Ahsanullah University of Science and Technology

PROJECT REPORT

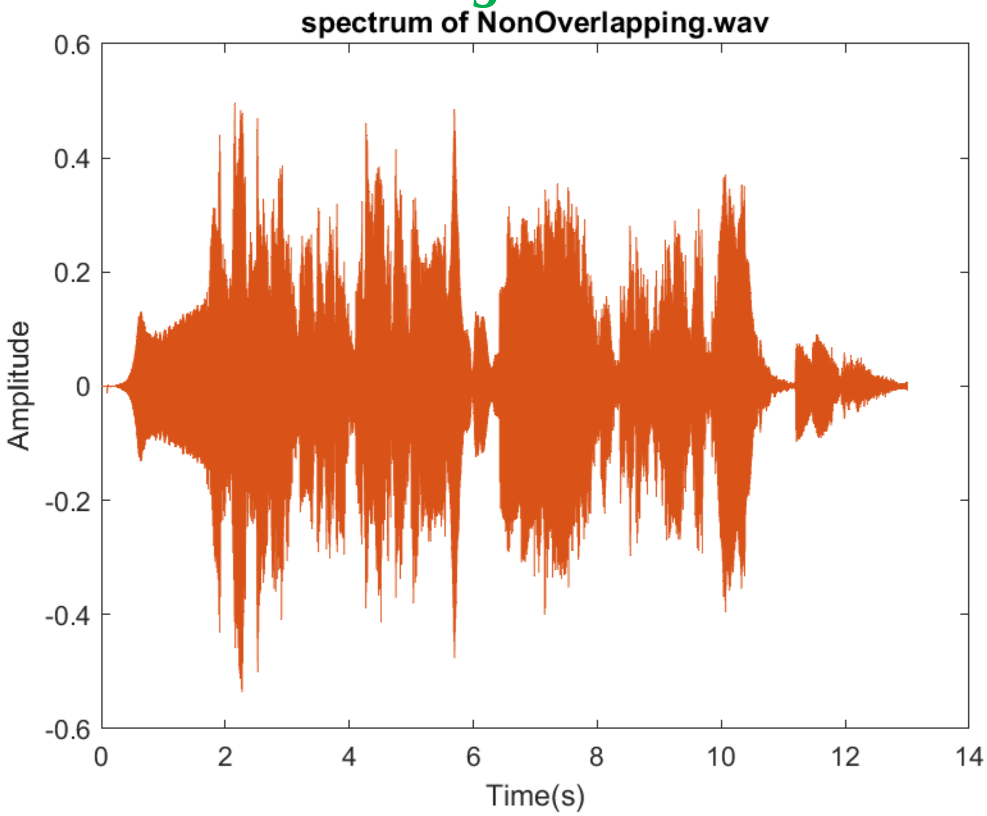
Course No: ***EEE3218***
Course Name: ***Digital Signal Processing Laboratory***

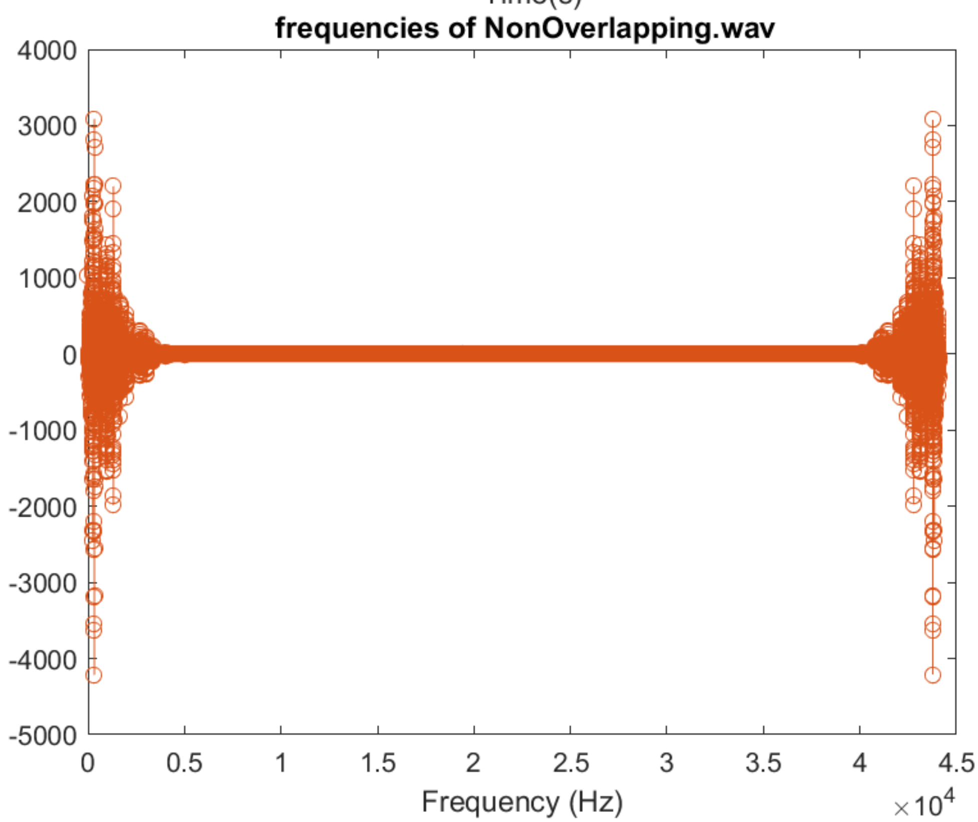
- Name: ***Md. Idrak Efaz***
- ID: *190205121*
- Year: 3 , Semester: 2
- Section: B-2
- Department of *EEE*

TASK 01

In question said that *'NonOverlapping.wav'* contains the non-overlapping **modified** sounds of the musical instruments – ***guitar, piano, trumpet and violin*** (in this order)

For guitar

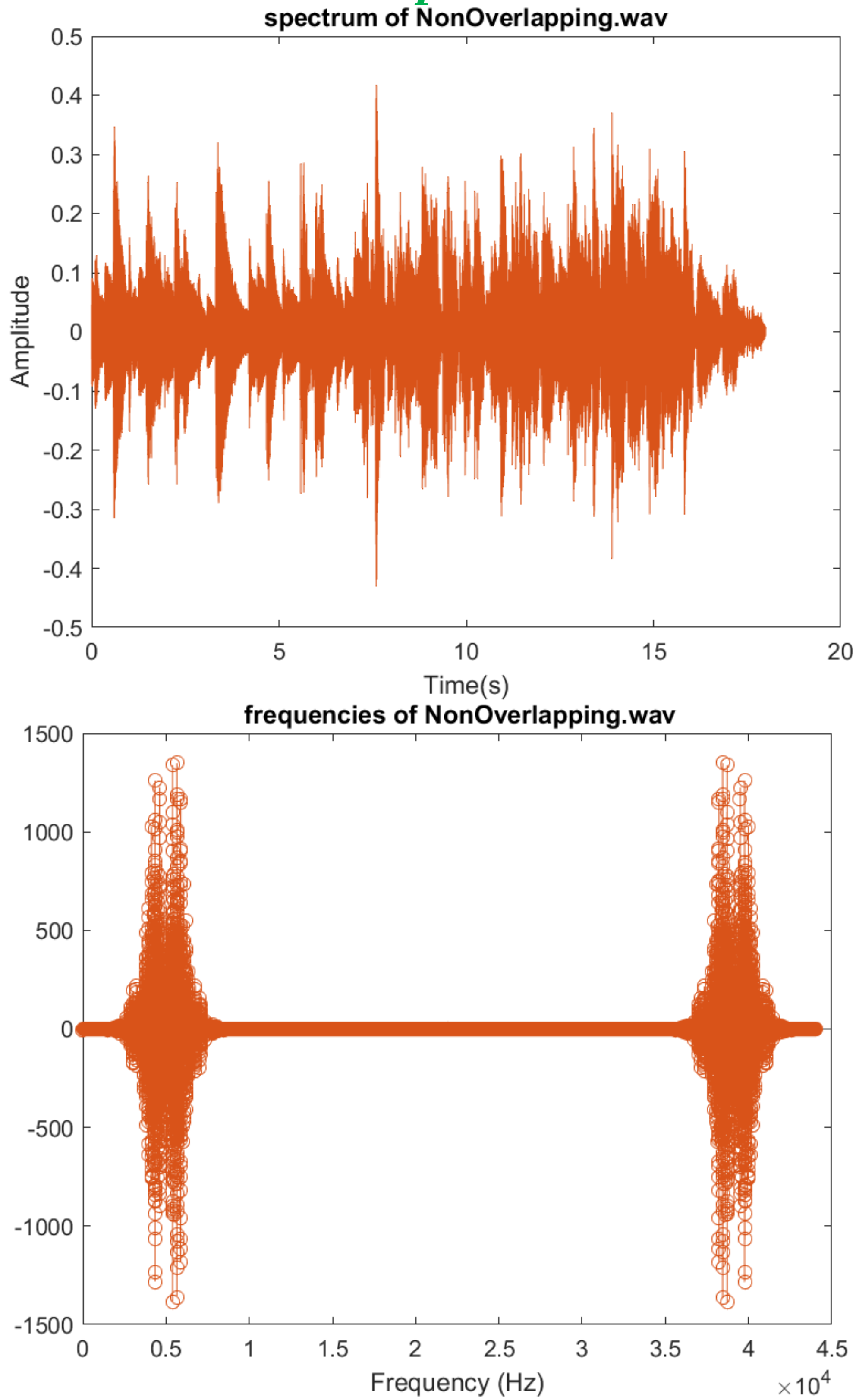

spectrum of NonOverlapping.wav
Amplitude
Time(s)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
2
4
6
8
10
12
14


frequencies of NonOverlapping.wav
Frequency (Hz)
$\times 10^4$
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

Frequency:0-2000(about)

```
clc ;
clear all;
close all;
samples = [1,13*44100];%range for
[es1,Fs1]=audioread('NonOverlapping.wav',samples);
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
% time domain plot
figure(1)
plot(t, es1); % plots the audio
title('spectrum of 'NonOverlapping.wav');
xlabel('Time(s)');
ylabel('Amplitude');
%find the frequencies of the signal
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of NonOverlapping.wav');
```

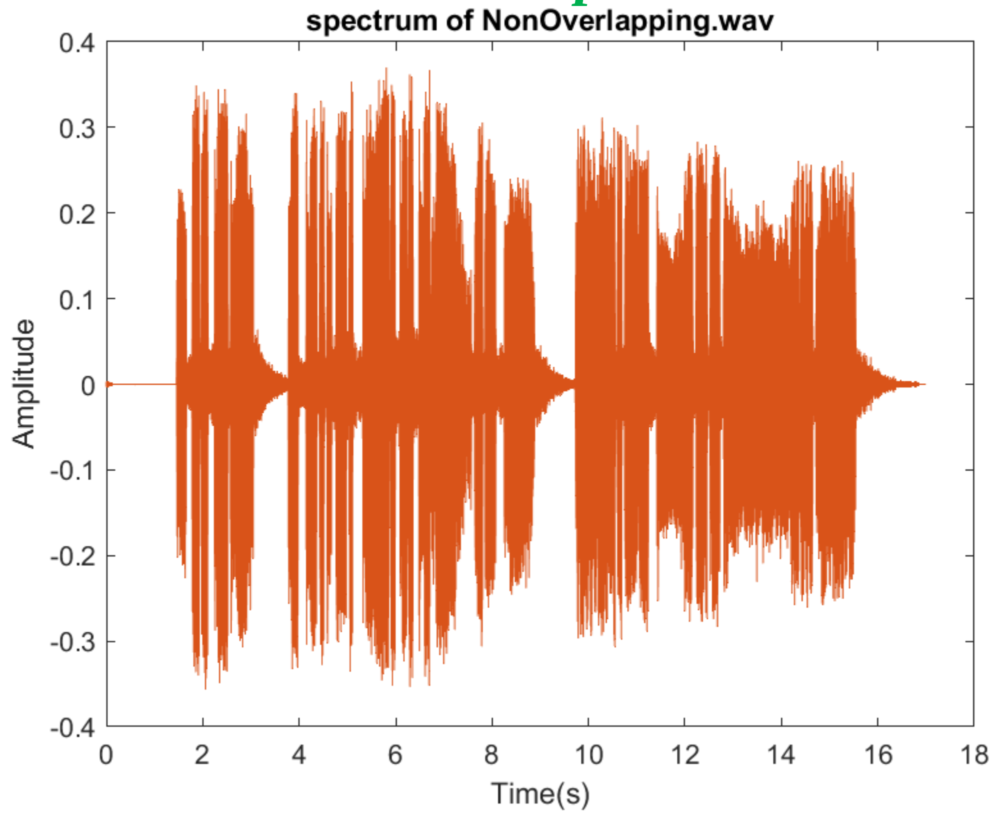
For piano

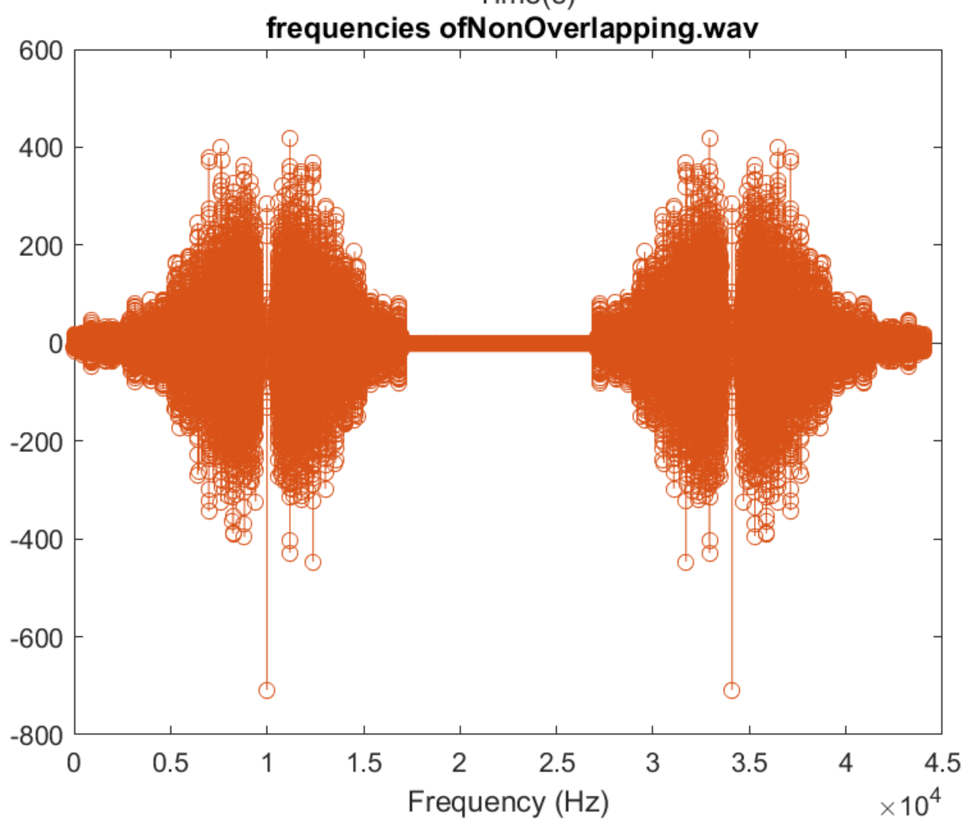

spectrum of NonOverlapping.wav
Amplitude
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
0
5
10
15
20
Time(s)
frequencies of NonOverlapping.wav
1500
1000
500
0
-500
-1000
-1500
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Frequency (Hz)
×10^4

Frequency:2100-5000(about)
See code below

```
clc ;
clear all;
close all;
samples = [14*44100,32*44100];%range for
[es1,Fs1]=audioread('NonOverlapping.wav',samples);
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
% time domain plot
figure(1)
plot(t, es1); % plots the audio
title('spectrum of NonOverlapping.wav');
xlabel('Time(s)');
ylabel('Amplitude');
%find the frequencies of the signal
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of NonOverlapping.wav');
```

For trumpet

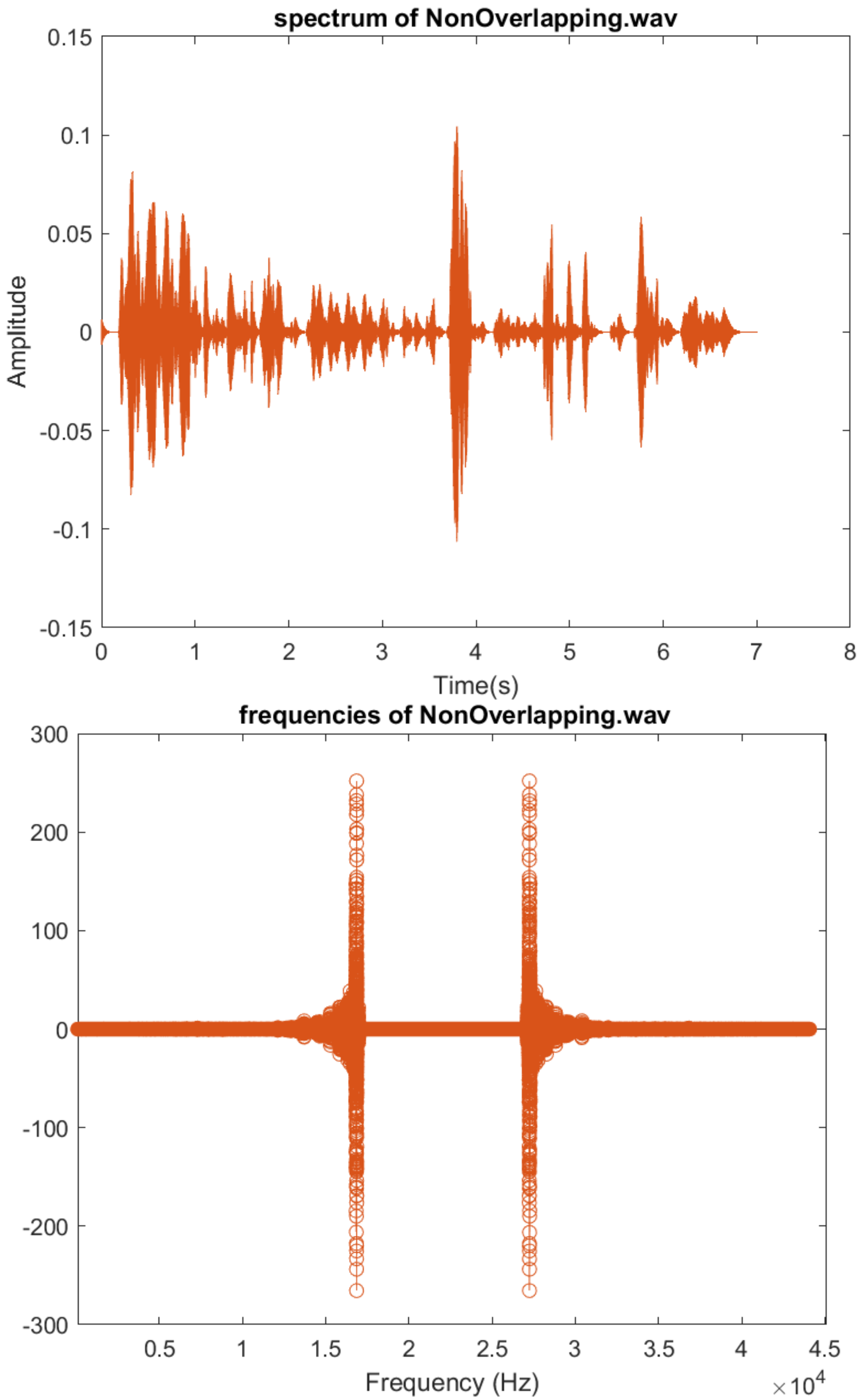

spectrum of NonOverlapping.wav
Amplitude
Time(s)


frequencies ofNonOverlapping.wav
Frequency (Hz)
$\times 10^4$

Frequency:5000-10000(about)

<pre>clc ;
clear all;
close all;
samples = [33*44100,50*44100];%range for
[es1,Fs1]=audioread('NonOverlapping.wav',samples);
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
% time domain plot
figure(1)
plot(t, es1); % plots the audio
title('spectrum of NonOverlapping.wav');
xlabel('Time(s)');
ylabel('Amplitude');
%find the frequencies of the signal
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of NonOverlapping.wav');</pre>

For violin

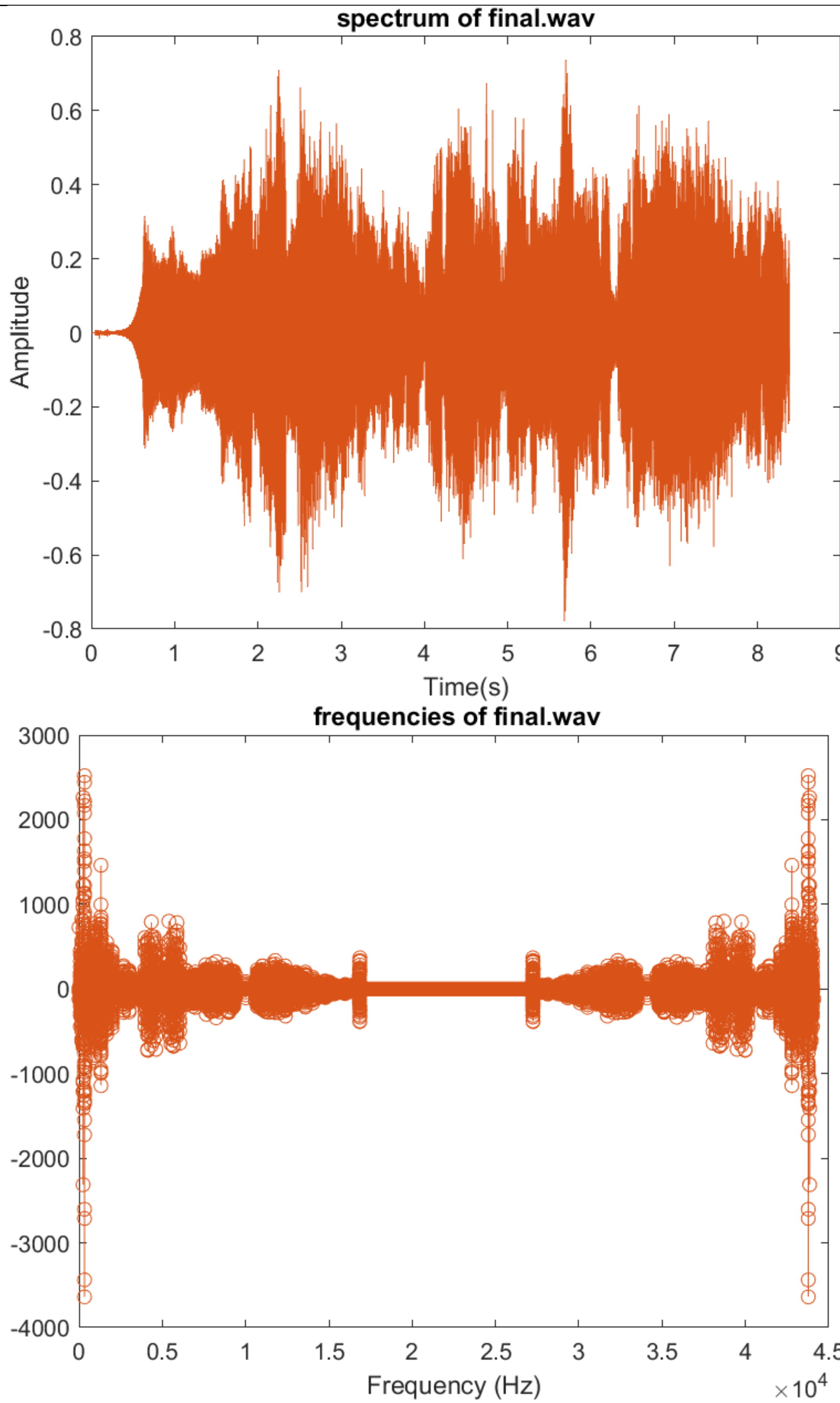

spectrum of NonOverlapping.wav
Amplitude
Time(s)
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
0
1
2
3
4
5
6
7
8
frequencies of NonOverlapping.wav
Frequency (Hz)
$\times 10^4$
300
200
100
0
-100
-200
-300
0.5
1
1.5
2
2.5
3
3.5
4
4.5

Frequency:16500-17000(about)

```
clc ;
clear all;
close all;
samples = [51*44100,58*44100];%range for
[es1,Fs1]=audioread('NonOverlapping.wav',samples);
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
% time domain plot
figure(1)
plot(t, es1); % plots the audio
title('spectrum of NonOverlapping.wav'');
xlabel('Time(s)');
ylabel('Amplitude');
%find the frequencies of the signal
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of NonOverlapping.wav');
```

TASK 02

```
clc ;
clear all;
close all;
%samples = [51*44100,58*44100];%range for
[es1,Fs1]=audioread('final.wav');
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
% time domain plot
figure(1)
plot(t, es1); % plots the audio
title('spectrum of final.wav');
xlabel('Time(s)');
ylabel('Amplitude');
%find the frequencies of the signal
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of final.wav');
```



Frequency Range 00hz to 17k

TASK 03

Filter no 1
Low pass FIR filter
Method: Window(Hamming)
Order:1000
Fc:2000;

Filter no 2
Band pass FIR filter
Method: Window(Blackman)
Order:2426
Fc:2000-5000;

Filter no 3
Band pass FIR filter
Method: Window(Blackman)
Order:2426
Fc:5000-10000;

Filter no 4
Band pass FIR filter
Method: Window(blackman)
Order:2426
Fc:14000-16000;

TASK 04

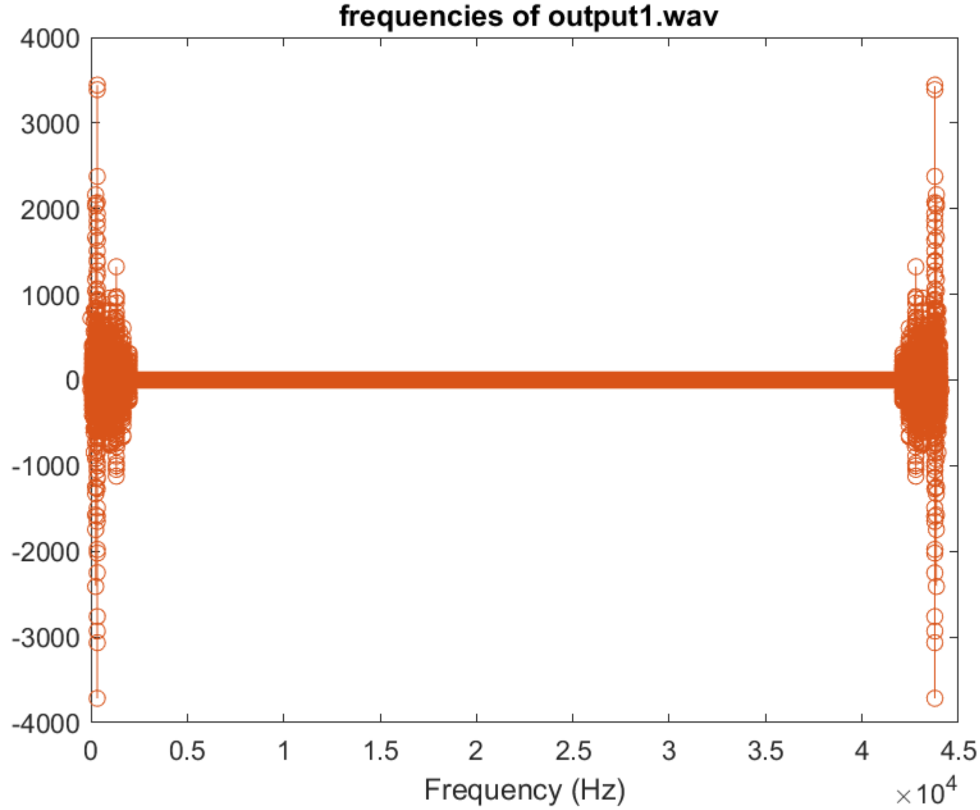
```
clc;
clear all;
close all;
[es1,Fs1]=audioread('final.wav');
%% low pass FIR filter
TW = 0.11;
PBE = 2000;
M1=1000;
corner = PBE+TW/2;
wn = 2*corner/Fs1;
a1 = fir1(M1, wn, 'low', hamming(M1+1));
%% Filtering the Audio Data
filtered_audio_data_1 = filter(a1,1,es1) ;
audiowrite('output1.wav',filtered_audio_data_1 ,Fs1);
%% FIR Bandpass  filter 1
Fs = Fs1;
TW = 100;
PBE1 = 2000;
PBE2 = 5000;
delf = TW/Fs;
M2 = round(5.5/delf);
corner1 = PBE1+TW/2;
corner2 = PBE2+TW/2;
wn1 = 2*corner1/Fs;
wn2 = 2*corner2/Fs;
wn=[wn1,wn2];
a2= fir1(M2, wn, 'bandpass', blackman(M2+1));
%% Filtering the Audio Data
filtered_audio_data_2 = filter(a2,1,es1) ;
audiowrite('output2.wav',filtered_audio_data_2,Fs1);
%% FIR Band pass filter 2
TW3 = 100;
PBE31 = 5000;
PBE32 = 10000;
delf3 = TW3/Fs;
M3 = round(5.5/delf3);
corner31 = PBE31+TW3/2;
corner32 = PBE32+TW3/2;
```

```
wn31 = 2*corner31/Fs;
wn32 = 2*corner32/Fs;
wn3=[wn31,wn32];
a3= fir1(M3, wn3, 'bandpass', blackman(M3+1));
%% Filtering the Audio Data
filtered_audio_data_3 = filter(a3,1,es1) ;
audiowrite('output3.wav',filtered_audio_data_3,Fs1);
%% FIR Band pass filter 3
TW4 = 100;
PBE41 = 14000;
PBE42 = 16000;
delf4 = TW3/Fs;
M4 = round(5.5/delf4);
corner41 = PBE41+TW4/2;
corner42 = PBE42+TW4/2;
wn41 = 2*corner41/Fs;
wn42 = 2*corner42/Fs;
wn4=[wn41,wn42];
a4= fir1(M4, wn4, 'bandpass', blackman(M4+1));
%% Filtering the Audio Data
filtered_audio_data_4 = filter(a4,1,es1) ;
audiowrite('output4.wav',filtered_audio_data_4,Fs1);
```

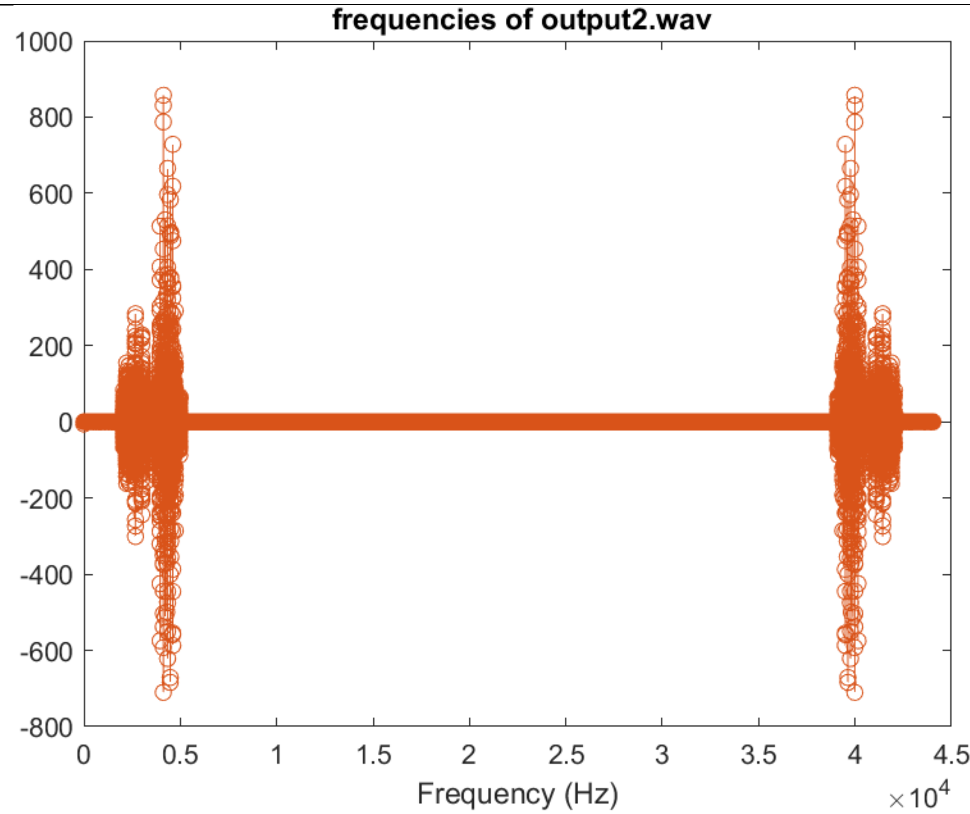
TASK05

```
clc;
close all;
clear all;
[es1,Fs1]=audioread('output1.wav');
Ts=1/Fs1;
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
%frequencies Plot
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
```

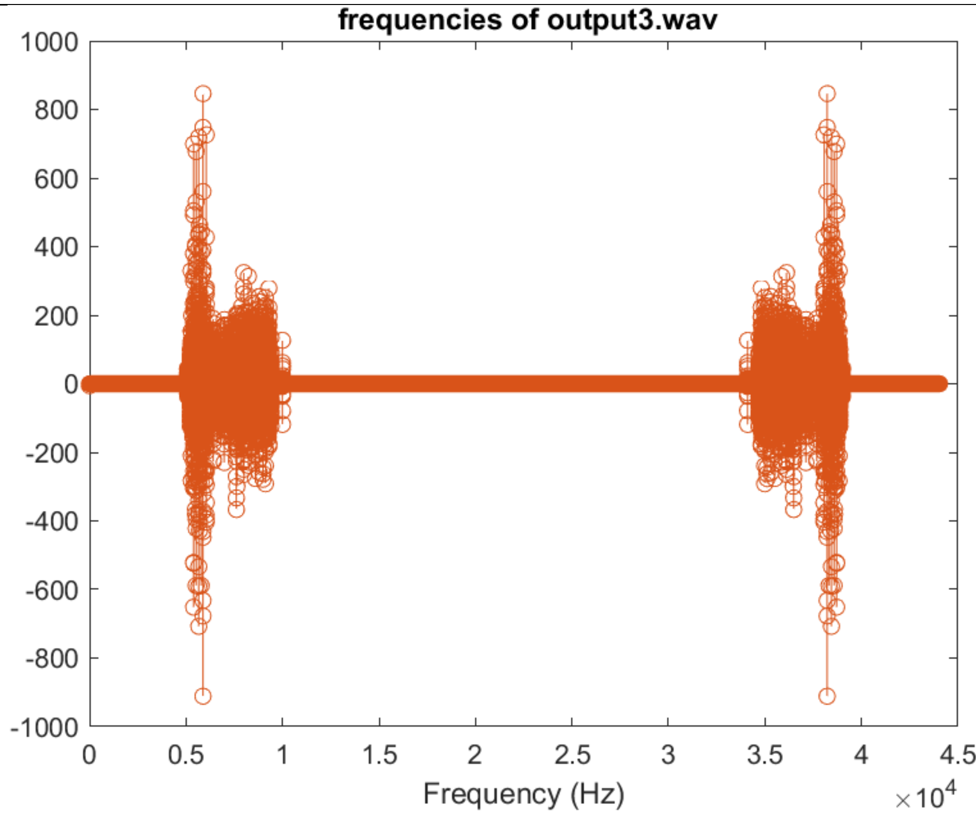
```
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of output1.wav');
```



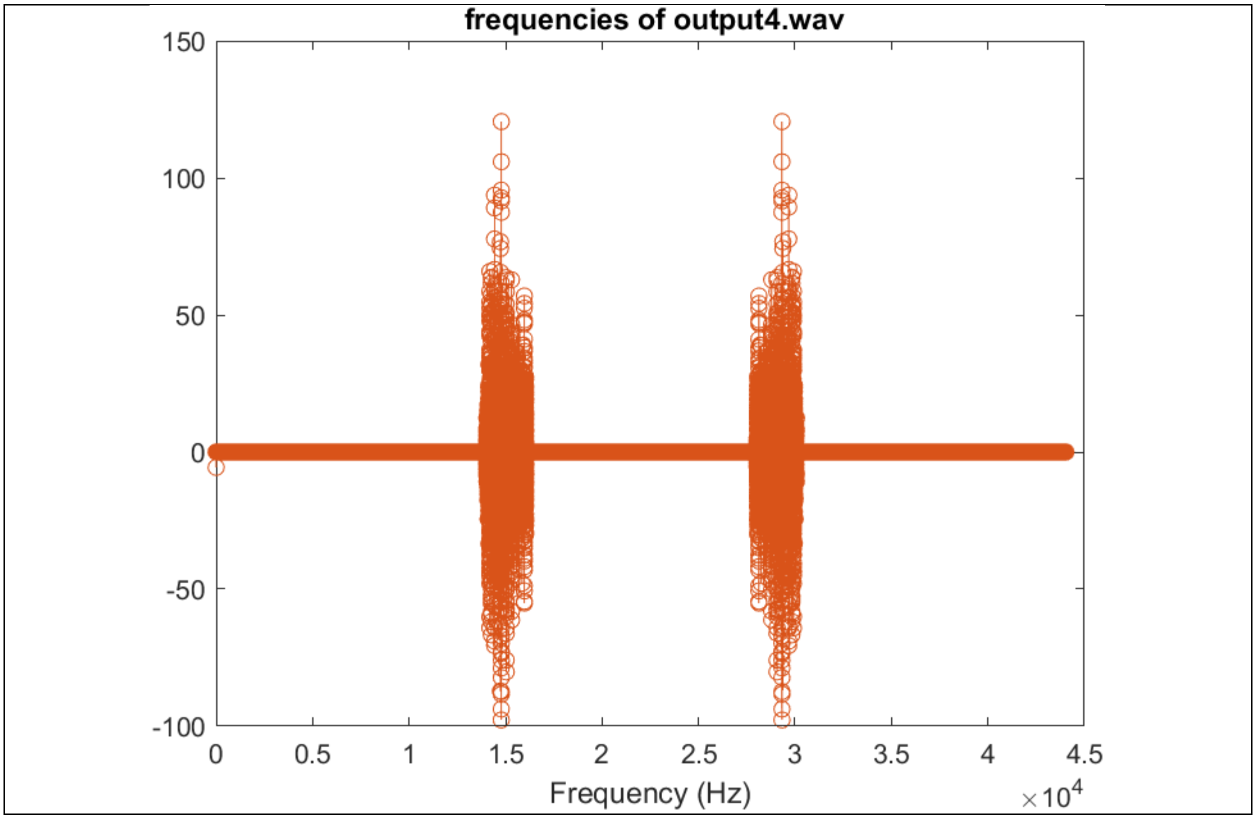

```
clc;
close all;
clear all;
[es1,Fs1]=audioread('output2.wav');
Ts=1/Fs1;
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
%frequencies Plot
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of output2.wav');
```




```
clc;
close all;
clear all;
[es1,Fs1]=audioread('output3.wav');
Ts=1/Fs1;
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
%frequencies Plot
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of output3.wav');
```



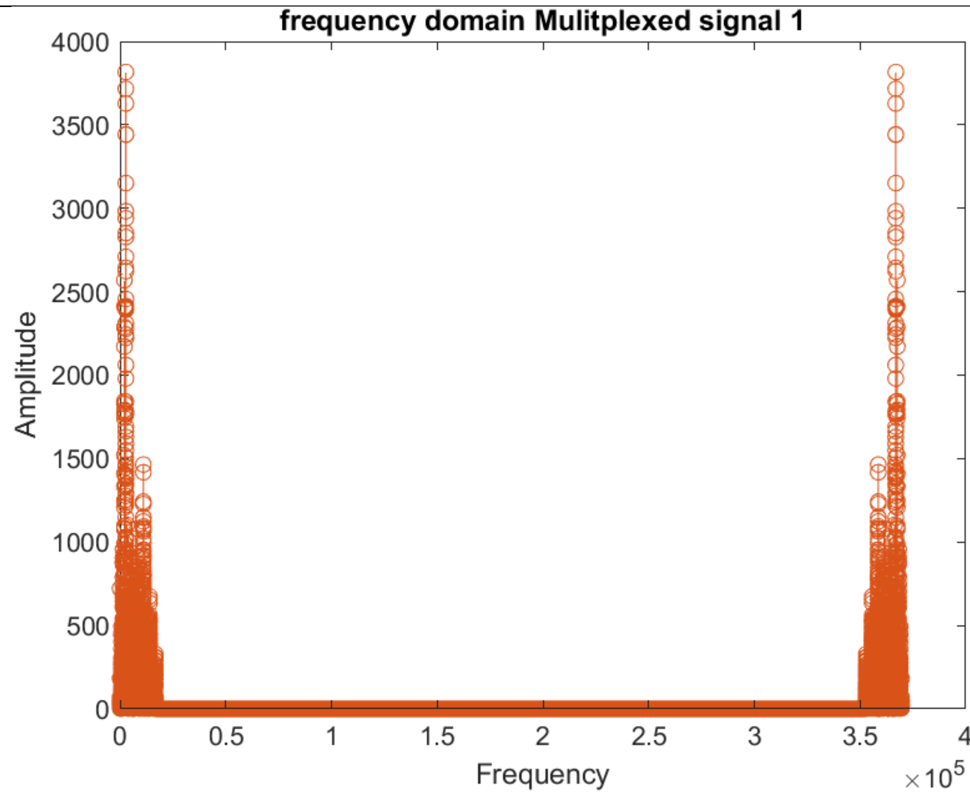

```
clc;
close all;
clear all;
[es1,Fs1]=audioread('output4.wav');
Ts=1/Fs1;
N = length(es1); % sample lenth
slength = N/Fs1; % total time span of audio signal
t = linspace(0, N/Fs1, N);
n=0:length(es1)-1;
%frequencies Plot
es2=fft(es1);
N=length(es2);
figure(2)
f=(n*Fs1)/N;
stem(f,es2);
xlabel('Frequency (Hz)');
title(' frequencies of output4.wav');
```

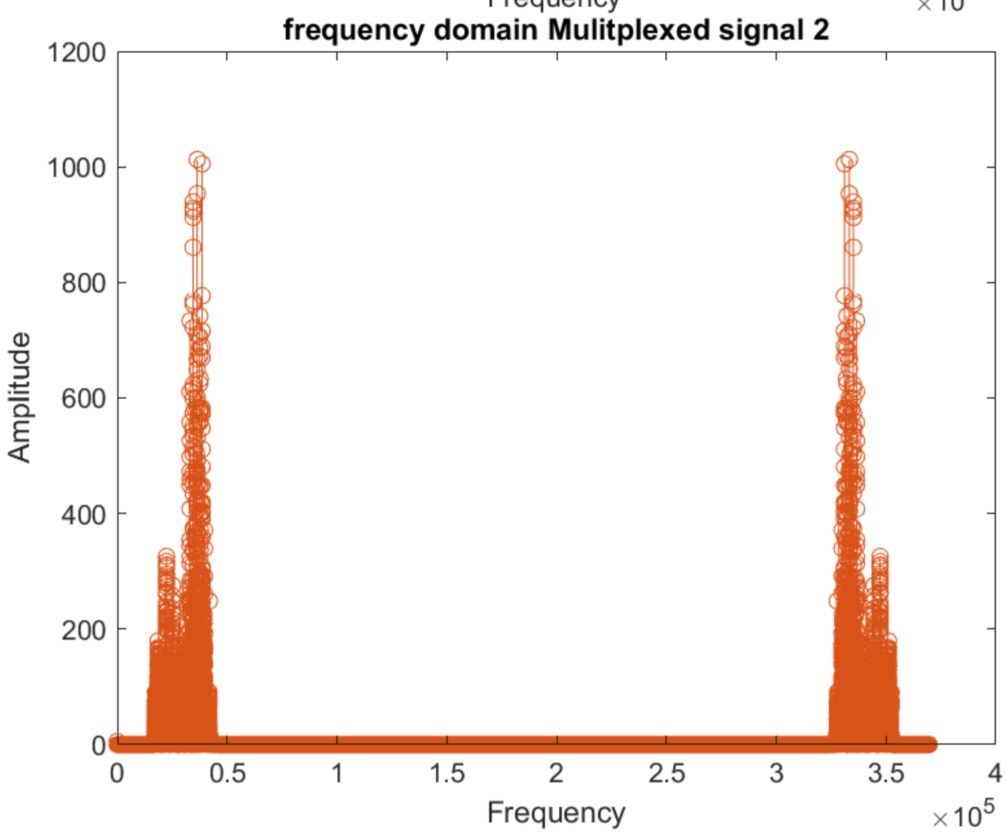


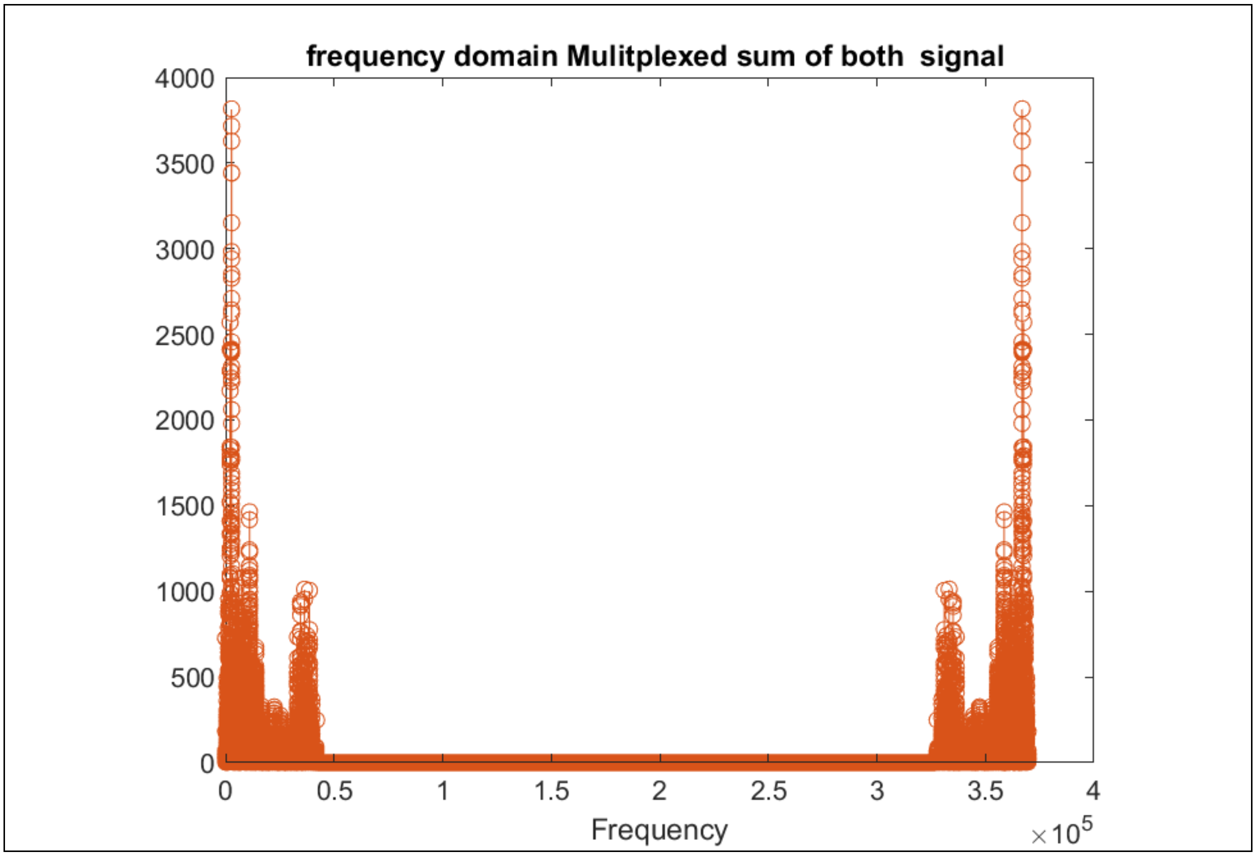
Pass the individual wav files separately using "Time-division multiplexing (TDM)".

TASK06

```
clc;
clear all;
close all;
%% FDM multiplexer
fc1=5121;
[m,fs1]=audioread('output1.wav');
[n,fs2]=audioread('output2.wav');
t1=[1:length(m)]';
ct1=cos(2*pi*fc1*t1);
Xfdm1 = m.*ct1;
Xfdm_fft1=abs(fft(Xfdm1));
figure
stem(Xfdm_fft1);
title('frequency domain Mulitplexed signal 1');
xlabel('Frequency');
ylabel('Amplitude');
fc2=6000; %chosse another carrier
t2=[1:length(n)]';
ct2=cos(2*pi*fc2*t2);
Xfdm2 = n.*ct2;
Xfdm_fft2=abs(fft(Xfdm2));
figure
stem(Xfdm_fft2);
title('frequency domain Mulitplexed signal 2');
xlabel('Frequency');
ylabel('Amplitude');
figure
stem(Xfdm_fft1+Xfdm_fft2);
title('frequency domain Mulitplexed sum of both 
signal ');
xlabel('Frequency');
```


frequency domain Mulitplexed signal 1
Amplitude
Frequency
×10^5
0
500
1000
1500
2000
2500
3000
3500
4000
0.5
1
1.5
2
2.5
3
3.5
4


frequency domain Mulitplexed signal 2
Amplitude
Frequency
×10^5
0
200
400
600
800
1000
1200
0.5
1
1.5
2
2.5
3
3.5
4



TASK07

Convert this into an overlapping yet melodious one with proper synchronization of octaves.

```
clc;
close all;
clear all;
[es1,Fs1]=audioread('output1.wav');
[es2,Fs2]=audioread('output2.wav');
[es3,Fs3]=audioread('output3.wav');
[es4,Fs4]=audioread('output4.wav');

final=es1+es2+es3+es4;
%% convertthis into an overlapping yet melodious ...
... one with proper synchronization of octaves
audiowrite('mFinal.wav',final,Fs1);
sound(final,Fs1)
```