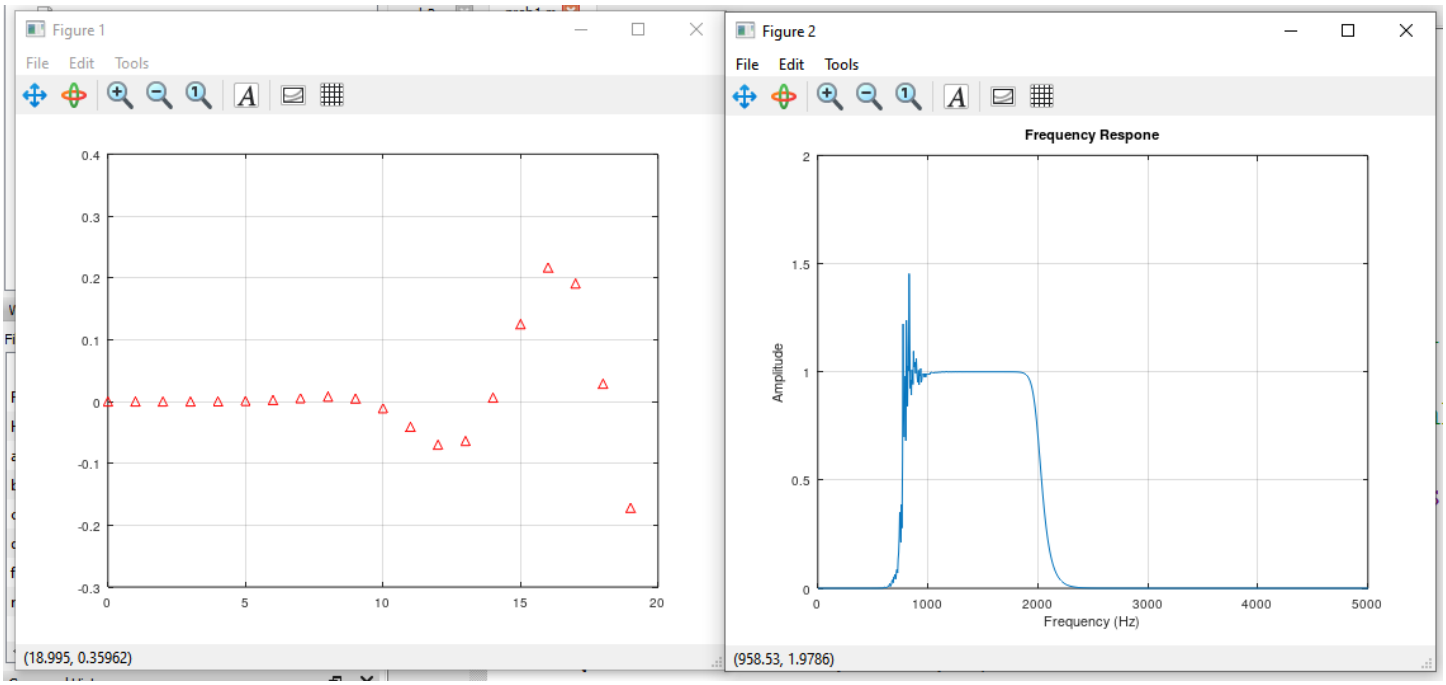
The signal is stable because the function isstable(b,a) output is 1

And this is the result is



And for n = 21

```
% Infinite impluse filter (IIR)  => order = 21
Fs = 10000;
n = 21;
[d ,c] = butter(n ,[200 2000]/ (Fs/2) ,'bandpass');
figure; impz( d ,c ,20 );grid;
f = (0 : 0.001 :1)* Fs/2;
H = freqz (d,c,f,Fs);
figure;plot(f , abs(H) );
xlabel('Frequency (Hz)')
ylabel('Amplitude')
title('Frequency Respone')
grid
```



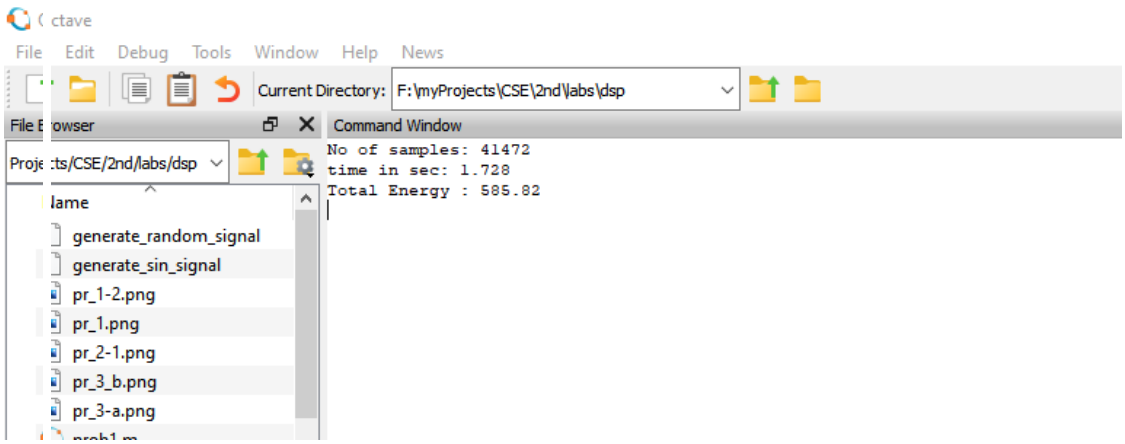
The signal is unstable

Problem – 2

1 – Reading the file called ‘whistle.wav’ into octave and specifying samples and time in sec

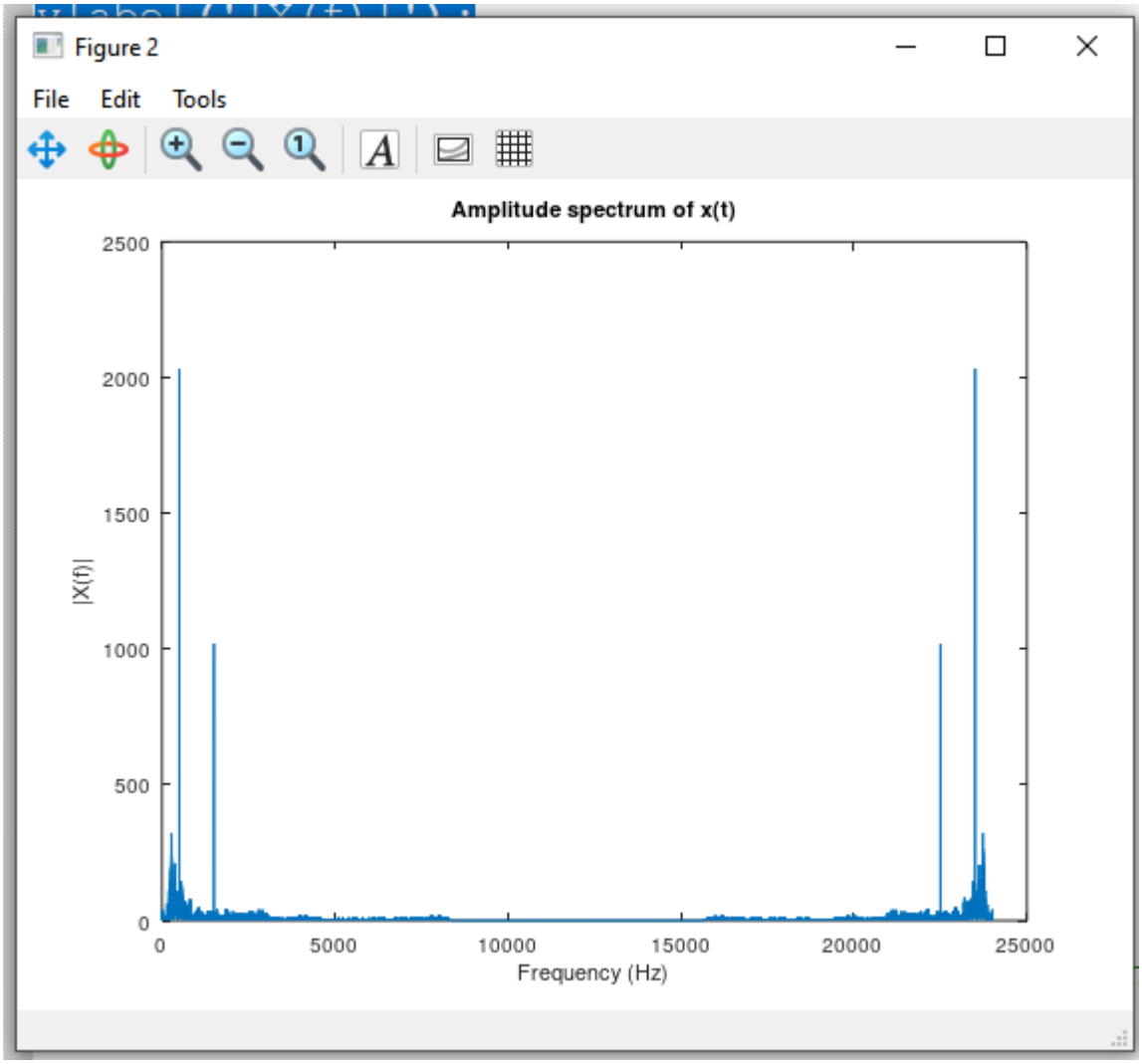
The code is

```
clc;clear;close all;
% To read the file
[x,Fs] = audioread('whistle.wav');
%% No of Samples
N = length(x);
fprintf('No of samples: %i\n', N);
%% time in sec
time = N / Fs;
fprintf('time in sec: %.3f\n', time);
%% Energy of the signal before wistle rejection
energy1  = sum(x.^2);
fprintf('Total Energy : %.2f\n',energy1)
%% time domain representation
t = linspace(0 , time ,N);
```



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

```
X_k = abs(fft(x)); %calc abs of fast fourier transform
f = linspace(0,Fs,N); %discretize freq
figure(2);plot(f,X_k);
title('Amplitude spectrum of x(t)');
xlabel('Frequency (Hz)');
ylabel('|X(f)|');
```



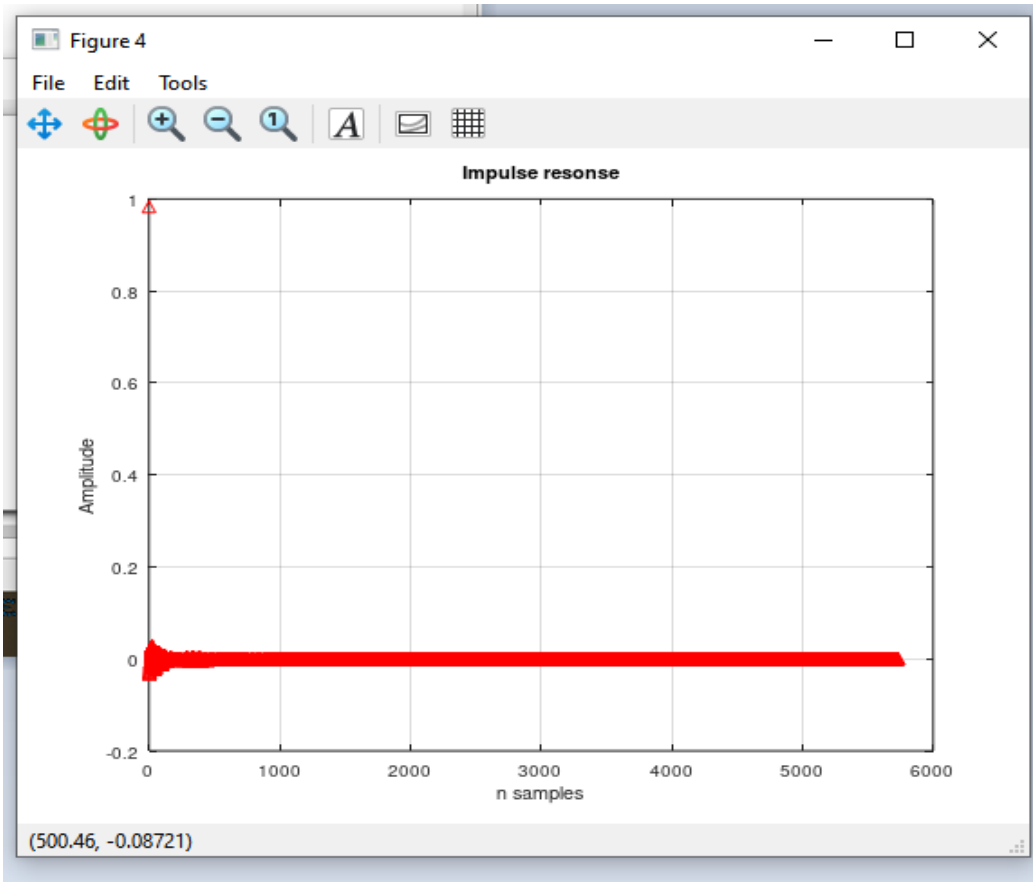
3- Design a filter reject the sinusoidal signals from signal x

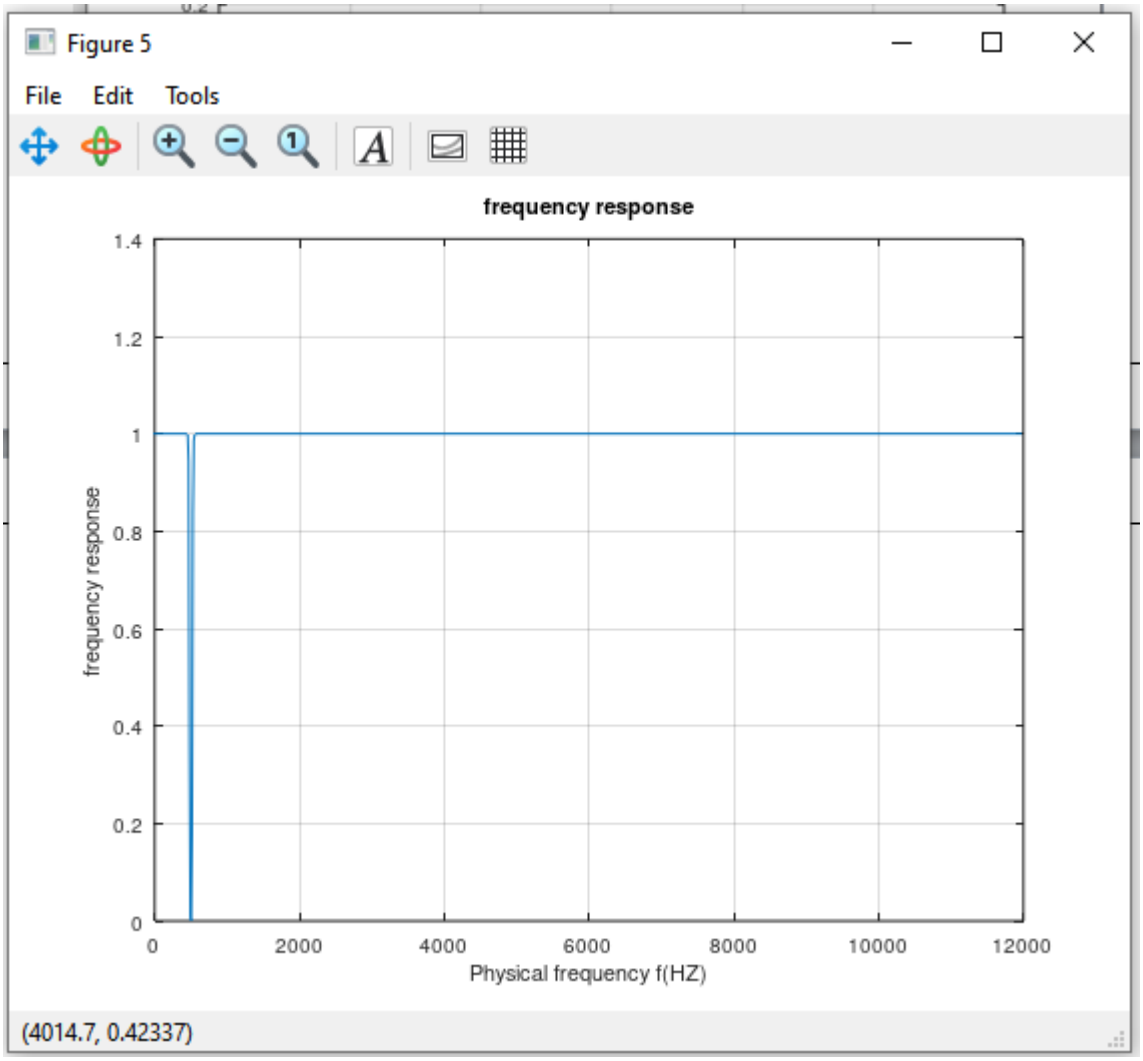
4- Plot freq response, impulse response, is filtered stable

```
% Design a Butterworth bandstop filter
n = 4; % Filter order
fstop = [475 525]; % Stopband frequency range
[b, a] = butter(n, fstop/(Fs/2), 'stop');
% Check if the filter is stable
if all(abs(roots(a)) < 1)
    disp('Filter is stable');
else
    disp('Filter is unstable');
end
% Apply the filter to the audio signal
y = filter(b, a, x);
% Play the filtered audio signal
sound(y, Fs);
pause(time);
%% Energy of the signal after y bandstop
energy2 = sum(y.^2);
fprintf('Total Energy of filtered signal : %.2f\n',energy2);
%% Impulse Response
figure(4);
```

```
impz(b , a),grid;
%% Freq response
f=(0:0.001:1)*Fs/2;
H= freqz(b,a,f,Fs);
figure(5);plot(f,abs(H)),grid;
title('frequency response');
xlabel('Physical frequency f(HZ)');
ylabel('frequency response');
%% plot y in  time domain
figure(6);plot(t,y),grid;
xlabel('Time (sec)');
ylabel('Amplitude');
title('Time domain representation of y(t)');
%% Plot y in freq domain
Y_k = abs( fft(y) ); %calc abs of fast fourier transform
f = linspace(0 , Fs, N); %discretize freq
figure(7);
plot(f ,Y_k);grid;
xlabel('Frequency (Hz)');
ylabel('Amplitude');
title('Amp spectrum of y(t) filtered signal')
%% Bandstop filter design
```

```
n=4;
[b , a] = butter(n ,[1475 1525] / (Fs/2), 'stop');
if all(abs(roots(a)) < 1)
    n=n-1;
   [b , a] = butter(n ,[1475 1525] / (Fs/2), 'stop');
   disp('Filter is stable');
else
    disp('Filter is unstable');
end
S =filter (b , a , y);
sound(S, Fs, 16);
```



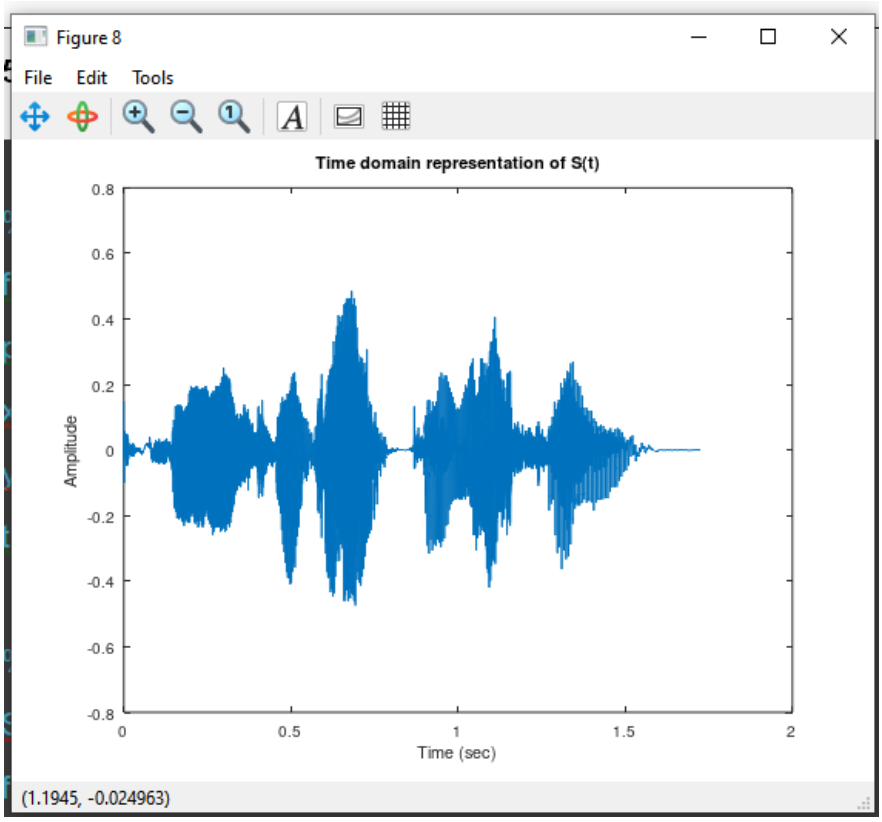


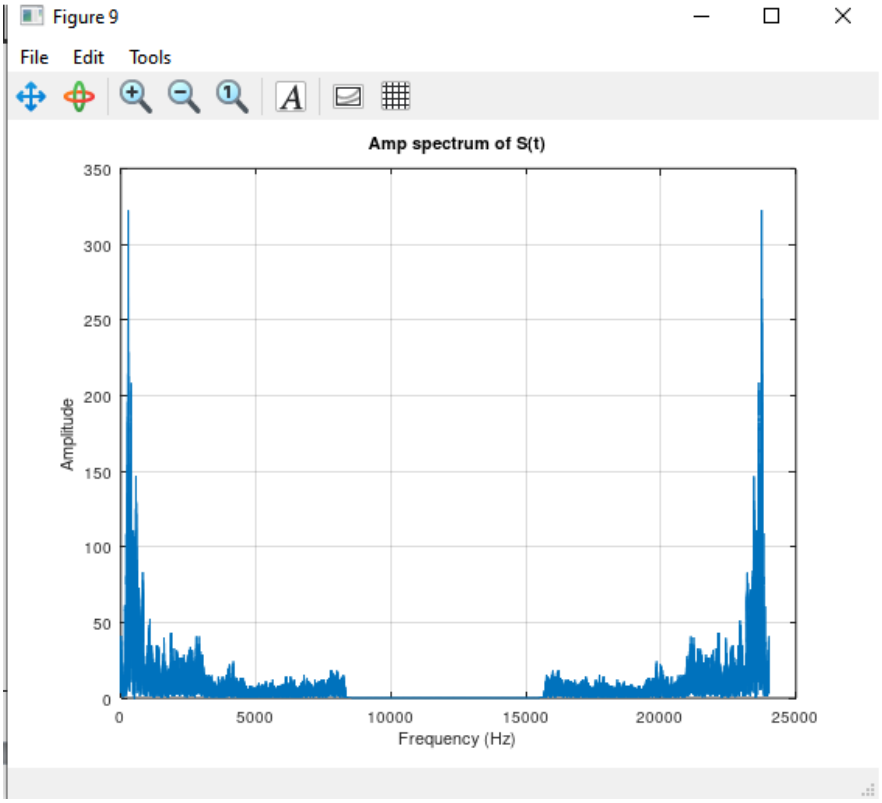
Filter is stable

5 – Plot the frequency spectrum of signal y

```
%% plot S in  time domain
figure(8);
plot(t,S);
xlabel('Time (sec)');
ylabel('Amplitude');
title('Time domain representation of S(t)');

%% Plot S in freq domain
S_k = abs( fft(S) ); %calc abs of fast fourier transform
f = linspace(0 , Fs, N); %discretize freq
figure(9);
plot(f ,S_k);
grid on ;
xlabel('Frequency (Hz)');
ylabel('Amplitude');
title('Amp spectrum of S(t)');
```





There is no whistel the voice is clear

```
敫□Total Energy : 311.91
```

Problem 3

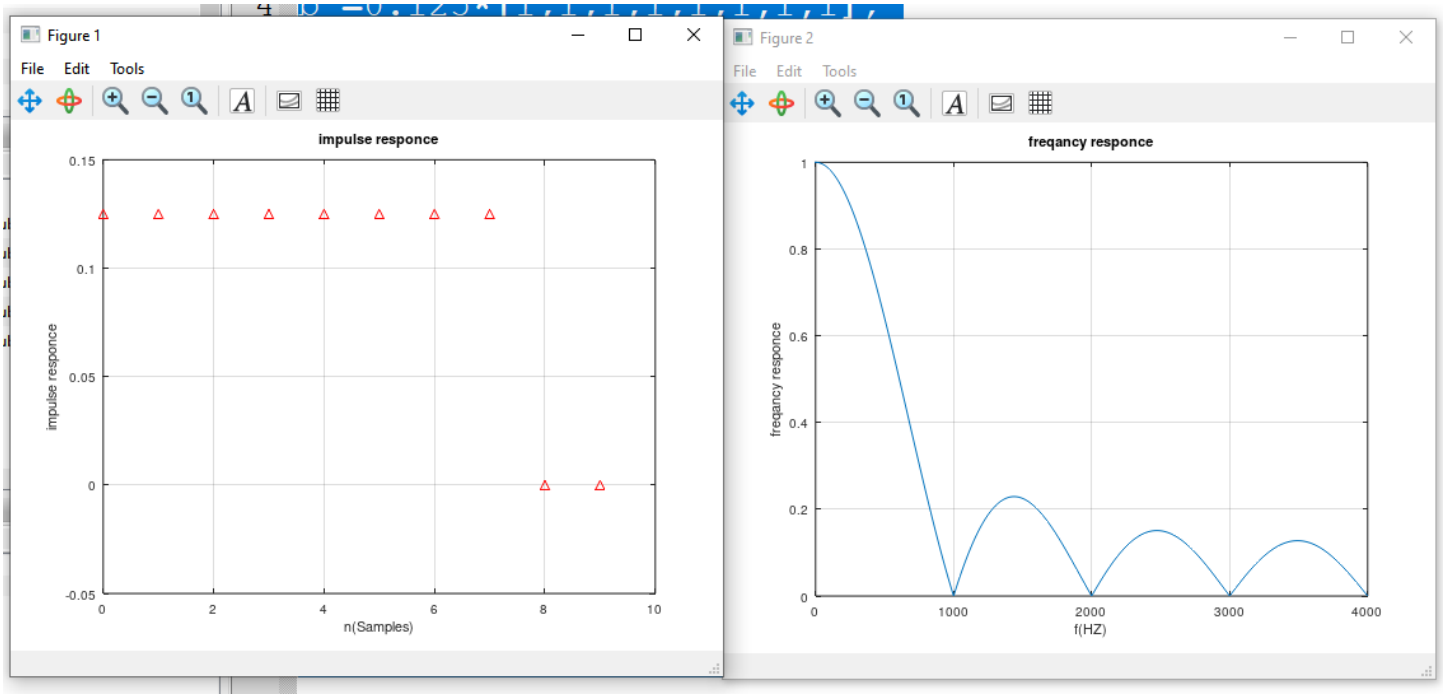
For each of the following plot frequency response,impulse response:

a.

Code

```
% A)finite low pass filter
a =1;
b =0.125*[1,1,1,1,1,1,1,1];
Fs=8000;
%impulse responce
figure;impz(b,a,10),grid;
title('impulse responce');
xlabel('n(Samples)');
ylabel('impulse responce');
%freqancy responce
f=(0:.001:1)*Fs/2;
H= freqz(b,a,f,Fs);
figure;plot(f,abs(H)),grid;
title('freqancy responce');
```

```
xlabel('f(HZ)');
ylabel('freqancy responce');
```



b.

```
% b)infinite low pass filter
a =[1 -1];
b =0.125*[1,0,0,0,0,0,0,0,-1];
Fs=8000;
%impulse responce
figure;impz(b,a,10),grid;
title('impulse responce');
xlabel('n(Samples)');
ylabel('impulse responce');
```

```
%freqancy responce
f=(0:.001:1)*Fs/2;
H= freqz(b,a,f,Fs);
figure;plot(f,abs(H)),grid;
title('freqancy responce');
xlabel('f(HZ)');
ylabel('freqancy responce');
```