



Ahsanullah University of Science & Technology

Department of Electrical and Electronic Engineering

Assignment

Course No : EEE 3218
Course Title : Digital Signal Processing Lab

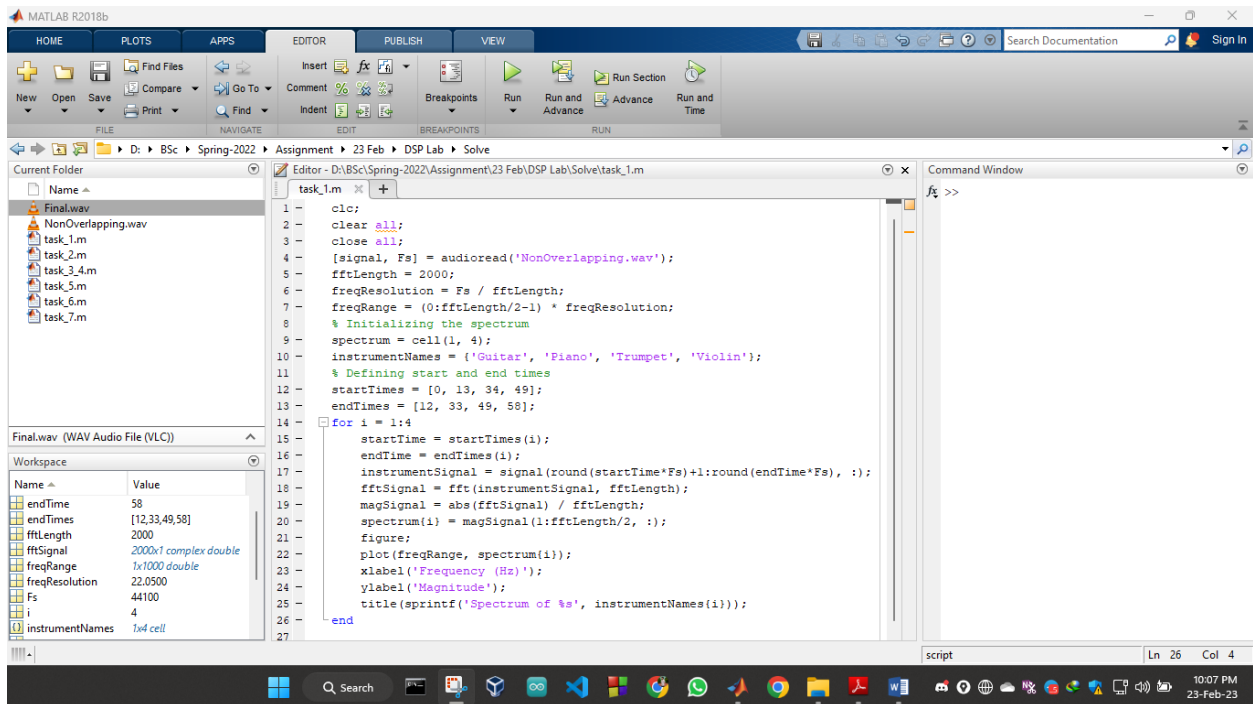
Submission Date : 23-02-2023

Submitted by

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Section : C2
Year : 3rd
Semester : 2nd

Task 1:

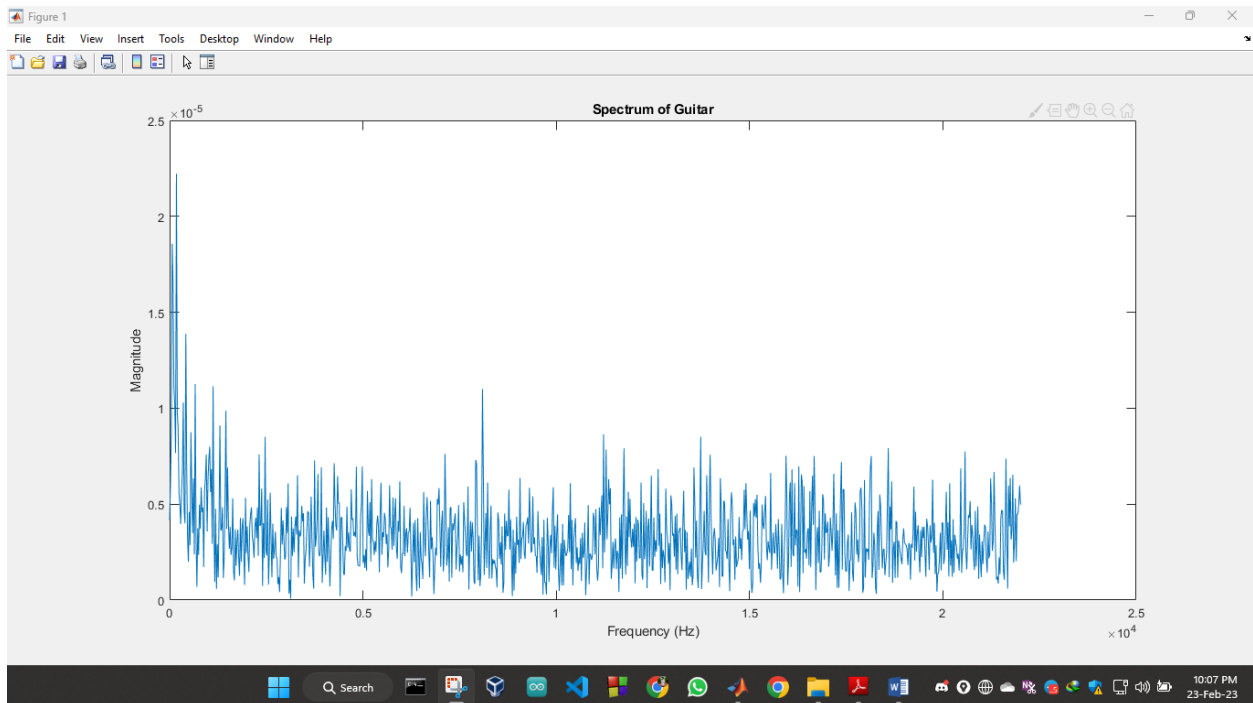
Code:



```
1 clc;
2 clear all;
3 close all;
4 [signal, Fs] = audioread('NonOverlapping.wav');
5 fftLength = 2000;
6 freqResolution = Fs / fftLength;
7 freqRange = (0:fftLength/2-1) * freqResolution;
8 % Initializing the spectrum
9 spectrum = cell(1, 4);
10 instrumentNames = {'Guitar', 'Piano', 'Trumpet', 'Violin'};
11 % Defining start and end times
12 startTimes = [0, 13, 34, 49];
13 endTimes = [12, 33, 49, 58];
14 for i = 1:4
15     startTime = startTimes(i);
16     endTime = endTimes(i);
17     instrumentSignal = signal(round(startTime*Fs)+1:round(endTime*Fs), :);
18     fftSignal = fft(instrumentSignal, fftLength);
19     magSignal = abs(fftSignal) / fftLength;
20     spectrum(i) = magSignal(1:fftLength/2, :);
21     figure;
22     plot(freqRange, spectrum(i));
23     xlabel('Frequency (Hz)');
24     ylabel('Magnitude');
25     title(sprintf('Spectrum of %s', instrumentNames(i)));
26 end
```

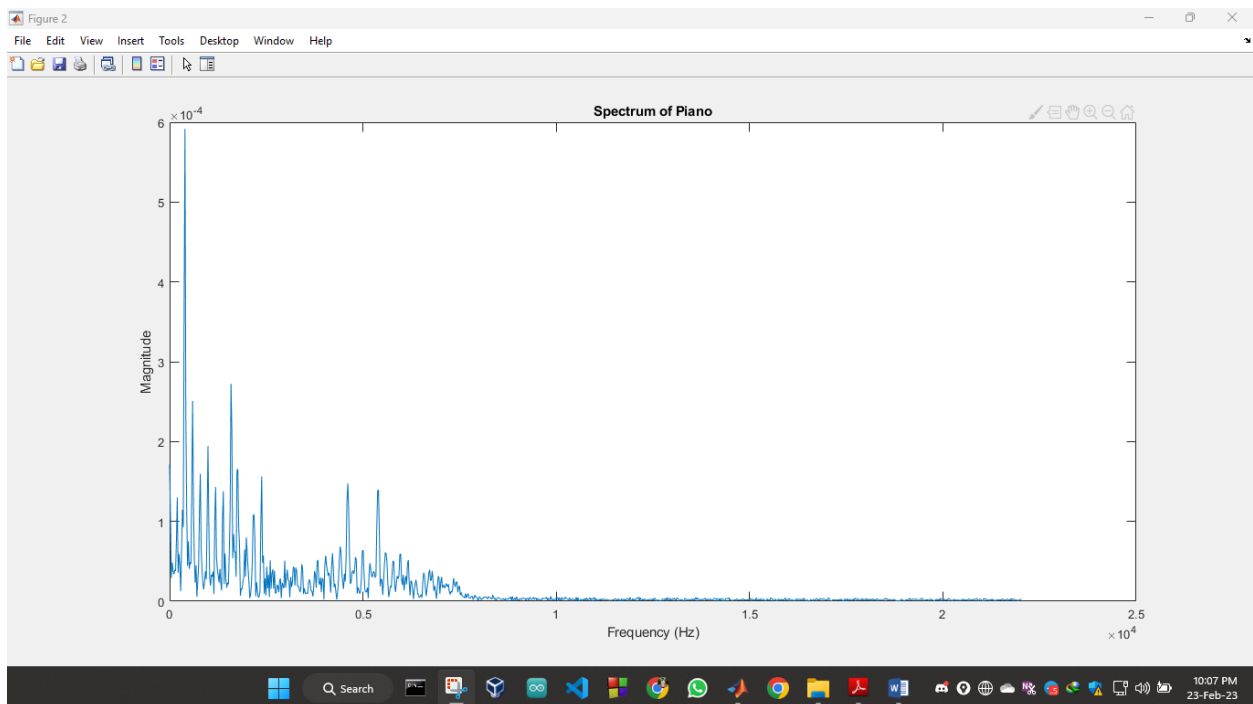
Name	Value
endTime	58
endTimes	[12, 33, 49, 58]
fftLength	2000
fftSignal	2000x1 complex double
freqRange	1x1000 double
freqResolution	22.0500
Fs	44100
i	4
instrumentNames	1x4 cell

Guitar:



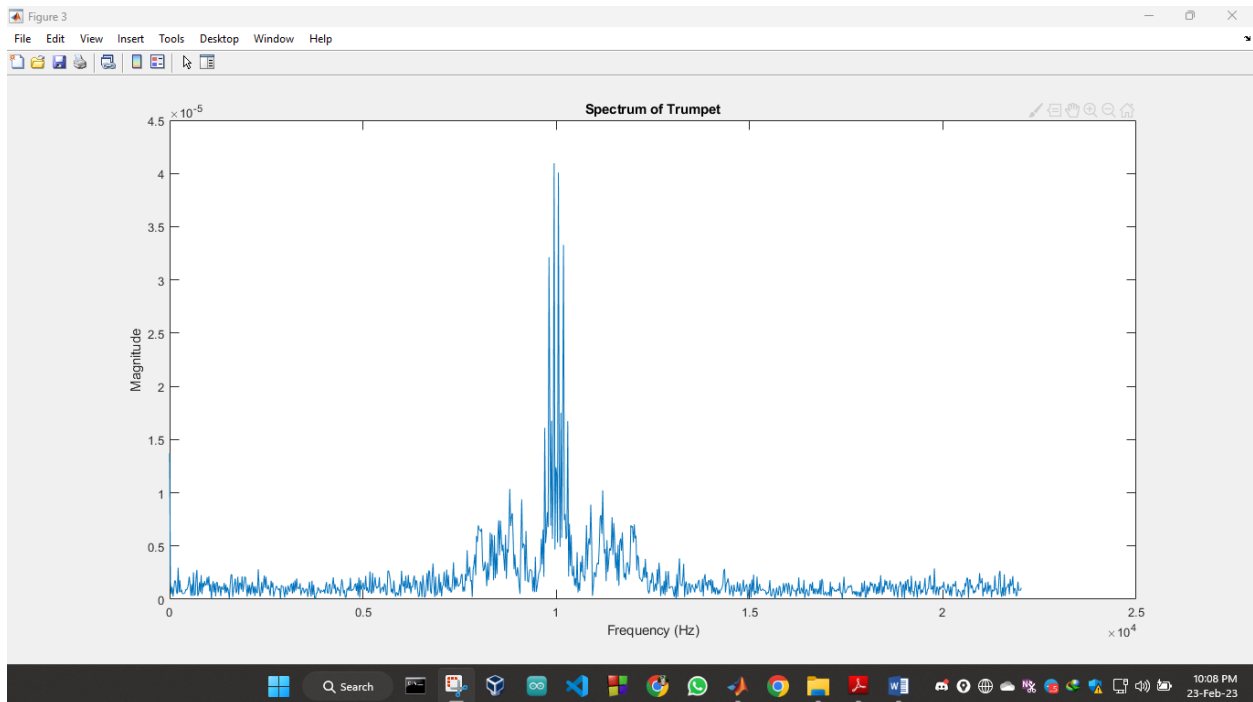
It has a frequency range between 0 Hz to 22010 Hz.

Piano:



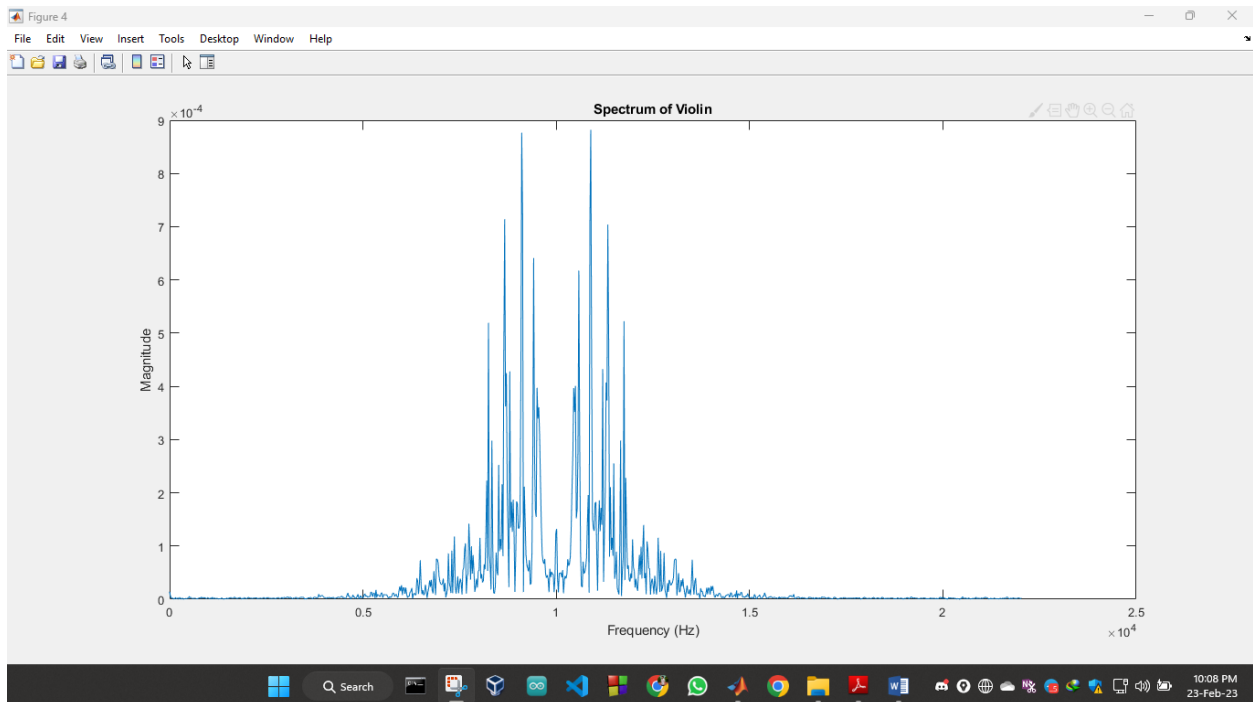
It has a frequency range between 0 Hz to 7629 Hz.

Trumpet:



It has a frequency range between 0 Hz to 22030 Hz.

Violin:



It has a frequency range between 5005 Hz to 16140 Hz.

Task 2:

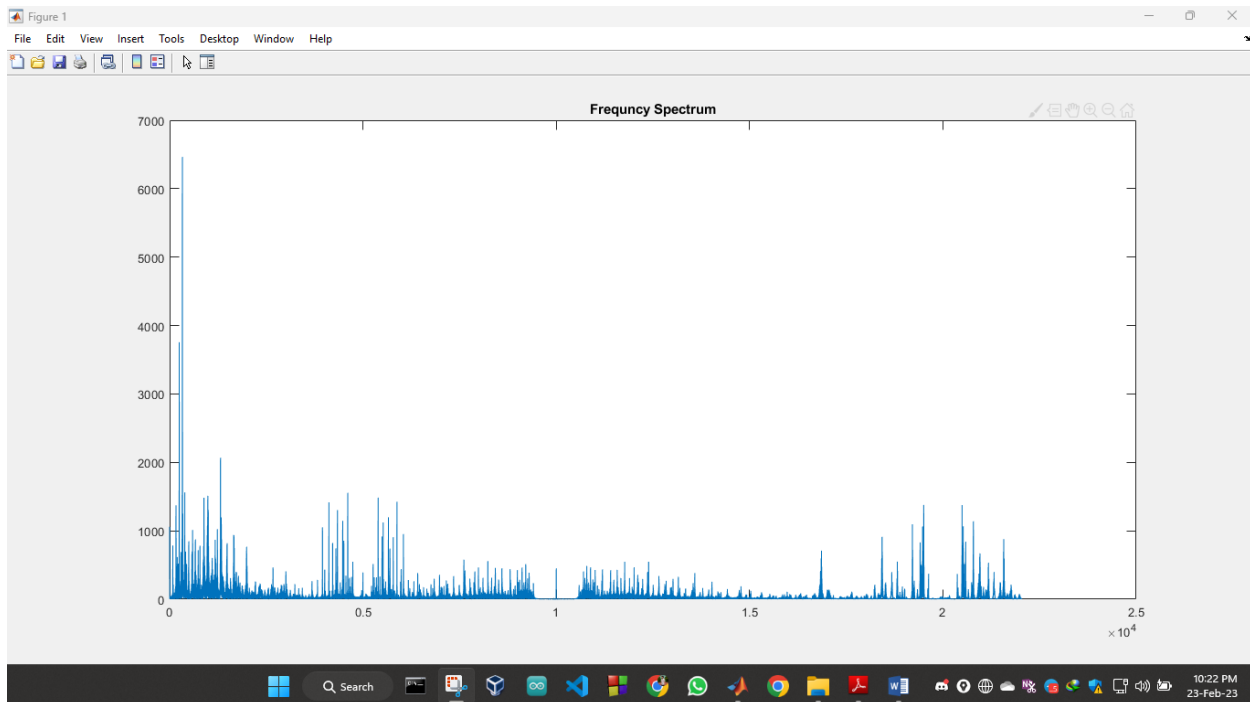
Code:

```
1 - clear;
2 - clear all;
3 - close all;
4
5 % Reading audio file
6 [x1,fs1]=audioread('Final.wav');
7
8 % nextpow2() calculate the next highest power of 2
9 nfftF=2^nextpow2(length(x1));
10 f1=fs1/2* linspace(0,1,nfftF/2+1);
11 y1=abs(fft(x1,nfftF));
12 figure(1);
13 plot(f1,y1(1:nfftF/2+1));
14 title('Frequency Spectrum');
```

Workspace:

Name	Value
f1	1x262145 double
fs1	44100
nfftF	524288
x1	370466x1 double
y1	524288x1 double

Spectrum:



The frequency range is between 0 Hz to 22050 Hz.

Task 3 & 4:

Code:

```
MATLAB R2018b

HOME PLOTS APPS EDITOR PUBLISH VIEW
New Open Save Find Files Compare Go To Find Comment Indent Breakpoints Run Run and Advance Run Section Run and Time
FILE NAVIGATE EDIT BREAKPOINTS RUN

Current Folder: D:\BSc Spring-2022\Assignment\23 Feb\DSP Lab\Solve\task_3_4.m
task_1.m task_2.m task_3_4.m
Name: Final.wav, Guitar.wav, NonOverlapping.wav, Piano.wav, task_1.m, task_2.m, task_3_4.m, task_5.m, task_6.m, task_7.m, Trumpet.wav, Violin.wav
task_3_4.m (Script)
Workspace: Name, Value, f1 (1x262145 double), filter1 (1x1 digitalFilter), filter2 (1x1 digitalFilter), filter3 (1x1 digitalFilter), filter4 (1x1 digitalFilter), fs1 (44100), nfftF (524288), signalGuitar (370466x1 double), signalPiano (370466x1 double)
Editor: D:\BSc Spring-2022\Assignment\23 Feb\DSP Lab\Solve\task_3_4.m
task_1.m task_2.m task_3_4.m
1: clc;
2: clear all;
3: close all;
4:
5: [x1,fs1]=audioread('Final.wav');
6: nfftF=2^nextpow2(length(x1));
7: f1=fs1/2* linspace(0,1,nfftF/2+1);
8:
9: filter1=designfilt('lowpassfir','PassbandFrequency',1970,'StopbandFrequency',2
10: signalGuitar=filter(filter1,x1);
11: audiowrite('Guitar.wav',signalGuitar,fs1);
12:
13: filter2=designfilt('bandpassfir','FilterOrder',32,'CutoffFrequency1',4600,'Cut
14: signalPiano=filter(filter2,x1);
15: audiowrite('Piano.wav',signalPiano,fs1);
16:
17: filter3=designfilt('bandpassfir','FilterOrder',24,'CutoffFrequency1',10000,'Cu
18: signalTrumpet=filter(filter3,x1);
19: audiowrite('Trumpet.wav',signalTrumpet,fs1);
20:
21: filter4=designfilt('highpassfir','PassbandFrequency',15000,'StopbandFrequency'
22: signalViolin=filter(filter4,x1);
23: audiowrite('Violin.wav',signalViolin,fs1);
Command Window: f1 >>
```

Guitar: Guitar uses low pass filter with pass band frequency of 1970 Hz, stopband frequency of 2290 Hz, pass band ripple 1, stopband attenuation of 94.

Piano: Piano uses band pass filter with order 32, cutoff frequency 4600Hz and 6100 Hz.

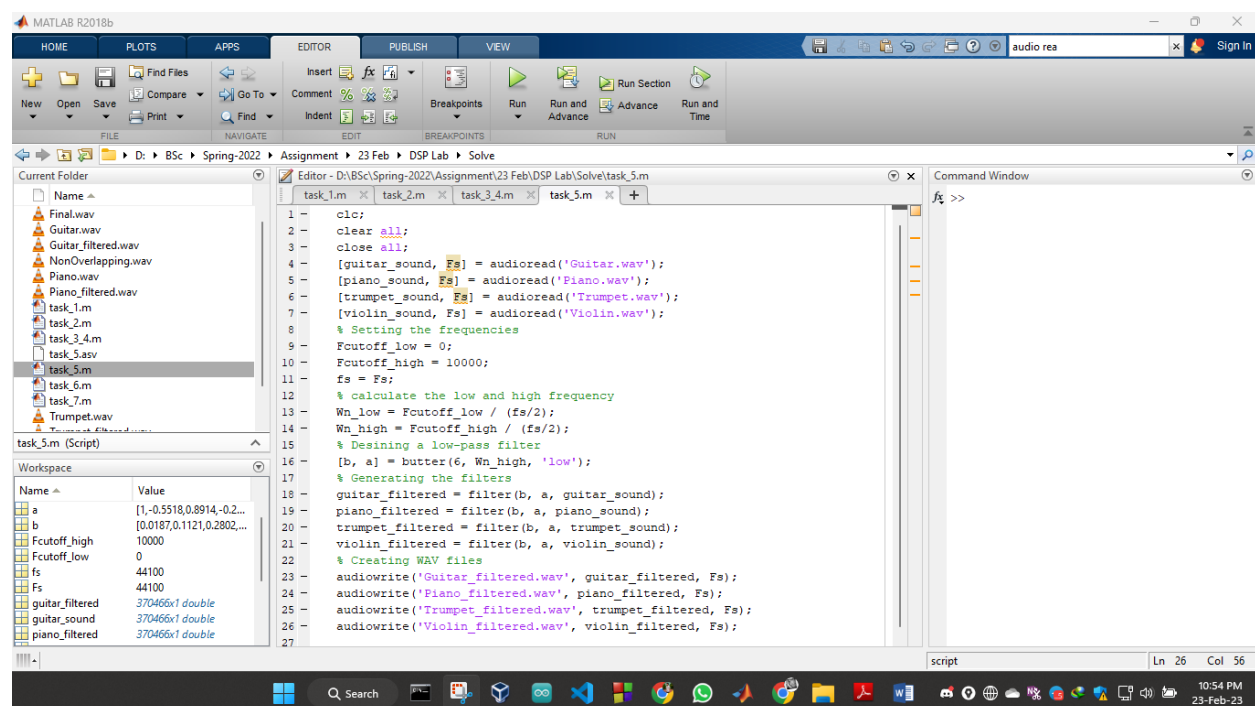
Trumpet: Trumpet uses band pass filter with filter order 24, cutoff frequency 10000Hz and 11000 Hz.

Violin: Violin uses high pass filter with pass band frequency of 15000 Hz, stopband frequency of 14900 Hz, pass band ripple 1, stopband attenuation of 77.

Extracted files are Guitar.wav, Piano.wav, Trumpet.wav and Violin.wav.

Task 5:

I can pass the individual wav files separately through a channel of bandwidth 0 to 10 kHz by setting the lower frequency to 0 Hz and higher frequency to 10000 Hz and using the low pass filter with butter function with filter order 6.



The image shows the MATLAB R2018b interface with a script editor and a workspace window. The script in the editor is as follows:

```
1 clear;
2 close all;
3 % Reading the audio files
4 [guitar_sound, Fs] = audioread('Guitar.wav');
5 [piano_sound, Fs] = audioread('Piano.wav');
6 [trumpet_sound, Fs] = audioread('Trumpet.wav');
7 [violin_sound, Fs] = audioread('Violin.wav');
8 % Setting the frequencies
9 Fcutoff_low = 0;
10 Fcutoff_high = 10000;
11 fs = Fs;
12 % calculate the low and high frequency
13 Wn_low = Fcutoff_low / (fs/2);
14 Wn_high = Fcutoff_high / (fs/2);
15 % Designing a low-pass filter
16 [b, a] = butter(6, Wn_high, 'low');
17 % Generating the filters
18 guitar_filtered = filter(b, a, guitar_sound);
19 piano_filtered = filter(b, a, piano_sound);
20 trumpet_filtered = filter(b, a, trumpet_sound);
21 violin_filtered = filter(b, a, violin_sound);
22 % Creating WAV files
23 audiowrite('Guitar_filtered.wav', guitar_filtered, Fs);
24 audiowrite('Piano_filtered.wav', piano_filtered, Fs);
25 audiowrite('Trumpet_filtered.wav', trumpet_filtered, Fs);
26 audiowrite('Violin_filtered.wav', violin_filtered, Fs);
```

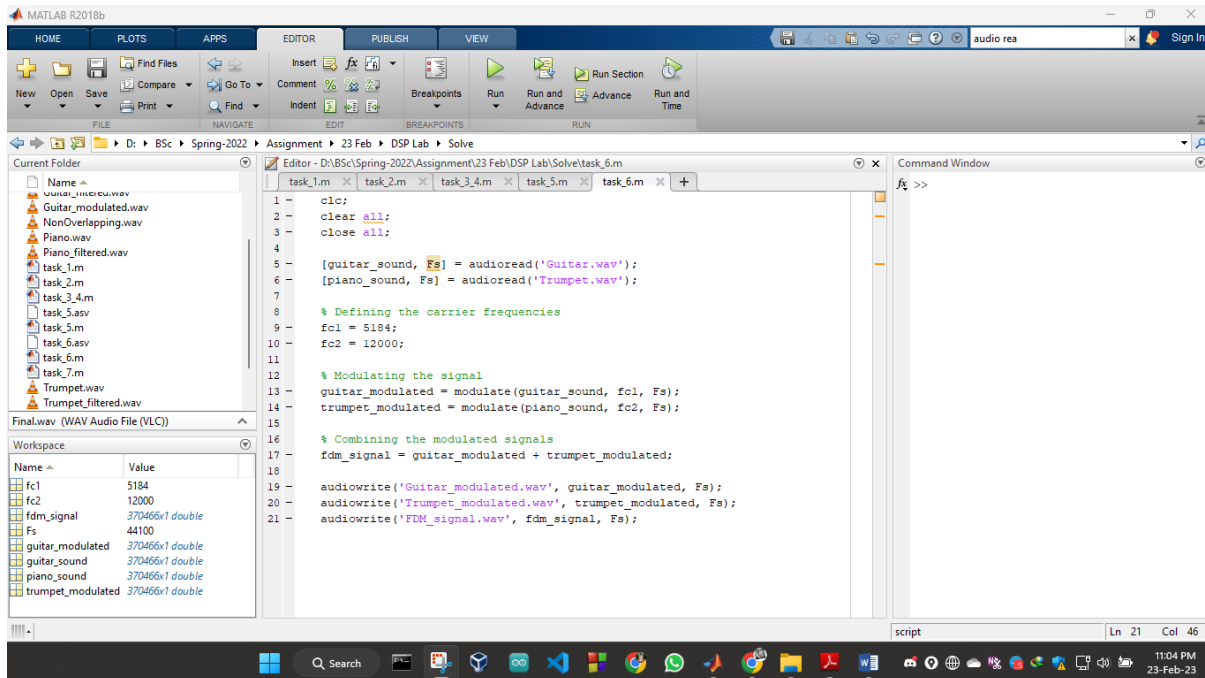
The workspace window shows the following variables:

Name	Value
a	[1, -0.5518, 0.8914, -0.2...
b	[0.0187, 0.1121, 0.2802, ...
Fcutoff_high	10000
Fcutoff_low	0
fs	44100
guitar_filtered	370466x1 double
guitar_sound	370466x1 double
piano_filtered	370466x1 double

Task 6:

Sending guitar and trumpet signals through a 2-channel FDM link using carrier frequency of 5184 Hz and 12000 Hz.

Code:

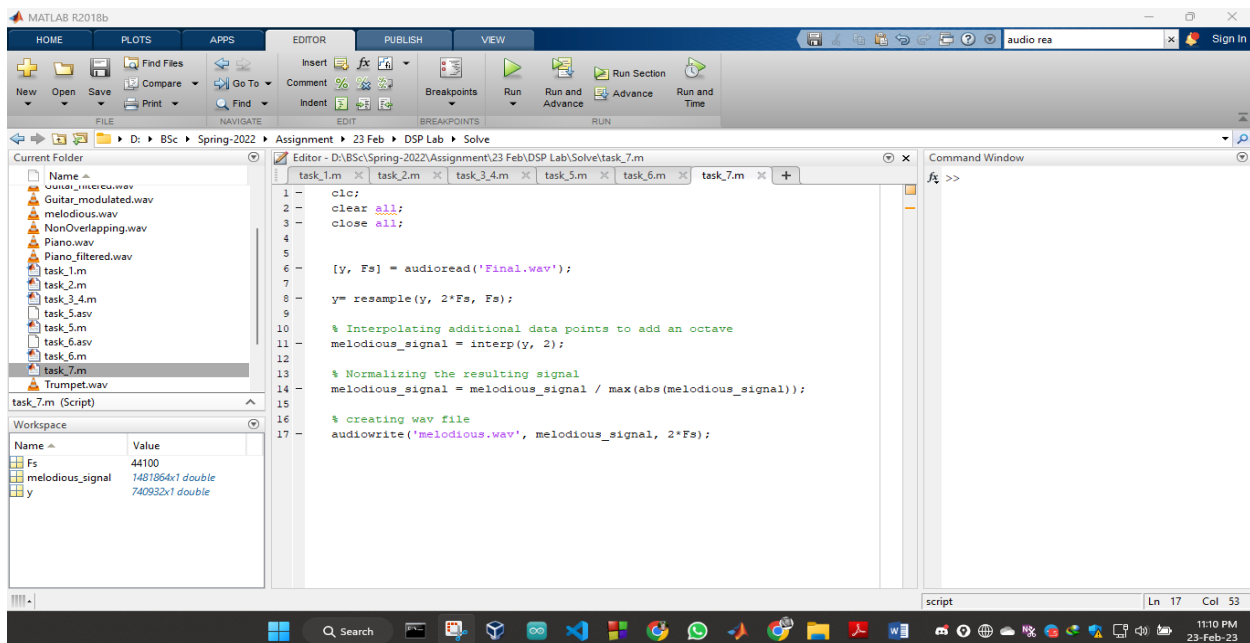


```
1 clear;
2 clear all;
3 close all;
4
5 [guitar_sound, Fs] = audioread('Guitar.wav');
6 [piano_sound, Fs] = audioread('Trumpet.wav');
7
8 % Defining the carrier frequencies
9 fc1 = 5184;
10 fc2 = 12000;
11
12 % Modulating the signal
13 guitar_modulated = modulate(guitar_sound, fc1, Fs);
14 trumpet_modulated = modulate(piano_sound, fc2, Fs);
15
16 % Combining the modulated signals
17 fdm_signal = guitar_modulated + trumpet_modulated;
18
19 audiowrite('Guitar_modulated.wav', guitar_modulated, Fs);
20 audiowrite('Trumpet_modulated.wav', trumpet_modulated, Fs);
21 audiowrite('FDM_signal.wav', fdm_signal, Fs);
```

Name	Value
fc1	5184
fc2	12000
fdm_signal	370466x1 double
Fs	44100
guitar_modulated	370466x1 double
guitar_sound	370466x1 double
piano_sound	370466x1 double
trumpet_modulated	370466x1 double

Task 7:

Code:



```
1 clear;
2 clear all;
3 close all;
4
5 [y, Fs] = audioread('Final.wav');
6
7 y = resample(y, 2*Fs, Fs);
8
9 % Interpolating additional data points to add an octave
10 melodious_signal = interp(y, 2);
11
12 % Normalizing the resulting signal
13 melodious_signal = melodious_signal / max(abs(melodious_signal));
14
15 % Creating wav file
16 audiowrite('melodious.wav', melodious_signal, 2*Fs);
```

Name	Value
Fs	44100
melodious_signal	1481864x1 double
y	740932x1 double