Hacettepe University

Department of Electrical and Electronics Engineering

ELE 409 Digital Signal Proccessing Laboratory

EXPERIMENT 1 – THE DFT and ITS PROPERTIES

PRELIMINARY WORK

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1)

Function :

```
function x=SinSamples(A,w,teta,d,ws)
fs=ws/(2*pi); % sampling frequency
ts=1/fs; % sampling period
n=0:1:ts-1; %number of sample
x=A*sin(w*n+teta);
end
```

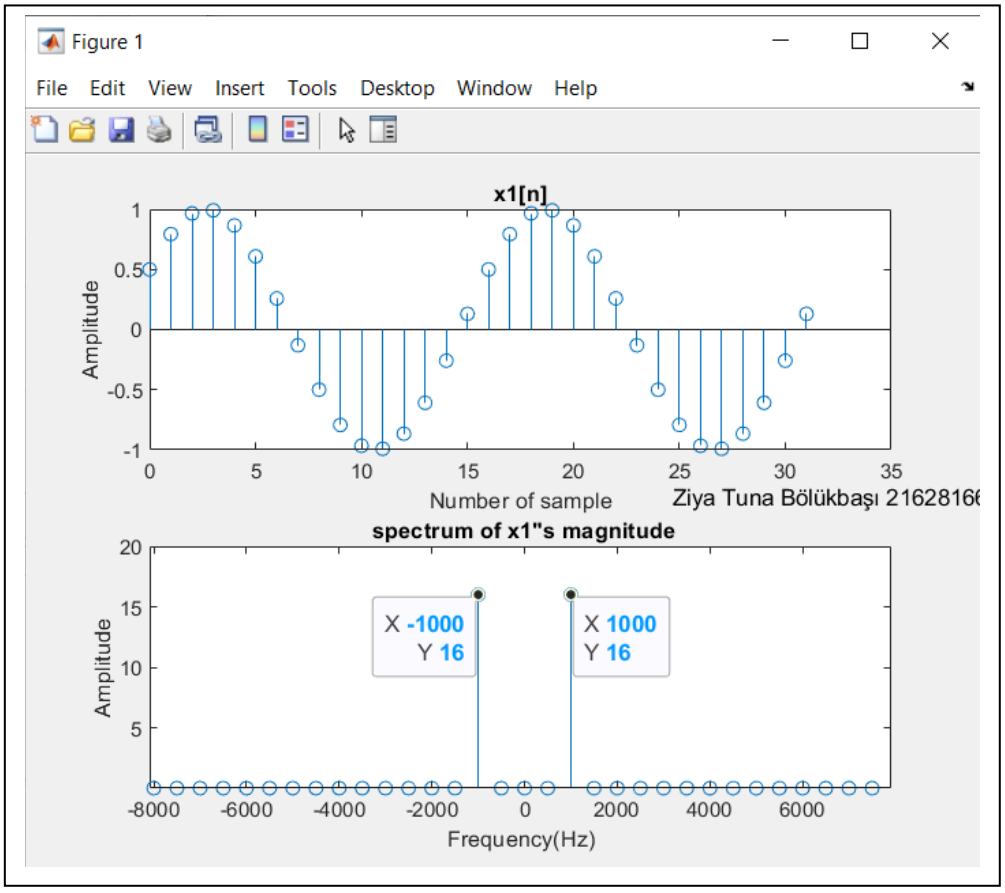
2)

Matlab Code :

a)

```
clc;
clear all;
close all;
fs=16000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,pi/6,0.002,2*pi*16000);
[ans2,n2]=sinsamplesfunction(1,2*pi*1000,0,0.002,2*pi*16000);
fft_ans1=fft(ans1);
fft_ans2=fft(ans2);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans2=fftshift(abs(fft_ans2));
length1=length(shift_fft_ans1);
length2=length(shift_fft_ans2);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency2=-fs/2:fs/length2:fs/2-fs/length2;
figure;

subplot(2,1,1);
stem(n1,ans1);
title('x1[n]');
xlabel('Number of sample');
ylabel('Amplitude');
subplot(2,1,2);
stem(range_of_frequency1,shift_fft_ans1);
title(' spectrum of x1"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')
gtext('Ziya Tuna Bölükbaşı 21628166')
```



b)

```
clc;
clear all;
close all;
fs=16000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,pi/6,0.002,2*pi*16000);
[ans2,n2]=sinsamplesfunction(1,2*pi*1000,0,0.002,2*pi*16000);
fft_ans1=fft(ans1);
fft_ans2=fft(ans2);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans2=fftshift(abs(fft_ans2));
length1=length(shift_fft_ans1);
length2=length(shift_fft_ans2);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency2=-fs/2:fs/length2:fs/2-fs/length2;
figure;

 subplot(2,1,1);
 stem(n2,ans2);
 title('x2[n]');
 xlabel('Number of sample');
 ylabel('Amplitude');
 subplot(2,1,2);
 stem(range_of_frequency2,shift_fft_ans2);
 title(' spectrum of x2"s magnitude');
 xlabel('Frequency(Hz)')
 ylabel('Amplitude')
 gtext('Ziya Tuna Bölükbaşı 21628166')
```

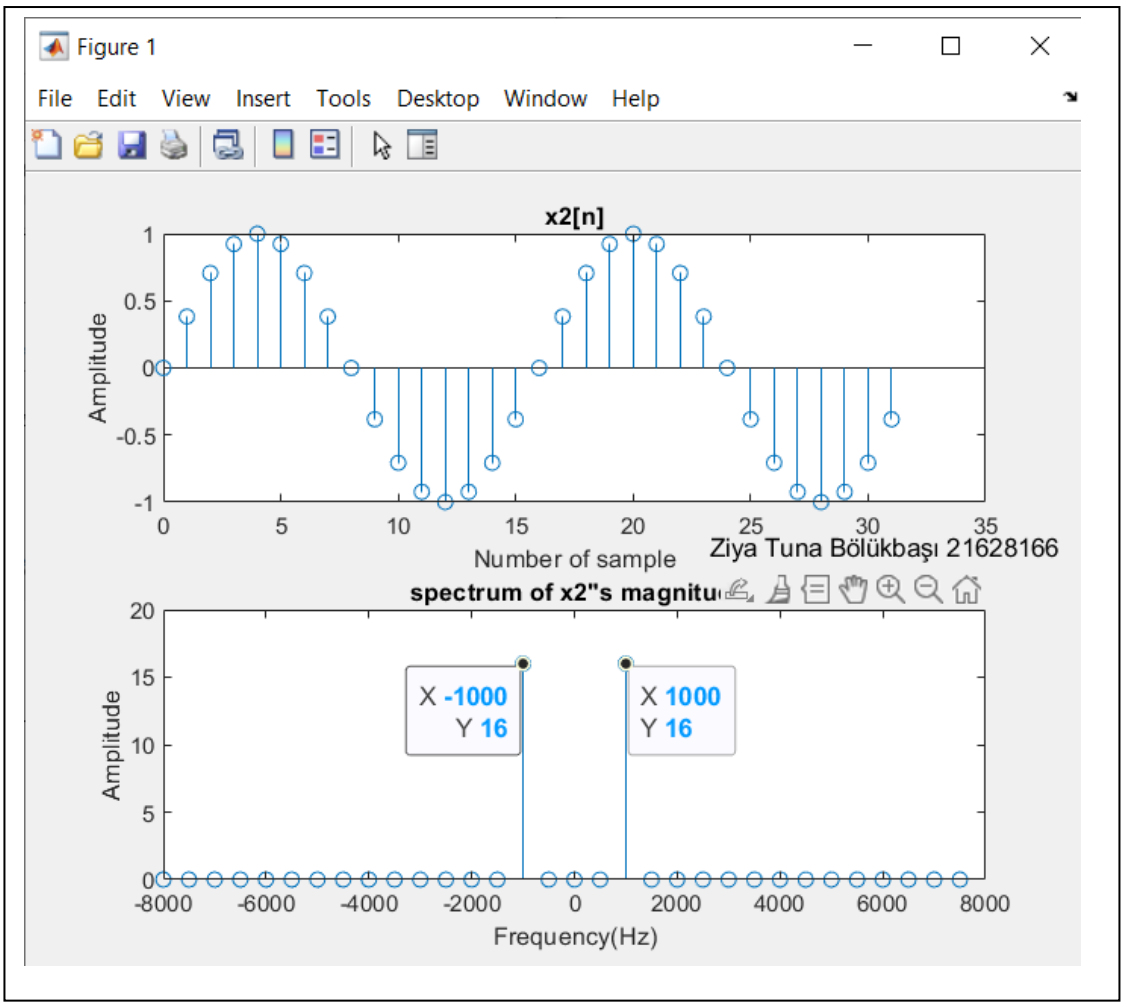


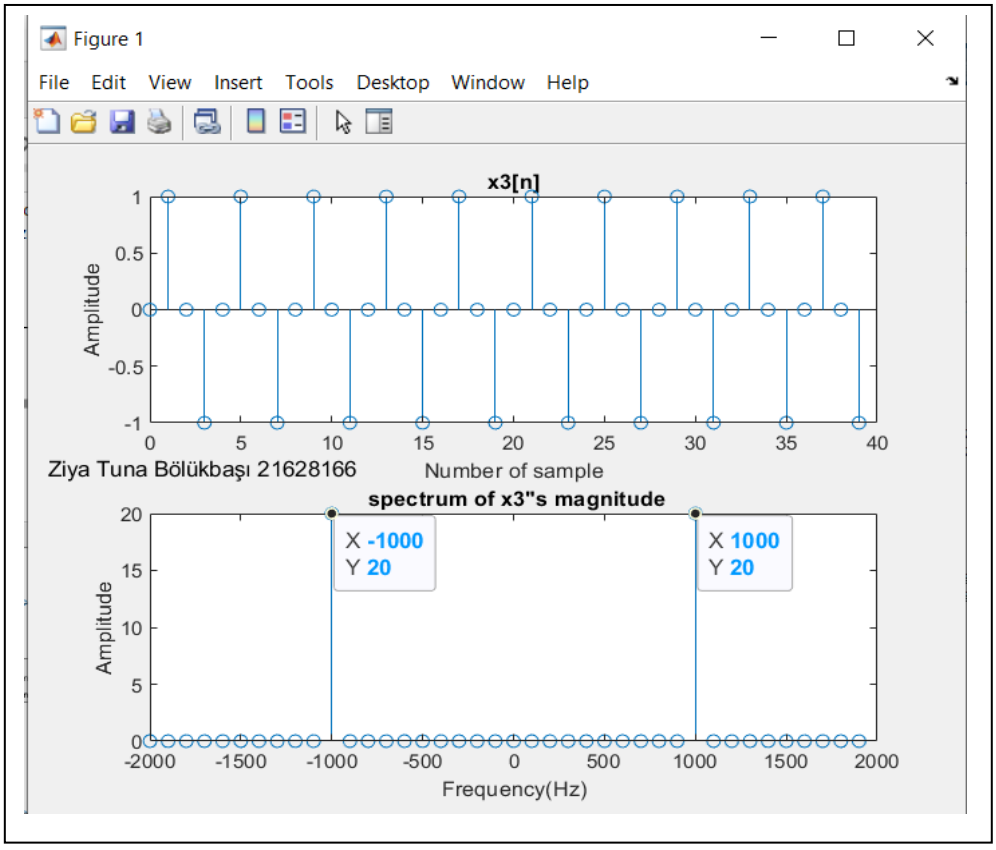
Figure 1
File Edit View Insert Tools Desktop Window Help
x2[n]
Amplitude
Number of sample
Ziya Tuna Bölükbaşı 21628166
spectrum of x2"s magnitu
X -1000
Y 16
X 1000
Y 16
Amplitude
Frequency(Hz)

3)

Matlab code:

a)

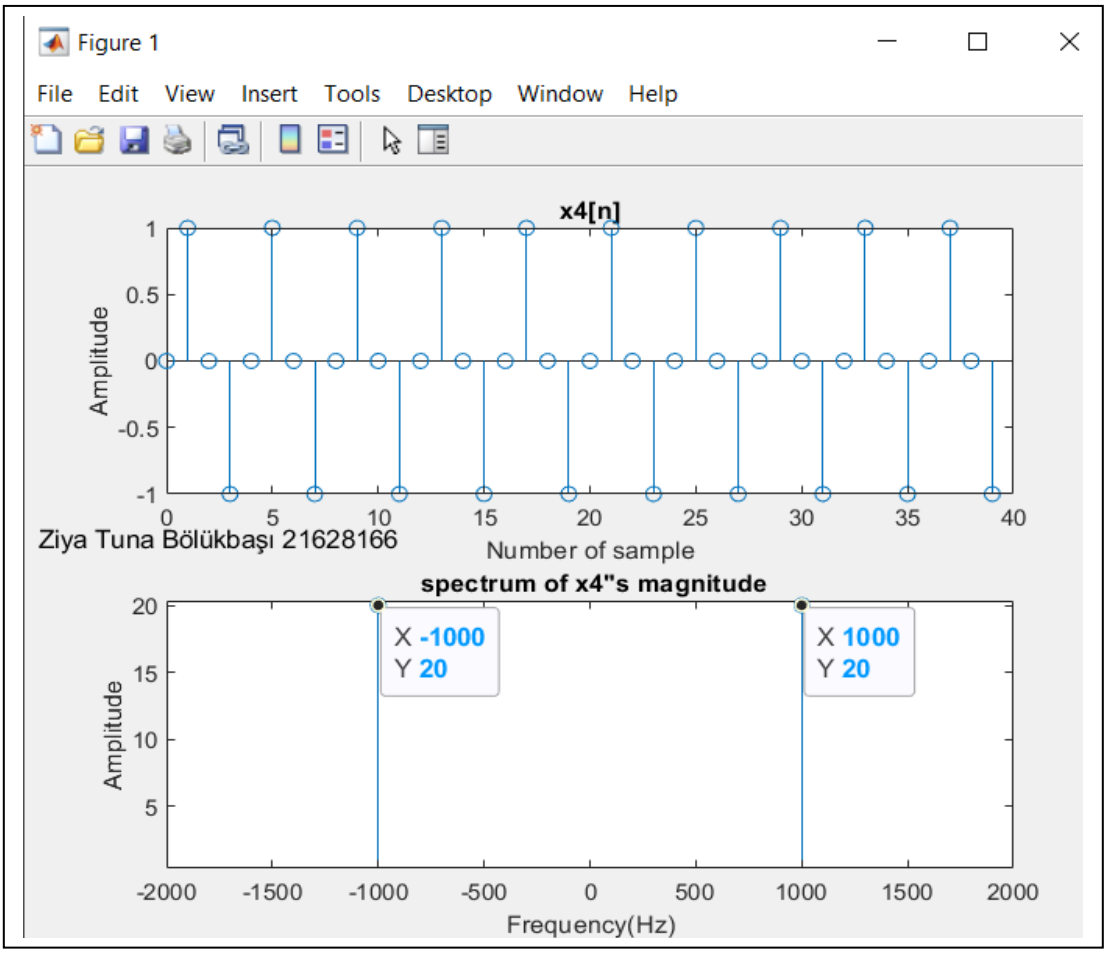
```
clc;
clear all;
close all;
fs=4000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,0,0.01,2*pi*4000);
[ans2,n2]=sinsamplesfunction(1,2*pi*5000,0,0.01,2*pi*4000);
fft_ans1=fft(ans1);
fft_ans2=fft(ans2);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans2=fftshift(abs(fft_ans2));
length1=length(shift_fft_ans1);
length2=length(shift_fft_ans2);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency2=-fs/2:fs/length2:fs/2-fs/length2;
figure;
subplot(2,1,1);
stem(n1,ans1);
title('x3[n]');
xlabel('Number of sample');
ylabel('Amplitude');
subplot(2,1,2);
stem(range_of_frequency1,shift_fft_ans1);
title(' spectrum of x3"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')
 gtext('Ziya Tuna Bölükbaşı 21628166')
```



b)

```
clc;

clear all;
close all;
fs=4000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,0,0.01,2*pi*4000);
[ans2,n2]=sinsamplesfunction(1,2*pi*5000,0,0.01,2*pi*4000);
fft_ans1=fft(ans1);
fft_ans2=fft(ans2);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans2=fftshift(abs(fft_ans2));
length1=length(shift_fft_ans1);
length2=length(shift_fft_ans2);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency2=-fs/2:fs/length2:fs/2-fs/length2;
figure;
 subplot(2,1,1);
 stem(n2,ans2);
 title('x4[n]');
 xlabel('Number of sample');
 ylabel('Amplitude');
 subplot(2,1,2);
 stem(range_of_frequency2,shift_fft_ans2);
 title(' spectrum of x4"s magnitude');
 xlabel('Frequency(Hz)')
 ylabel('Amplitude')
 gtext('Ziya Tuna Bölükbaşı 21628166')
```



Sample frequency should be less than twice original frequency, according to Nyquist theorem.In first of these examples there is no issue but in second example, there is a contradiction in this theorem.ALiasig appears in second case because of this.In frequency domain , frequency of both cases is same.

4)

```
clc;
clear all;
close all;
fs=16000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,0,0.001,2*pi*16000);
[ans2,n2]=sinsamplesfunction(1,2*pi*1000,0,0.0015,2*pi*16000);
[ans3,n3]=sinsamplesfunction(1,2*pi*1000,0,0.002,2*pi*16000);
fft_ans1=fft(ans1);
fft_ans2=fft(ans2);
fft_ans3=fft(ans3);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans2=fftshift(abs(fft_ans2));
shift_fft_ans3=fftshift(abs(fft_ans3));
length1=length(shift_fft_ans1);
length2=length(shift_fft_ans2);
length3=length(shift_fft_ans3);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency2=-fs/2:fs/length2:fs/2-fs/length2;
range_of_frequency3=-fs/2:fs/length2:fs/2-fs/length3;
figure;
% a;
subplot(2,1,1);
stem(n1,ans1);
title('x5[n]');
xlabel('Number of sample');
ylabel('Amplitude');
subplot(2,1,2);
stem(range_of_frequency1,shift_fft_ans1);
title(' spectrum of x5"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')
 gtext('Ziya Tuna Bölükbaşı 21628166')

% b;
% subplot(2,1,1);
% stem(n2,ans2);
% title('x6[n]');
% xlabel('Number of sample');
% ylabel('Amplitude');
% subplot(2,1,2);
% stem(range_of_frequency2,shift_fft_ans2);
% title(' spectrum of x6"s magnitude');
% xlabel('Frequency(Hz)')
% ylabel('Amplitude')
% gtext('Ziya Tuna Bölükbaşı 21628166')

% c
% subplot(2,1,1);
% stem(n3,ans3);
% title('x7[n]');
% xlabel('Number of sample');
% ylabel('Amplitude');
% subplot(2,1,2);
% stem(range_of_frequency3,shift_fft_ans3);
% title(' spectrum of x7"s magnitude');
% xlabel('Frequency(Hz)')
% ylabel('Amplitude')
% gtext('Ziya Tuna Bölükbaşı 21628166')
```

a)

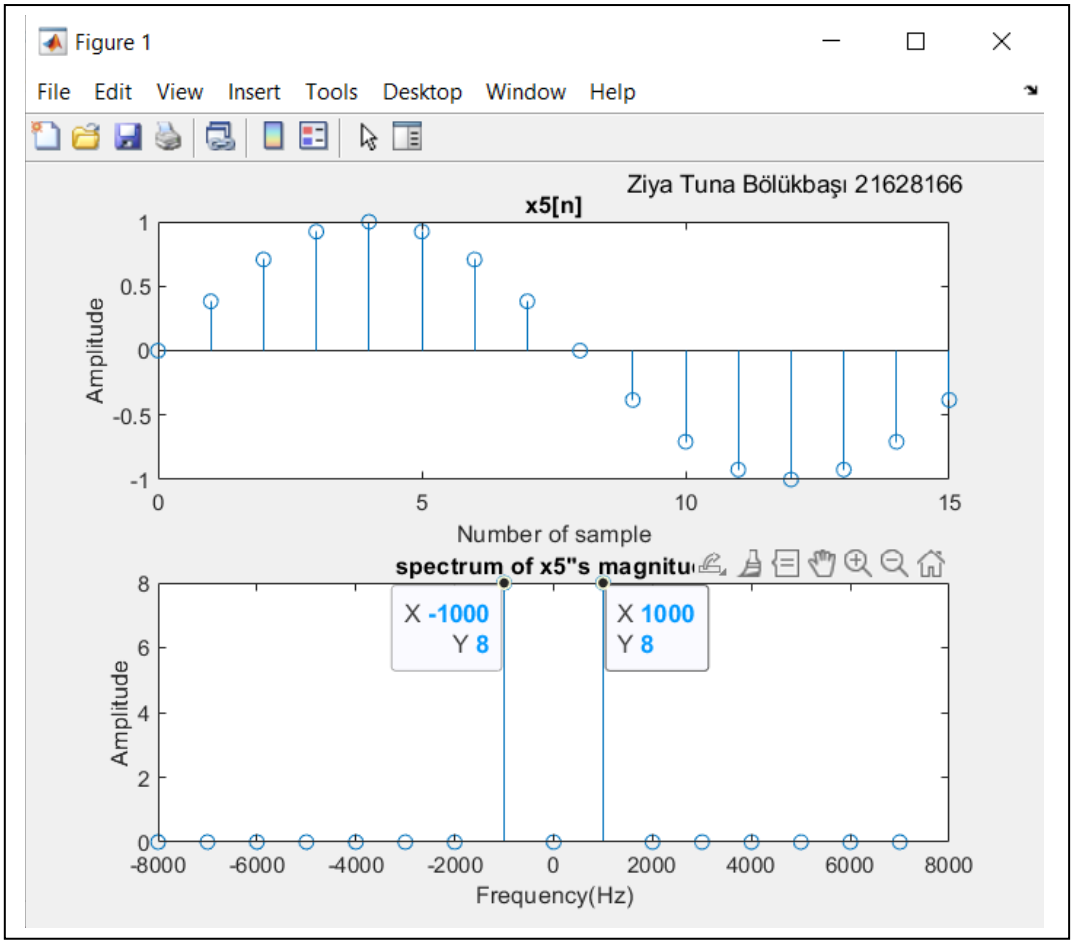


Figure 1
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
x5[n]
Amplitude
Number of sample
spectrum of x5"s magnitu
X -1000
Y 8
X 1000
Y 8
Amplitude
Frequency(Hz)

b)

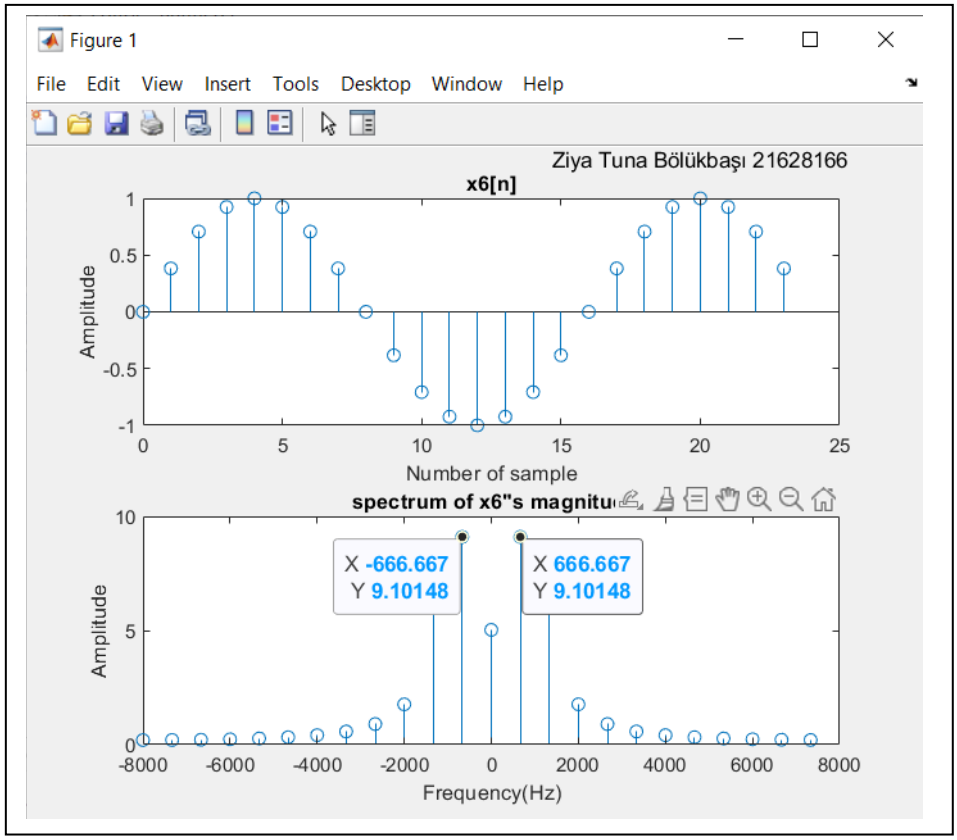
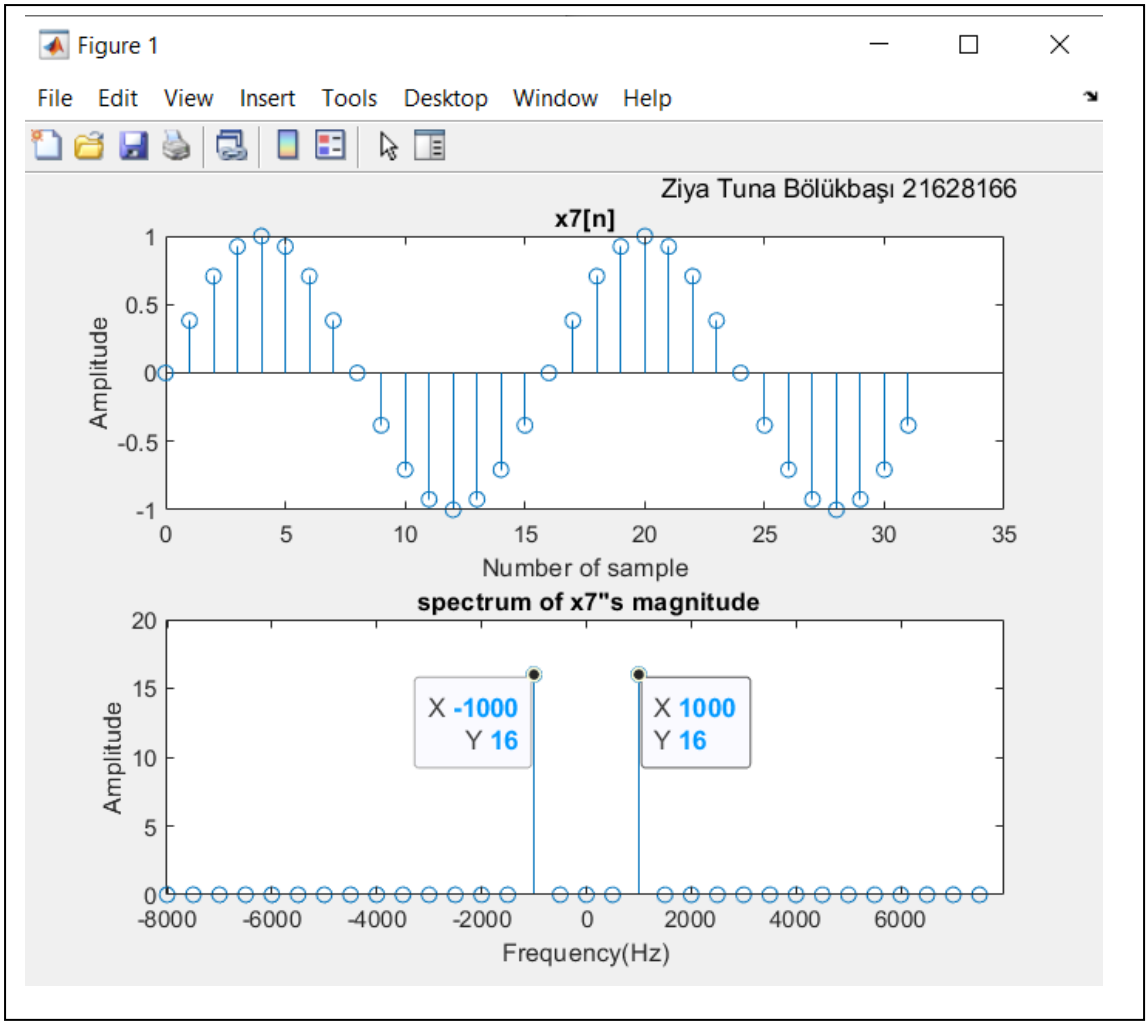


Figure 1
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
x6[n]
Amplitude
Number of sample
spectrum of x6"s magnitu
X -666.667
Y 9.10148
X 666.667
Y 9.10148
Amplitude
Frequency(Hz)

c)



In this problem we observe that vector needs to be an exact power of two in order to use fft.Magnitude spectrum are computed using fft.We could use ft because x5[n] and x7[n] signals provided in this question are axactly equivalent to Powers of two but x6[n].Because signal is not a power of two we were unable to determine spectrum using fft.

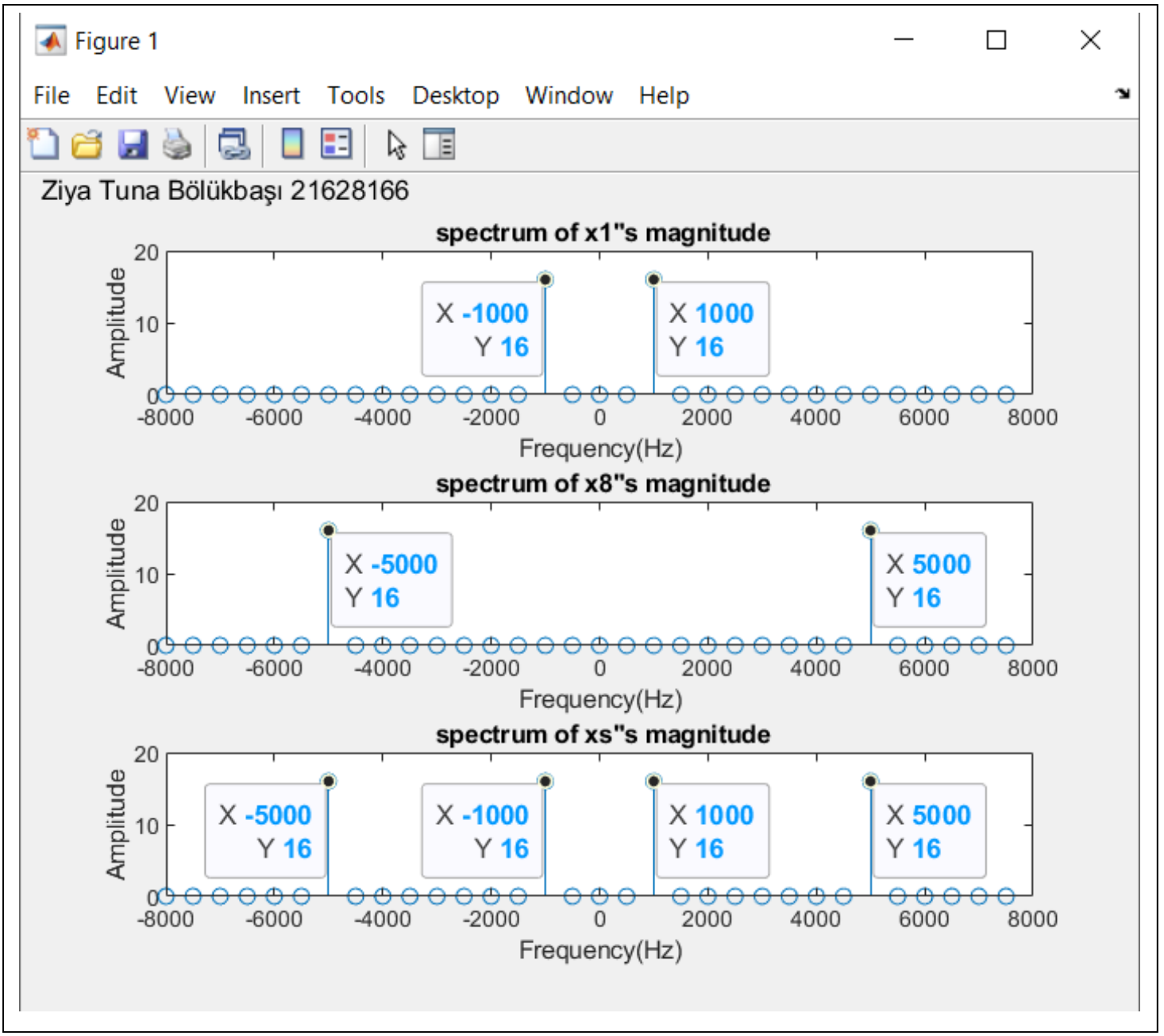
5)

Matlab code:

```
clc;
clear all;
close all;
fs=16000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,pi/6,0.002,2*pi*16000);
[ans8,n2]=sinsamplesfunction(1,2*pi*5000,pi/6,0.002,2*pi*16000);
x_s=ans1+ans8;
fft_ans1=fft(ans1);
fft_ans8=fft(ans8);
fft_ans_s=fft(x_s);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans8=fftshift(abs(fft_ans8));
shift_fft_ans_s=fftshift(abs(fft_ans_s));
length1=length(shift_fft_ans1);
length8=length(shift_fft_ans8);
length_s=length(shift_fft_ans_s);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency8=-fs/2:fs/length8:fs/2-fs/length8;
range_of_frequency_s=-fs/2:fs/length_s:fs/2-fs/length_s;
figure;
subplot(3,1,1);
stem(range_of_frequency1,shift_fft_ans1);
title(' spectrum of x1"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')

subplot(3,1,2);
stem(range_of_frequency8,shift_fft_ans8);
title(' spectrum of x8"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')

subplot(3,1,3);
stem(range_of_frequency_s,shift_fft_ans_s);
title(' spectrum of xs"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')
 gtext('Ziya Tuna Bölükbaşı 21628166')
```



We can observe that dtft of sum of two waves is equal to sum of dtft of same two signals.As a result we prove dtft's linearty.

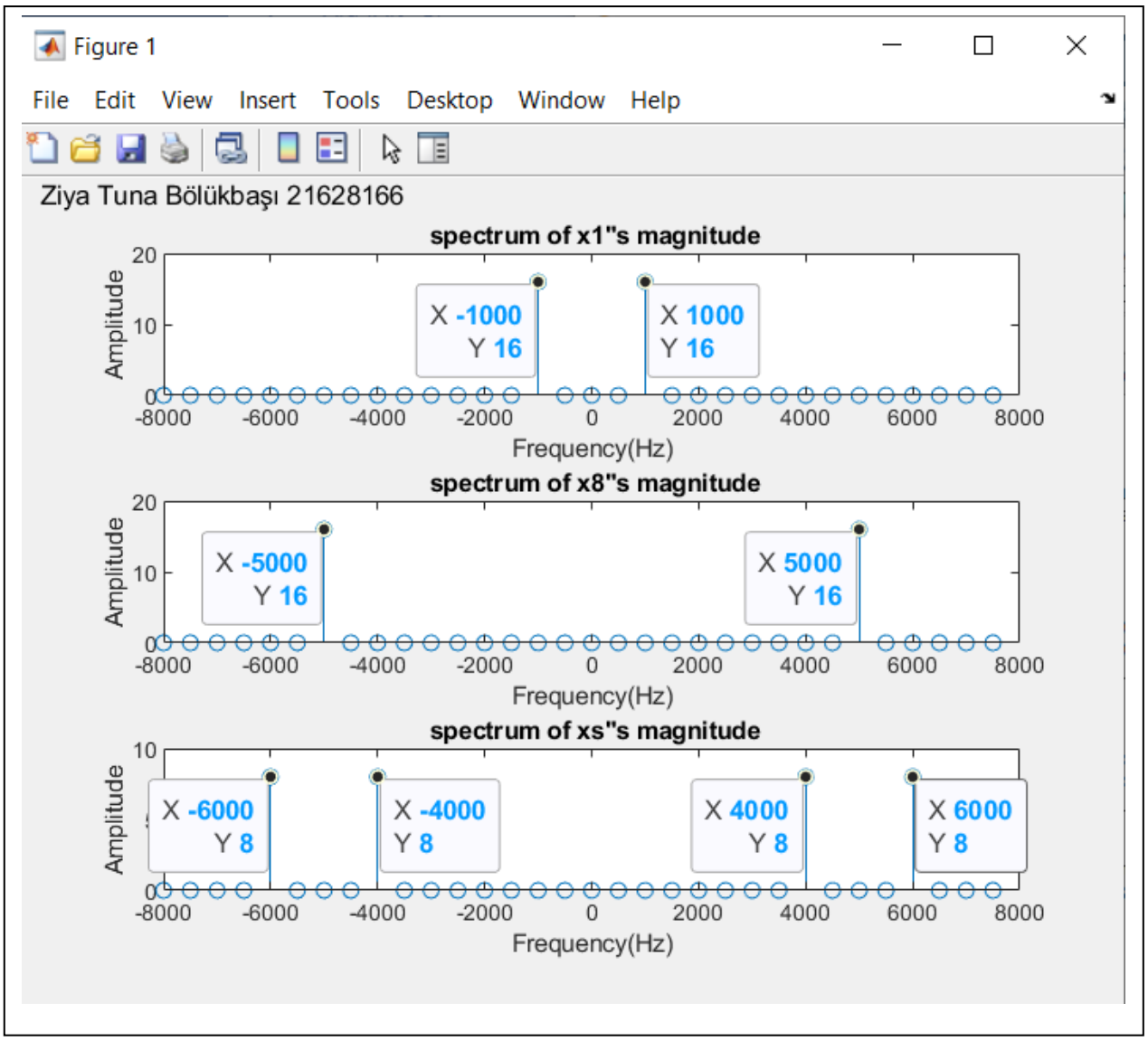
6)

Matlab Code:

```
clc;
clear all;
close all;
fs=16000;
[ans1,n1]=sinsamplesfunction(1,2*pi*1000,pi/6,0.002,2*pi*16000)
;
[ans8,n2]=sinsamplesfunction(1,2*pi*5000,pi/6,0.002,2*pi*16000)
;
x_s=ans1.*ans8;
fft_ans1=fft(ans1);
fft_ans8=fft(ans8);
fft_ans_s=fft(x_s);
shift_fft_ans1=fftshift(abs(fft_ans1));
shift_fft_ans8=fftshift(abs(fft_ans8));
shift_fft_ans_s=fftshift(abs(fft_ans_s));
length1=length(shift_fft_ans1);
length8=length(shift_fft_ans8);
length_s=length(shift_fft_ans_s);
range_of_frequency1=-fs/2:fs/length1:fs/2-fs/length1;
range_of_frequency8=-fs/2:fs/length8:fs/2-fs/length8;
range_of_frequency_s=-fs/2:fs/length_s:fs/2-fs/length_s;
figure;
subplot(3,1,1);
stem(range_of_frequency1,shift_fft_ans1);
title(' spectrum of x1"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')

subplot(3,1,2);
stem(range_of_frequency8,shift_fft_ans8);
title(' spectrum of x8"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')

subplot(3,1,3);
stem(range_of_frequency_s,shift_fft_ans_s);
title(' spectrum of xs"s magnitude');
xlabel('Frequency(Hz)')
ylabel('Amplitude')
 gtext('Ziya Tuna Bölükbaşı 21628166')
```



Multiplication in time domain corresponds to convolution in frequency domain.

5kHz+1kHZ=6kHz

5kHZ-1kHz=4kHz

(-5kHz)+(-1kHz)=-6kHz

(-5kHz)-(-1kHZ)=-4kHz

7)

```
clc;
clear all;
close all;
fs=16000;
[ans5,n5]=sinsamplesfunction(1,2*pi*1000,0,0.001,2*pi*16000);
l_ans5=length(ans5);
n9=zeros(1,l_ans5);
for x=2:l_ans5
    ans9(x)=ans5(x-1);
end
ans0=circshift(ans5,1);
fft_ans5=fft(ans5);
fft_ans9=fft(ans9);
fft_ans0=fft(ans0);
shift_fft_ans5=fftshift(abs(fft_ans5));
shift_fft_ans9=fftshift(abs(fft_ans9));
shift_fft_ans0=fftshift(abs(fft_ans0));
length5=length(shift_fft_ans5);
length9=length(shift_fft_ans9);
length0=length(shift_fft_ans0);
range_of_frequency5=-fs/2:fs/length5:fs/2-fs/length5;
range_of_frequency9=-fs/2:fs/length9:fs/2-fs/length9;
range_of_frequency0=-fs/2:fs/length0:fs/2-fs/length0;
%subplot(2,1,1);
%stem(n5,ans5);
%title('x5[n]');
%xlabel('Number of sample');
%ylabel('Amplitude');
%subplot(2,1,2);
%stem(range_of_frequency5,shift_fft_ans5);
%title(' spectrum of x5"s magnitude');
%xlabel('Frequency(Hz)')
%ylabel('Amplitude')
% gtext('Ziya Tuna Bölükbaşı 21628166')
% subplot(2,1,1);
% stem(n9,ans9);
% title('x9[n]');
% xlabel('Number of sample');
% ylabel('Amplitude');
% subplot(2,1,2);
% stem(range_of_frequency9,shift_fft_ans9);
% title(' spectrum of x9"s magnitude');
% xlabel('Frequency(Hz)')
% ylabel('Amplitude')
% gtext('Ziya Tuna Bölükbaşı 21628166')
%  subplot(2,1,1);
%  stem(n0,ans0);
%  title('x0[n]');
%  xlabel('Number of sample');
%  ylabel('Amplitude');
%  subplot(2,1,2);
%  stem(range_of_frequency0,shift_fft_ans0);
%  title(' spectrum of x0"s magnitude');
%  xlabel('Frequency(Hz)')
%  ylabel('Amplitude')
%  gtext('Ziya Tuna Bölükbaşı 21628166')
```

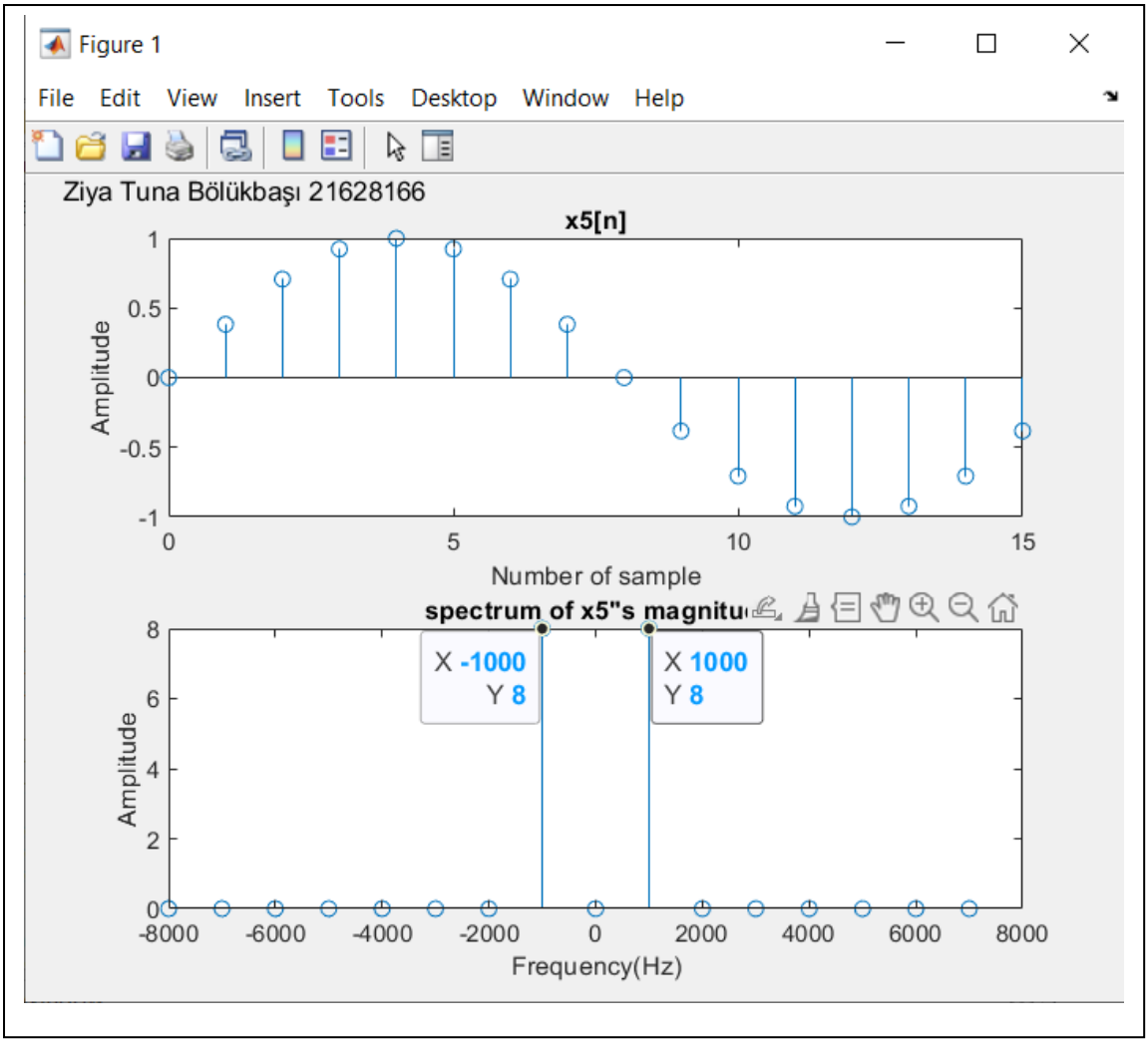


Figure 1
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
x5[n]
Amplitude
Number of sample
spectrum of x5"s magnitu
X -1000
Y 8
X 1000
Y 8
Amplitude
Frequency(Hz)

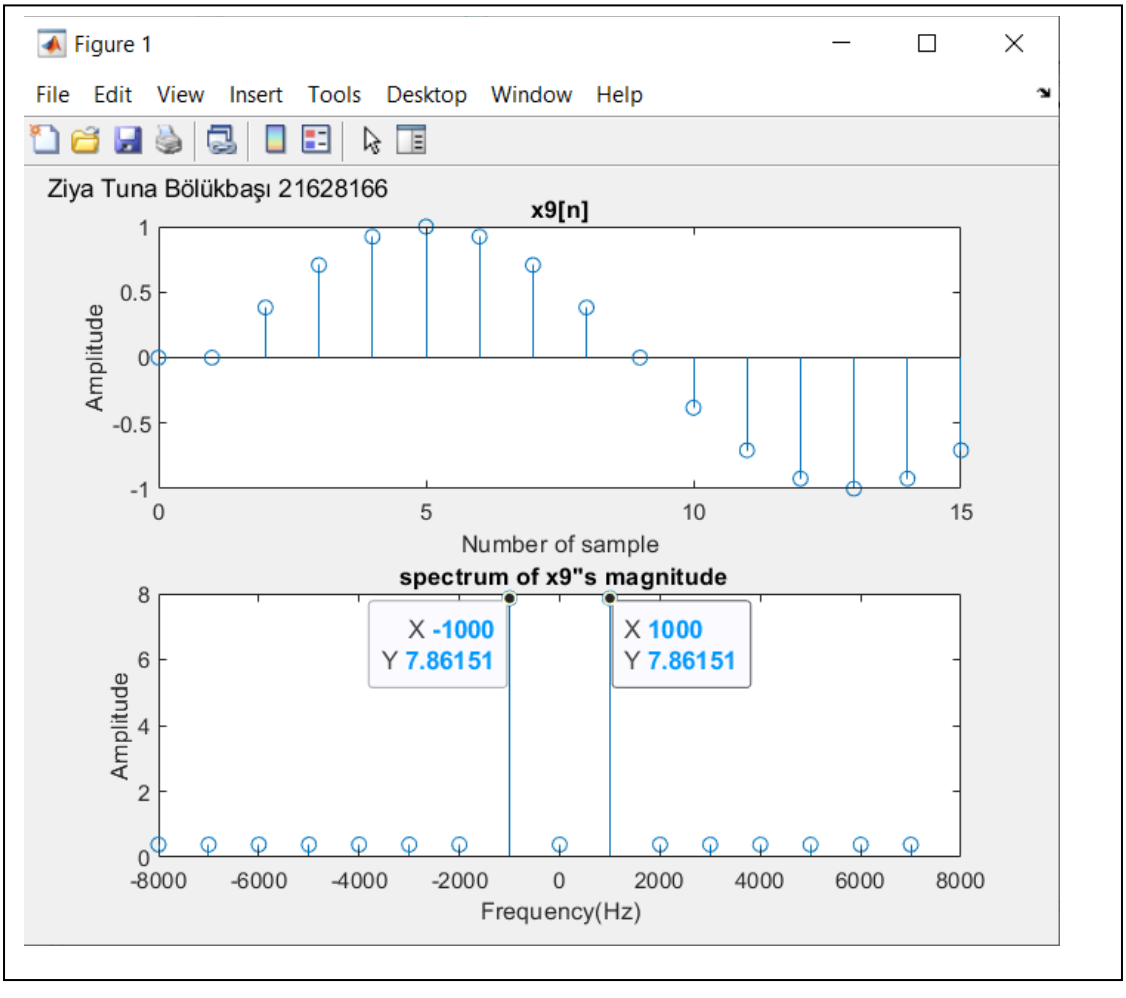
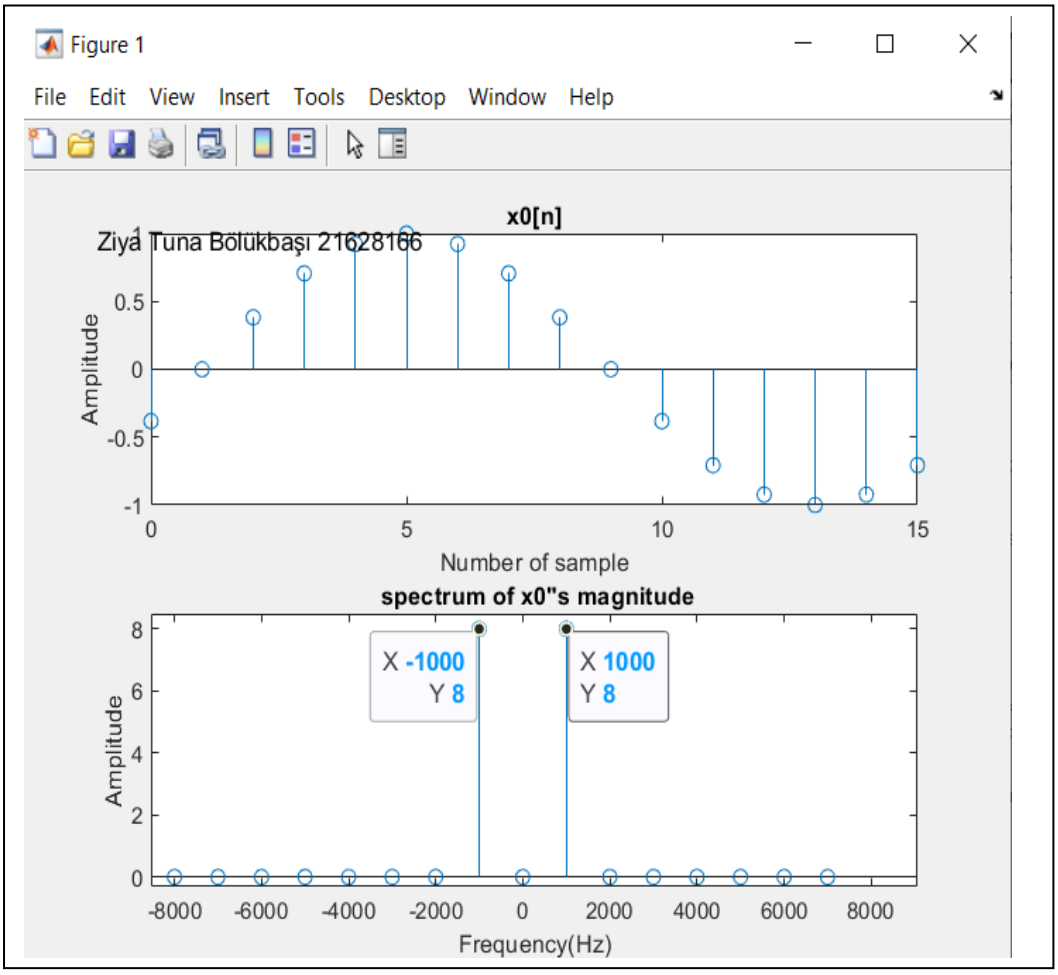


Figure 1
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
x9[n]
Amplitude
Number of sample
spectrum of x9"s magnitude
X -1000
Y 7.86151
X 1000
Y 7.86151
Amplitude
Frequency(Hz)



The magnitude spectrum is not affected by phase shift.

8)

```
clc;
clear all;
close all;
[y1,fs]=audioread('C:\Users\Tuna\OneDrive -
hacettepe.edu.tr\Masaüstü\sound1.wav');
l_y1=length(y1);
sample1=0:1:l_y1-1;

for k=1:512
    y2(k)=y1(k);
end
l_y2=length(y2);
sample2=0:1:l_y2-1;
fft_y2=fft(y2);
shift_fft_y1=fftshift(abs(fft_y2));
lengthy2=length(fft_y2);
range_of_frequency_y2=-fs/2:fs/lengthy2:fs/2-fs/lengthy2;

figure;
plot(sample1,y1);
title('y(t) > Waveform of Sound1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166')

figure;
plot(sample2,y2);
title('New y(t) > Waveform of Sound1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166')

figure;
stem(sample2,y2);
title('New y[n] > WAveform of Sound1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166')

figure;
stem(range_of_frequency_y2,shift_fft_y1);
title('Spectrum of y1 magnitude > Magnitude Spectrum of
Sound1');
xlabel('Frequency(Hz)');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166')
```

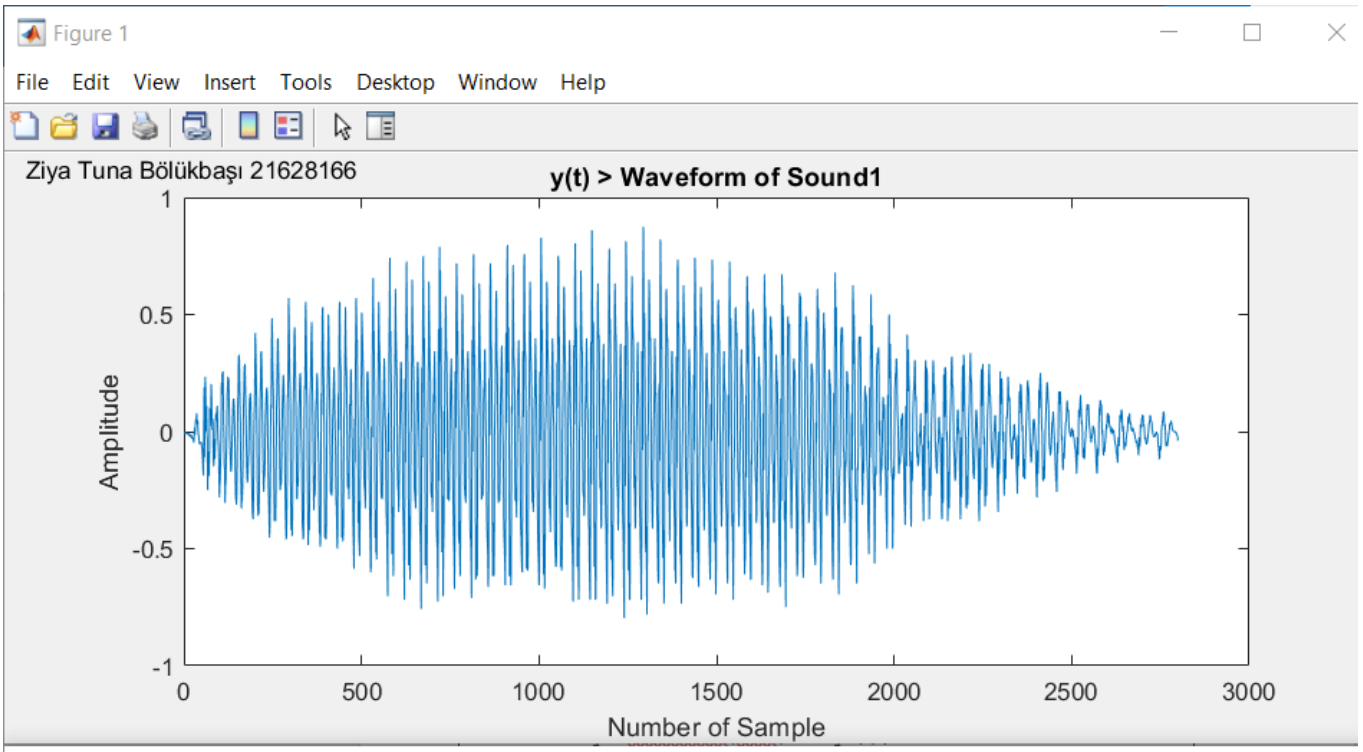


Figure 1
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
y(t) > Waveform of Sound1
Amplitude
Number of Sample
1
0.5
0
-0.5
-1
0
500
1000
1500
2000
2500
3000

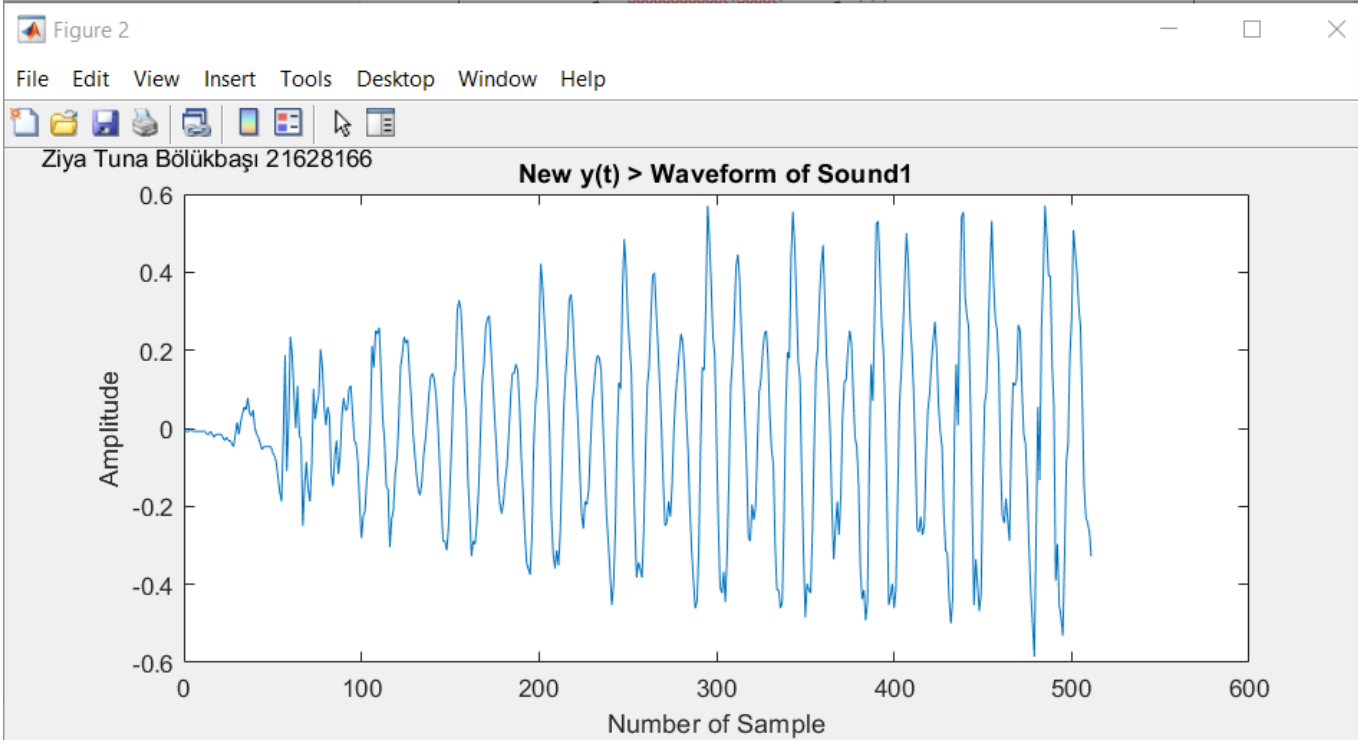


Figure 2
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
New y(t) > Waveform of Sound1
Amplitude
Number of Sample
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
100
200
300
400
500
600

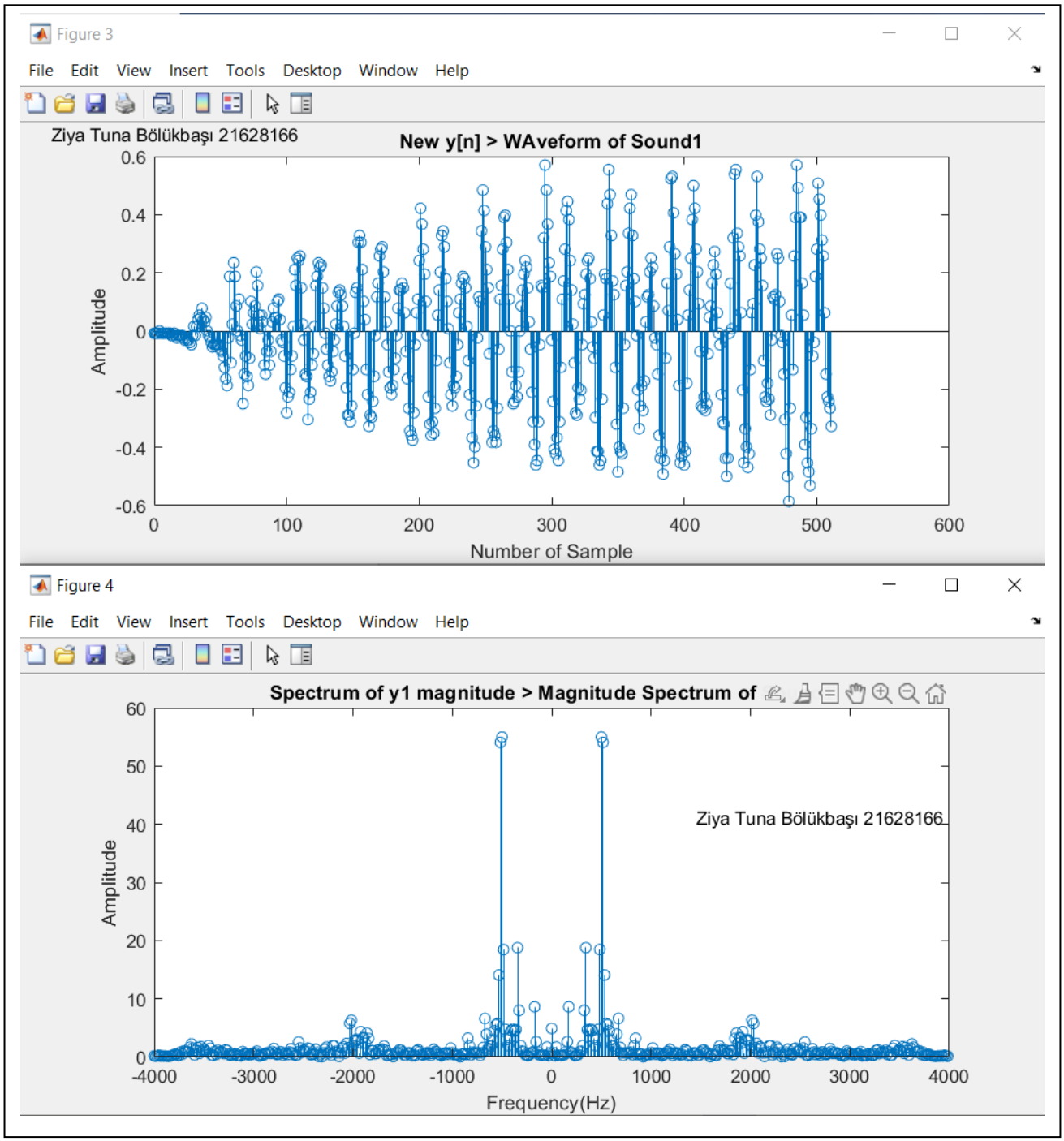


Figure 3
File Edit View Insert Tools Desktop Window Help
Ziya Tuna Bölükbaşı 21628166
New y[n] > WAveform of Sound1
Amplitude
Number of Sample
Figure 4
File Edit View Insert Tools Desktop Window Help
Spectrum of y1 magnitude > Magnitude Spectrum of
Ziya Tuna Bölükbaşı 21628166
Amplitude
Frequency(Hz)

9)

For x10[n] Matlab code

```
clc;
clear all;
close all;
n=0:1:255;
n10=  sinc(0.2*(n-128));
length1=length(n10);
sample1=0:1:length1-1;
fs=1/length(n);
xdown1=downsample(n10,2);
length2=length(xdown1)
sample2=0:1:length2-1;
fft_n10=fft(n10);
shift_fft_n10=fftshift(abs(fft_n10));
lengthn10=length(fft_n10);
range_of_frequency_n10=-fs/2:fs/lengthn10:fs/2-fs/lengthn10;
fft_xdown1=fft(xdown1);
shift_fft_xdown1=fftshift(abs(xdown1));
lengthxdown1=length(fft_xdown1);
range_of_frequency_xdown1=-fs/2:fs/lengthxdown1:fs/2-fs/lengthxdown1;
figure;
stem(sample1,n10);
title('x10');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(sample2,xdown1);
title('xdown1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(range_of_frequency_n10,shift_fft_n10);
title('x10 Magnitude Spectrum');
xlabel('Frequency(Hz)');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(range_of_frequency_xdown1,shift_fft_xdown1);
title('shift_fft_xdown1 Magnitude Spectrum');
xlabel('Frequency(Hz)');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

xinterp1=interp(xdown1,2);
length_xinterp1=length(xinterp1);
sample3=0:1:length_xinterp1-1;
fft_xinterp1=fft(xinterp1);
shift_fft_xinterp1=fftshift(abs(fft_xinterp1));
lengthxinterp1=length(fft_xinterp1);
range_of_frequency_xinterp1=-fs/2:fs/lengthxinterp1:fs/2-fs/lengthxinterp1;

figure;
stem(sample3,xinterp1);
title('xinterp1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');
```

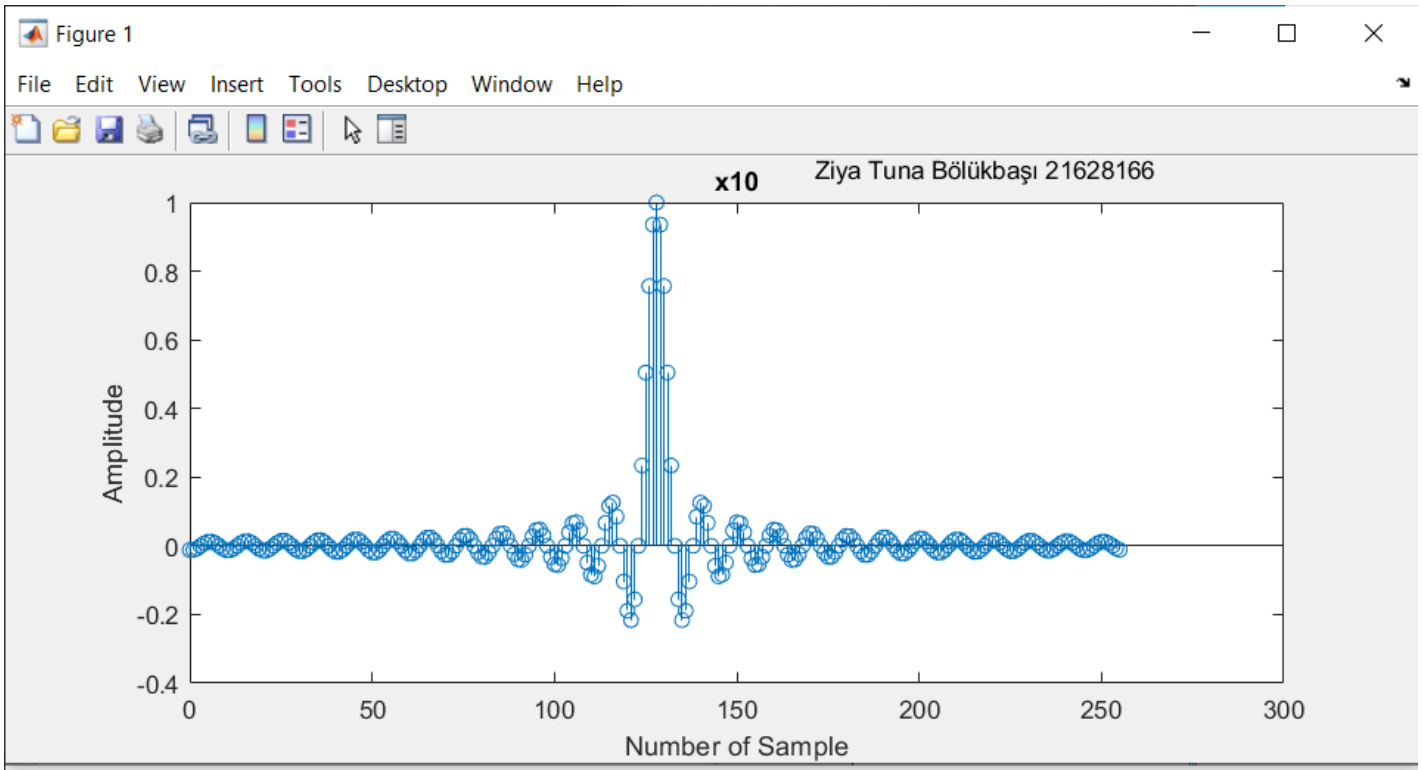


Figure 1
File Edit View Insert Tools Desktop Window Help
x10
Ziya Tuna Bölükbaşı 21628166
Amplitude
Number of Sample
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
50
100
150
200
250
300

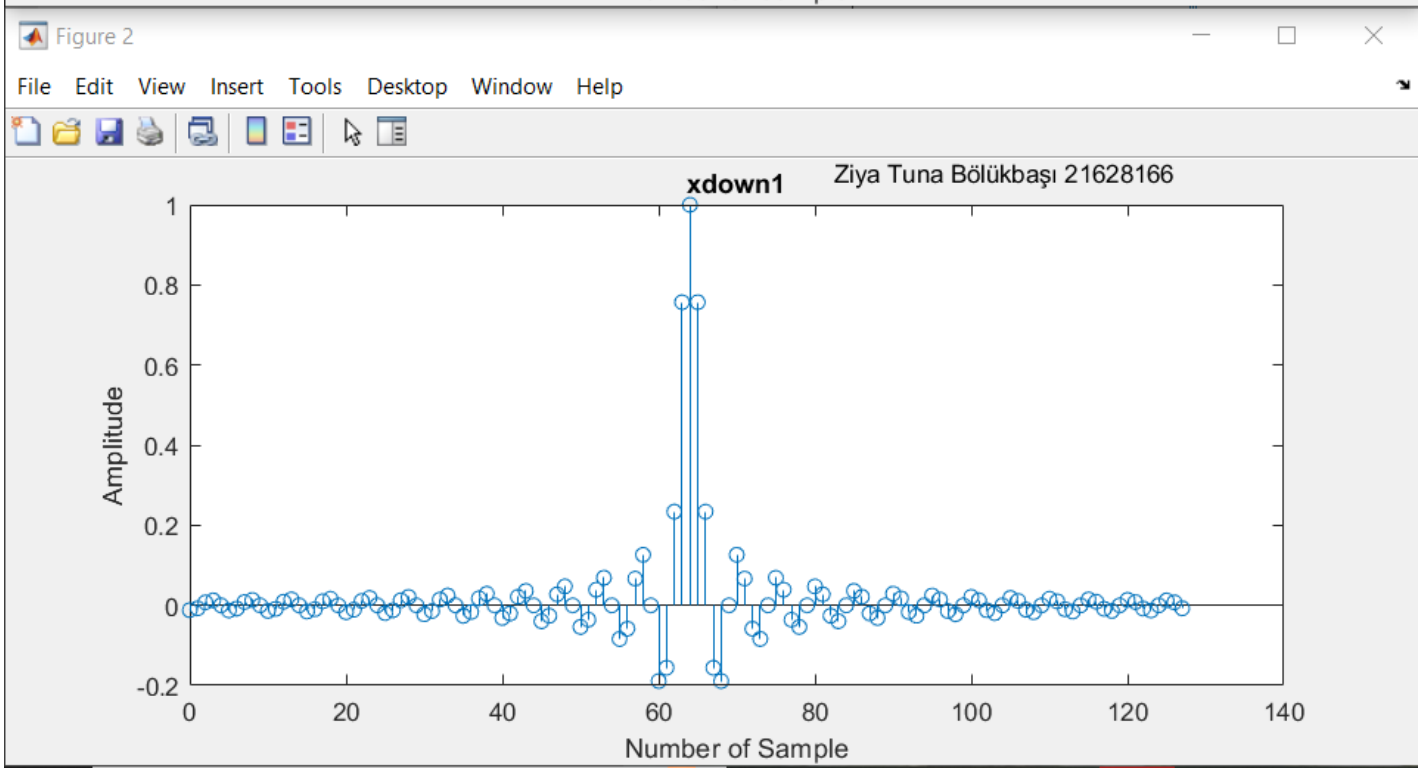


Figure 2
File Edit View Insert Tools Desktop Window Help
xdown1
Ziya Tuna Bölükbaşı 21628166
Amplitude
Number of Sample
1
0.8
0.6
0.4
0.2
0
-0.2
0
20
40
60
80
100
120
140

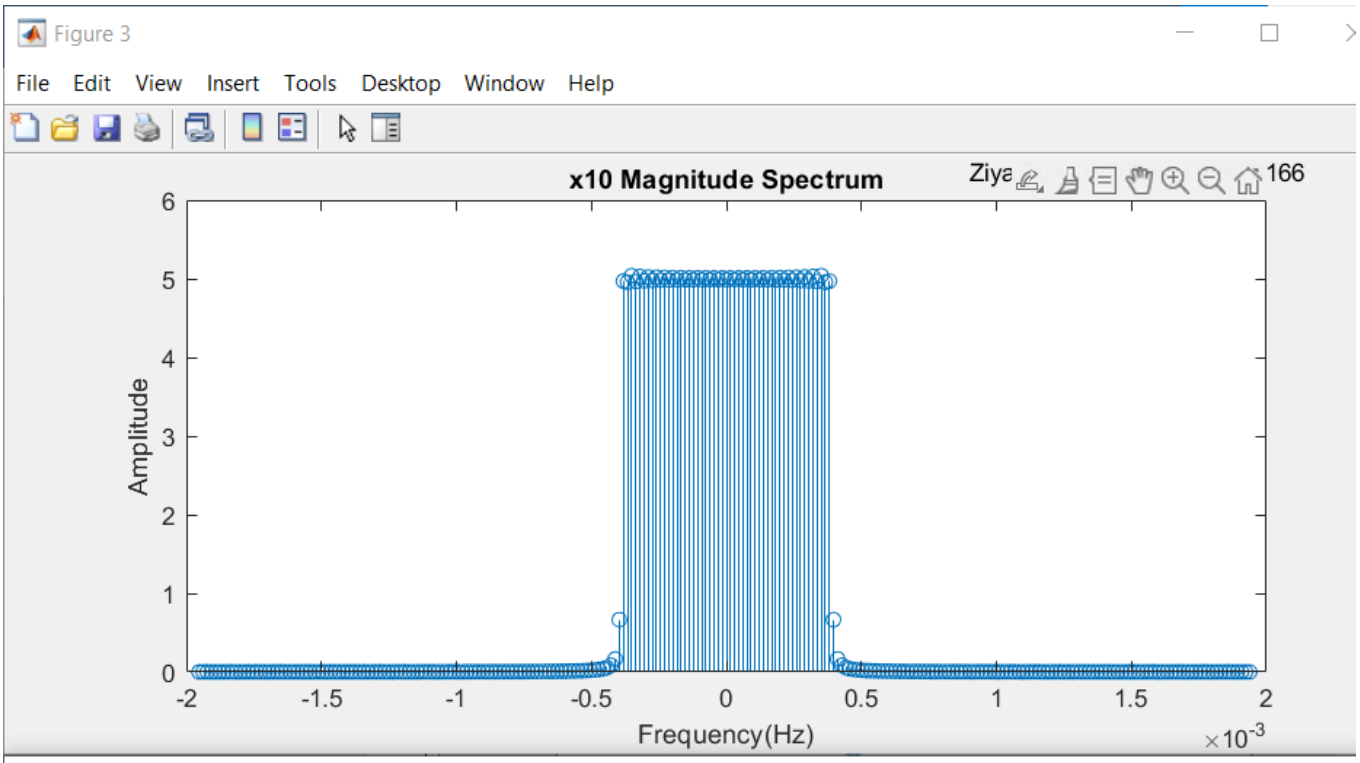


Figure 3
File Edit View Insert Tools Desktop Window Help
x10 Magnitude Spectrum
Ziya
166
Amplitude
Frequency(Hz)
×10^-3

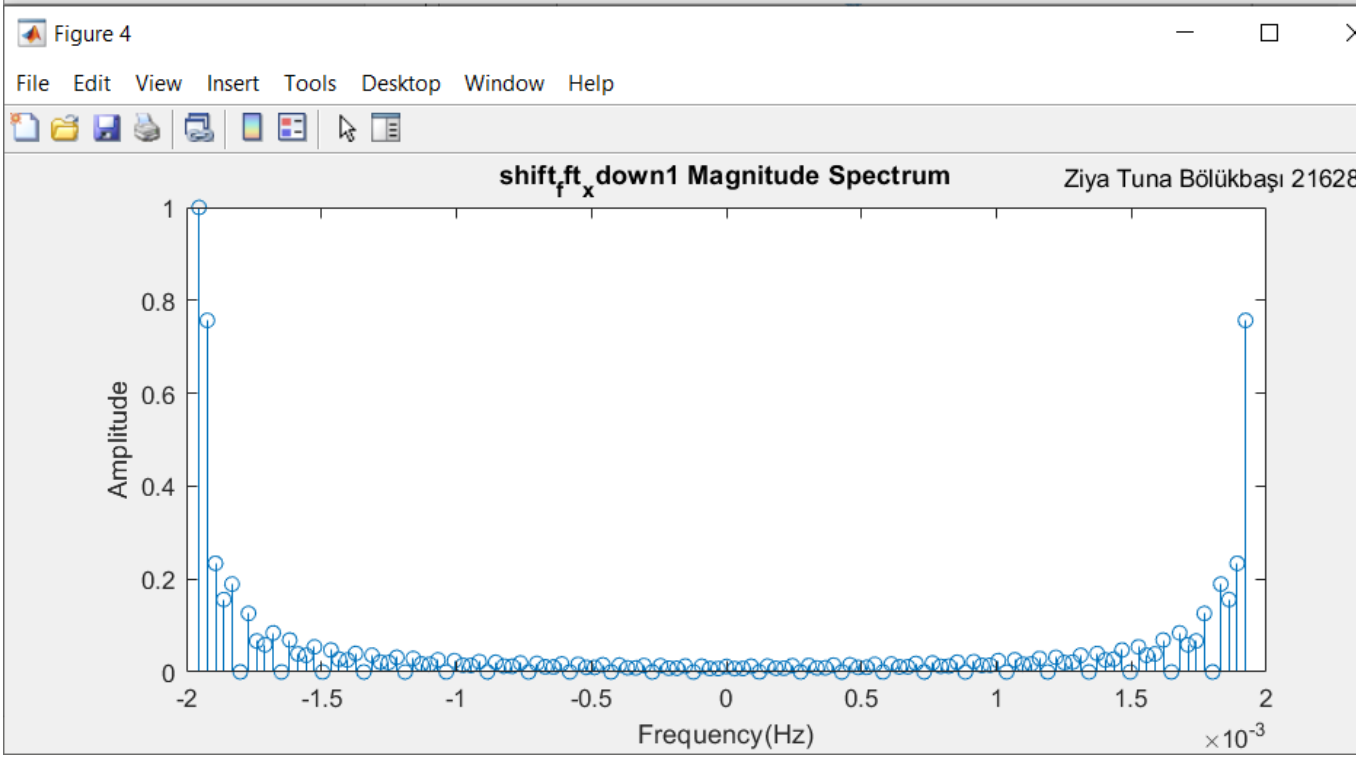


Figure 4
File Edit View Insert Tools Desktop Window Help
shift_f ft_x down1 Magnitude Spectrum
Ziya Tuna Bölükbaşı 21628
Amplitude
Frequency(Hz)
×10^-3

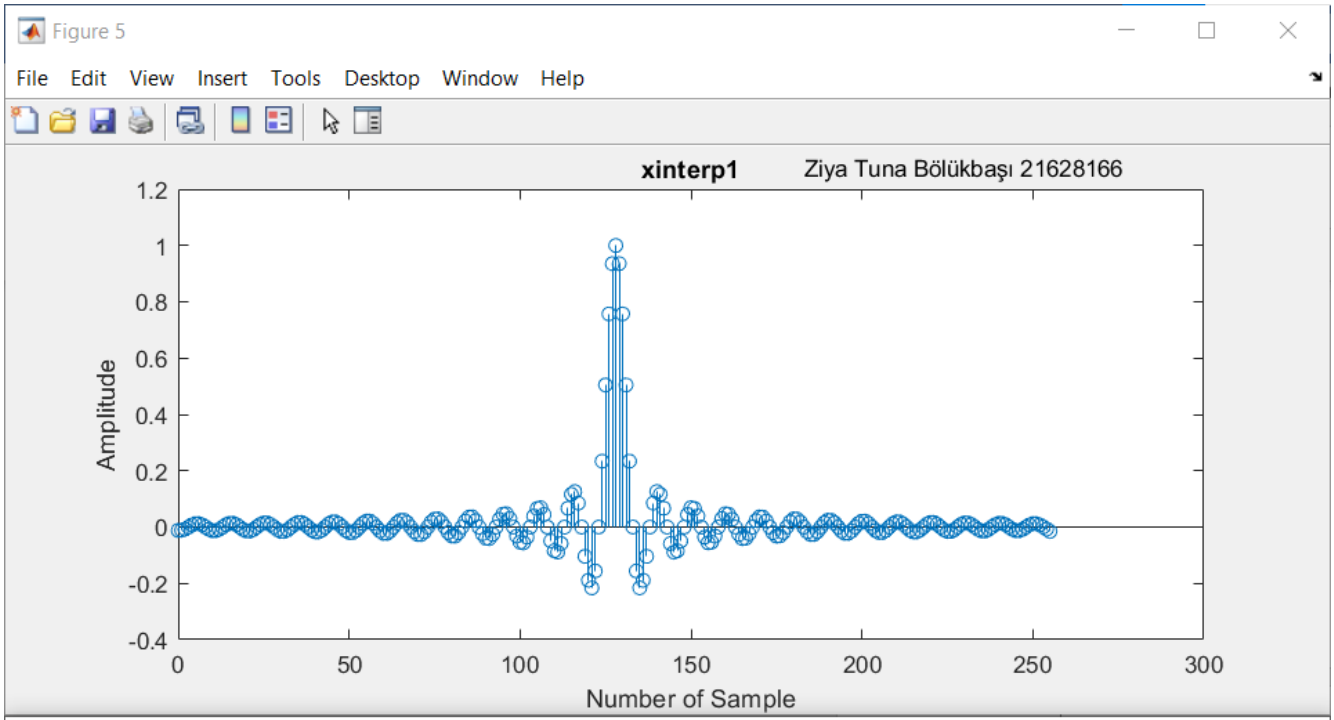


Figure 5
File Edit View Insert Tools Desktop Window Help
xinterp1
Ziya Tuna Bölükbaşı 21628166
Amplitude
Number of Sample

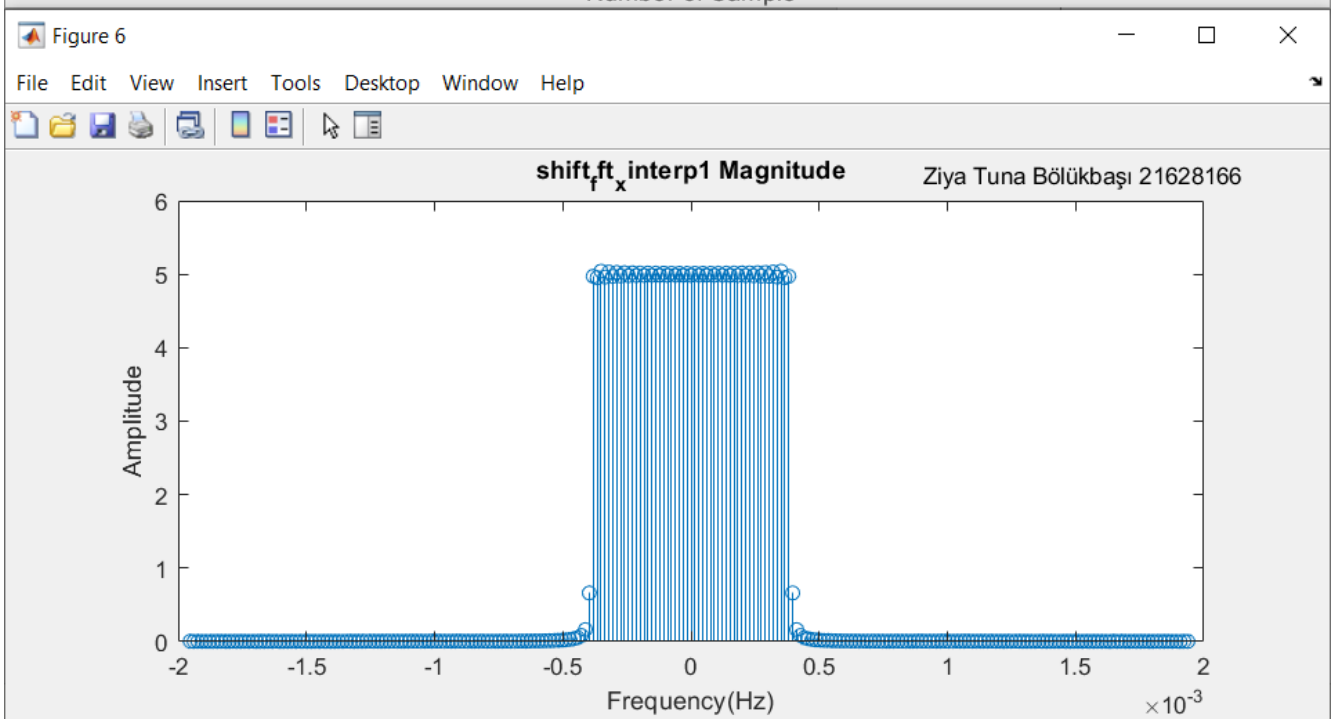


Figure 6
File Edit View Insert Tools Desktop Window Help
shift_ft_x interp1 Magnitude
Ziya Tuna Bölükbaşı 21628166
Amplitude
Frequency(Hz)
×10^-3

10)

For x11[n] Matlab Code

```
clc;
clear all;
close all;
n=0:1:255;
n10=  sinc(0.8*(n-128));
length1=length(n10);
sample1=0:1:length1-1;
fs=1/length(n);
xdown1=downsample(n10,2);
length2=length(xdown1)
sample2=0:1:length2-1;
fft_n10=fft(n10);
shift_fft_n10=fftshift(abs(fft_n10));
lengthn10=length(fft_n10);
range_of_frequency_n10=-fs/2:fs/lengthn10:fs/2-fs/lengthn10;
fft_xdown1=fft(xdown1);
shift_fft_xdown1=fftshift(abs(xdown1));
lengthxdown1=length(fft_xdown1);
range_of_frequency_xdown1=-fs/2:fs/lengthxdown1:fs/2-fs/lengthxdown1;
figure;
stem(sample1,n10);
title('x10');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(sample2,xdown1);
title('xdown1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(range_of_frequency_n10,shift_fft_n10);
title('x10 Magnitude Spectrum');
xlabel('Frequency(Hz)');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(range_of_frequency_xdown1,shift_fft_xdown1);
title('shift_fft_xdown1 Magnitude Spectrum');
xlabel('Frequency(Hz)');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

xinterp1=interp(xdown1,2);
length_xinterp1=length(xinterp1);
sample3=0:1:length_xinterp1-1;
fft_xinterp1=fft(xinterp1);
shift_fft_xinterp1=fftshift(abs(fft_xinterp1));
lengthxinterp1=length(fft_xinterp1);
range_of_frequency_xinterp1=-fs/2:fs/lengthxinterp1:fs/2-fs/lengthxinterp1;

figure;
stem(sample3,xinterp1);
title('xinterp1');
xlabel('Number of Sample');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');

figure;
stem(range_of_frequency_xinterp1,shift_fft_xinterp1);
title('shift_fft_xinterp1 Magnitude');
xlabel('Frequency(Hz)');
ylabel('Amplitude');
gtext('Ziya Tuna Bölükbaşı 21628166');
```

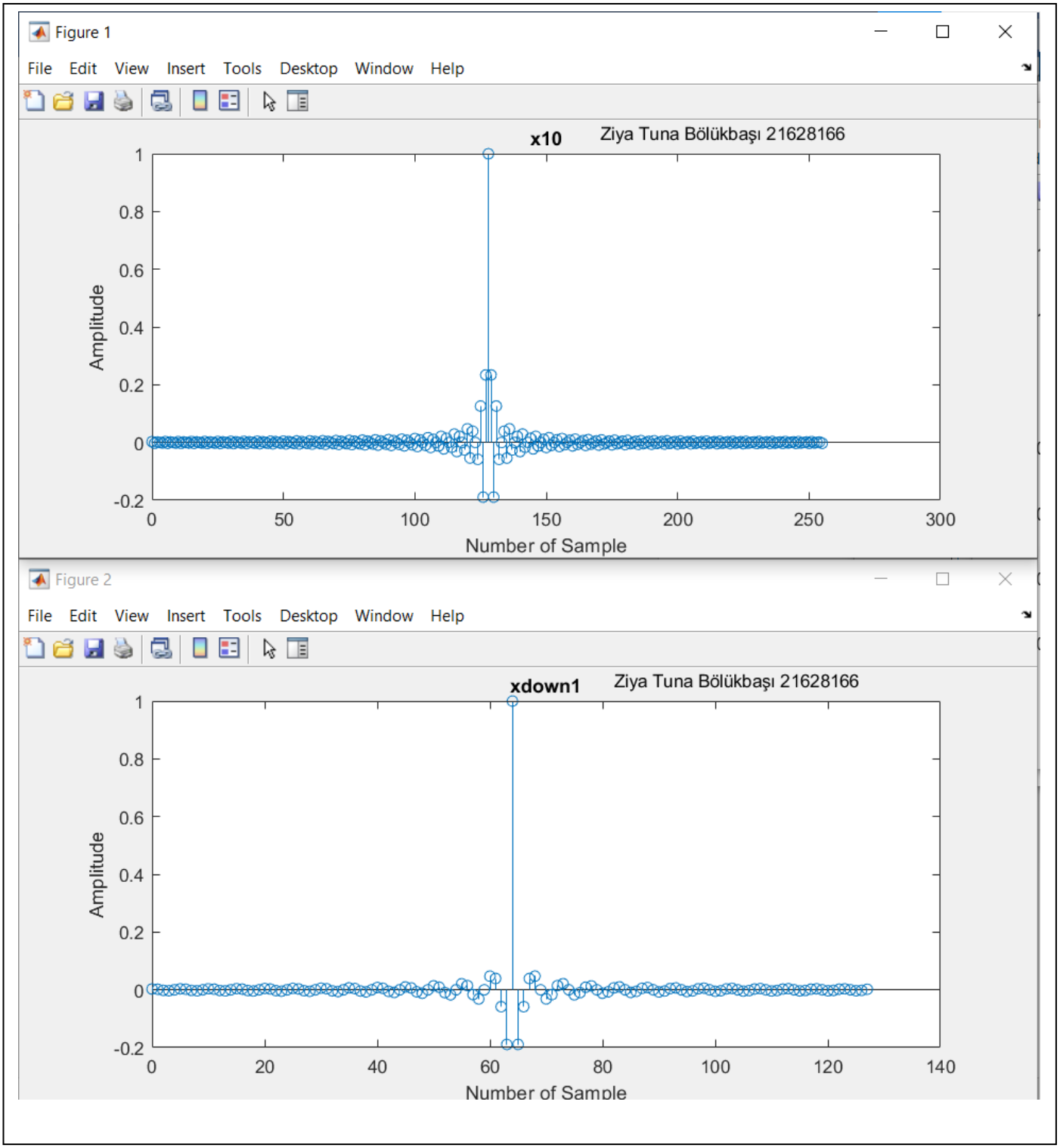


Figure 1
File Edit View Insert Tools Desktop Window Help
x10
Ziya Tuna Bölükbaşı 21628166
Amplitude
Number of Sample
Figure 2
File Edit View Insert Tools Desktop Window Help
xdown1
Ziya Tuna Bölükbaşı 21628166
Amplitude
Number of Sample

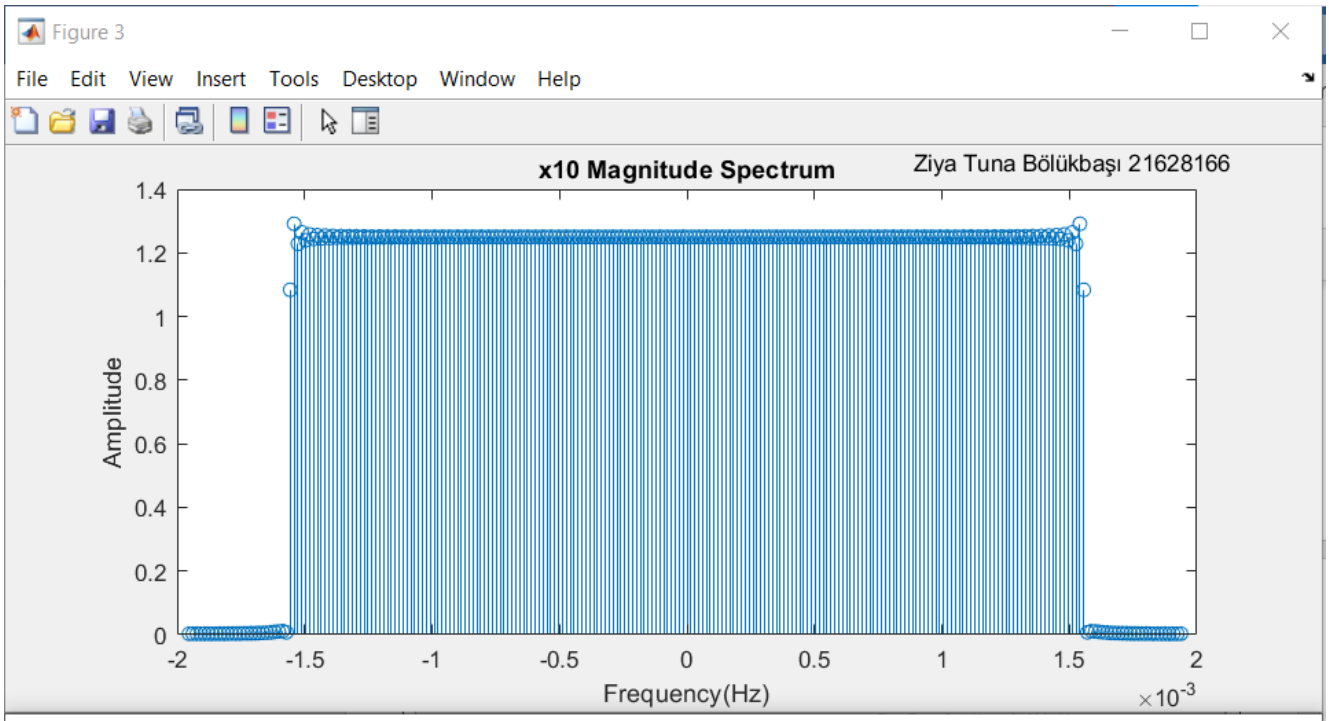


Figure 3
File Edit View Insert Tools Desktop Window Help
x10 Magnitude Spectrum
Ziya Tuna Bölükbaşı 21628166
Amplitude
Frequency(Hz)
×10^-3

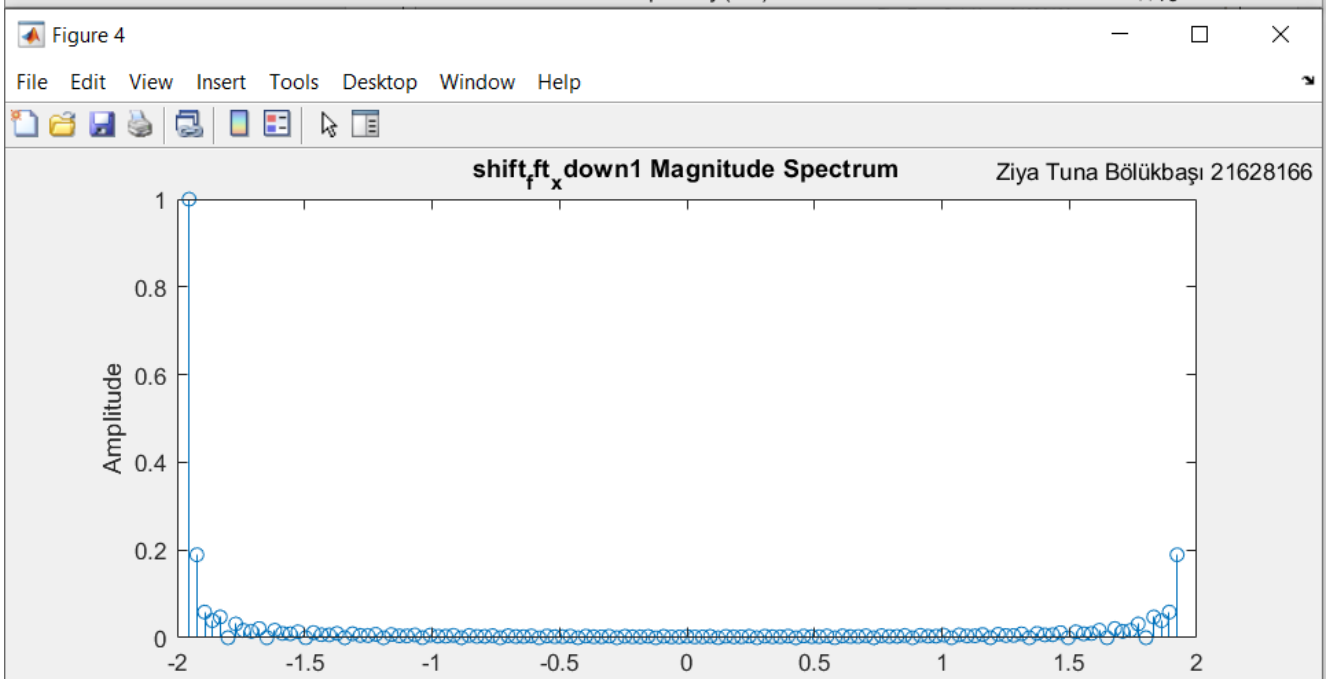


Figure 4
File Edit View Insert Tools Desktop Window Help
shift_f ft_x down1 Magnitude Spectrum
Ziya Tuna Bölükbaşı 21628166
Amplitude

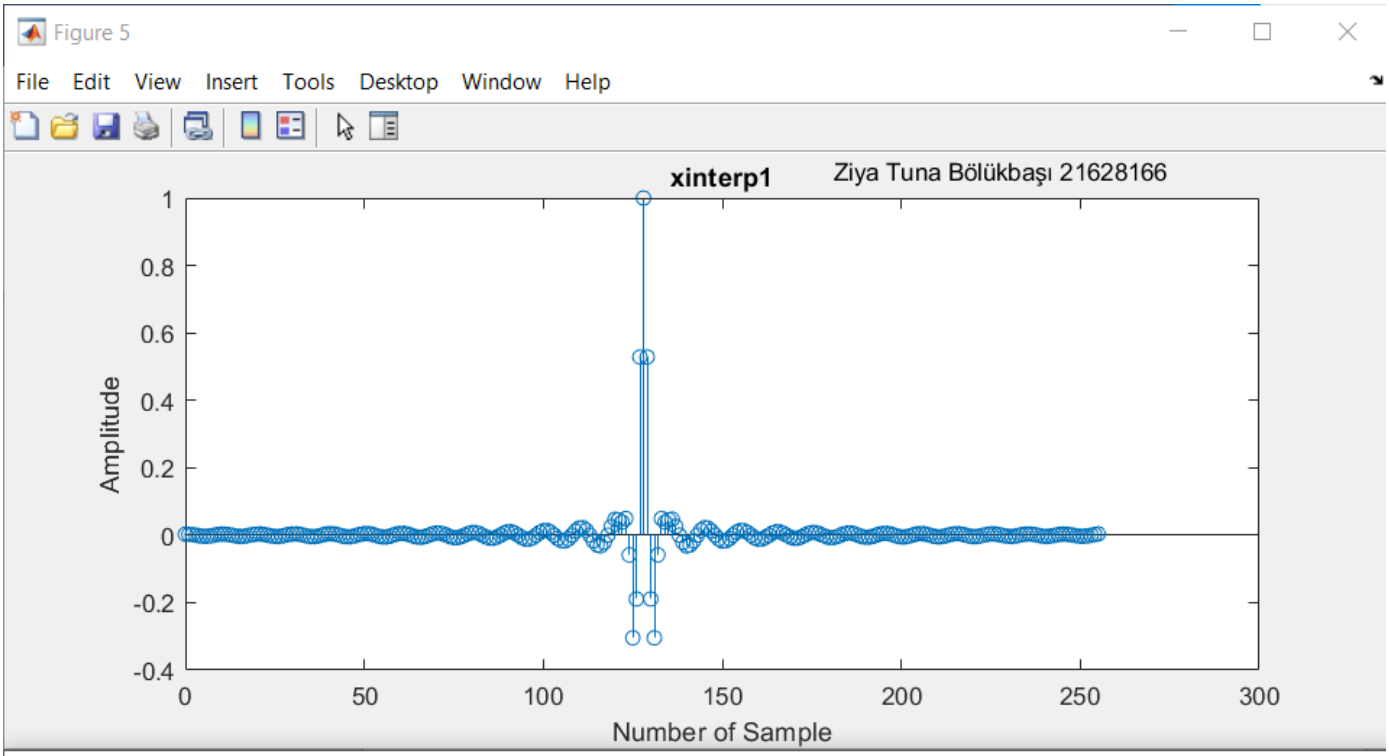


Figure 5
File Edit View Insert Tools Desktop Window Help
xinterp1
Ziya Tuna Bölükbaşı 21628166
Amplitude
Number of Sample

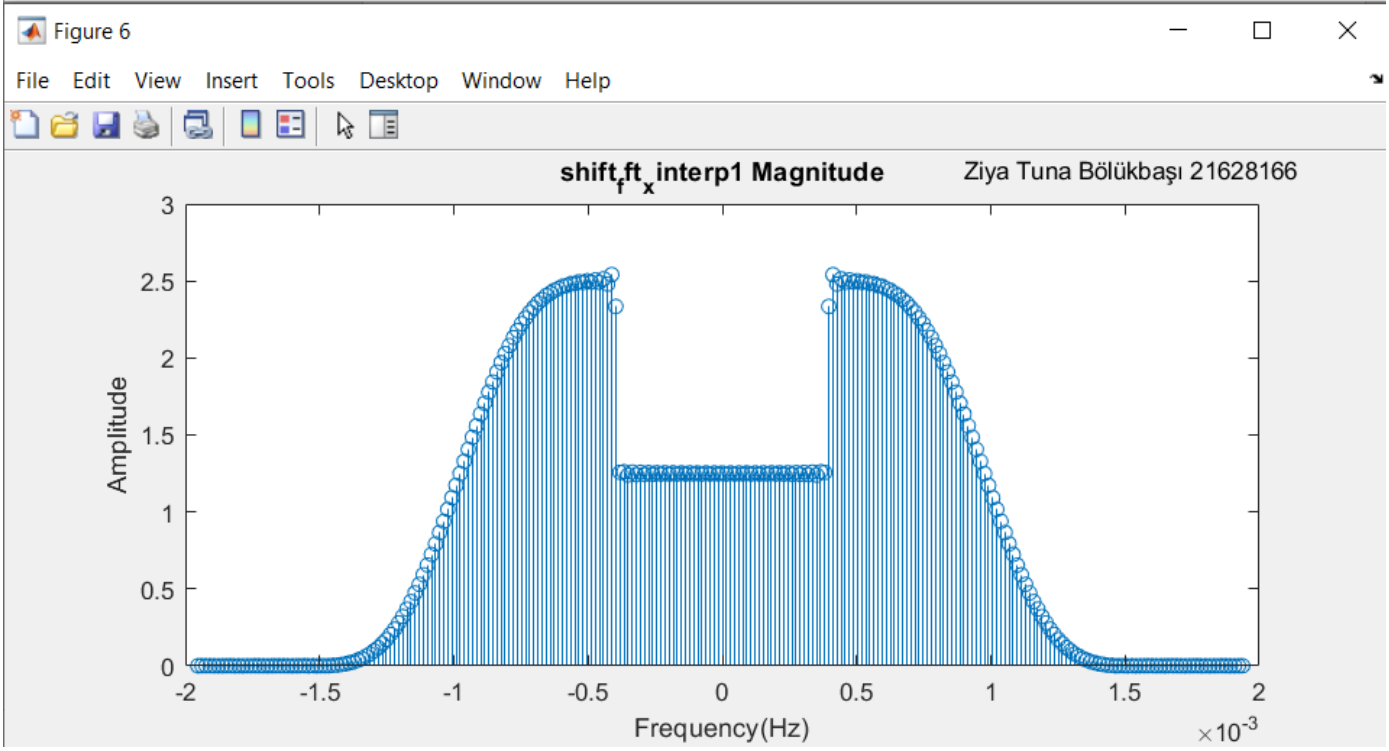


Figure 6
File Edit View Insert Tools Desktop Window Help
shift_ft_x interp1 Magnitude
Ziya Tuna Bölükbaşı 21628166
Amplitude
Frequency(Hz)
×10^-3