Code:

Signal:

```
clc;                                    %clear screen
clear all;                              %clear workspace
close all;                              %close all fiures windows

%to generate unit impulse signal
t = -2:1:2;                             %Define time vector
y = [zeros(1,2),ones(1),zeros(1,2)];%Define Amplitude values
subplot(2,2,1);
stem(t,y);
xlabel('time'); ylabel('amplitude');
title('Unit Impulse signal');

% to generate unit step
N = input('enter the value of N = '); % define the length of unit step signal
t = 0 : N-1;
y1=ones(1,N);
subplot(2,2,2);
stem(t,y1);
xlabel('time');
ylabel('amplitude');
title('Unit Step signal');

% to generate ramp signal
N1 = input('enter the value of N1 = '); % Define the length of unit ramp
signal
t = 0 : N1;
subplot(2,2,3);
stem(t,t);
xlabel('time');
ylabel('amplitude');
title('Ramp signal');

% to generate exponential
N2=input('enterthelengthN2=');
t = 0:1/4:N2;
a = input('enter the value of a = ');
y2 = exp(a*t);
subplot(2,2,4);
stem(t,y2);
xlabel('time');
ylabel('amplitude');
title('Exponential signal');

% to generate sine wave
t = 0:1/32:2;
x = sin(2*pi*t);
figure(2);
subplot(2,1,1);
stem(t,x);
xlabel('time'); ylabel('amplitude'); title('Sine wave');
```

```
% to generate Cosine wave
t = 0:1/32:2;
x = cos(2*pi*t);
subplot(2,1,2);
stem(t,x);
xlabel('time');
ylabel('amplitude');
title('Cosine wave');
```

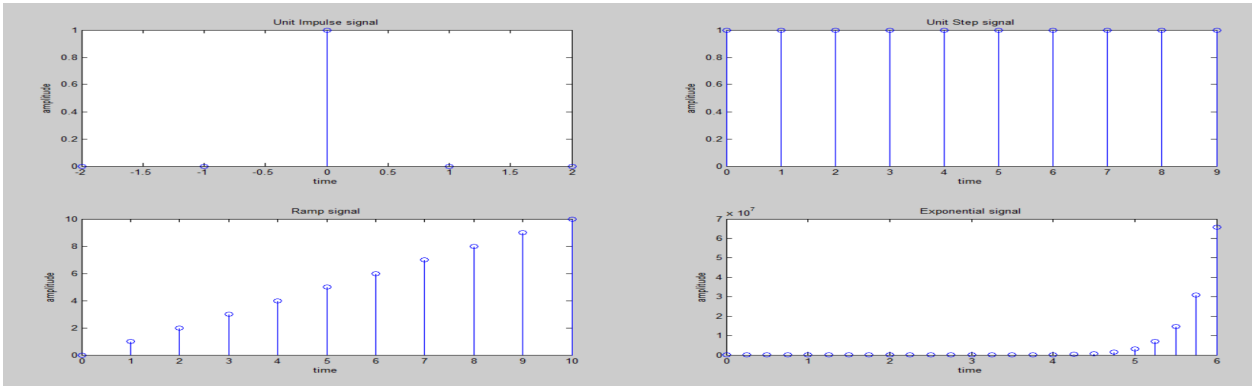
output:

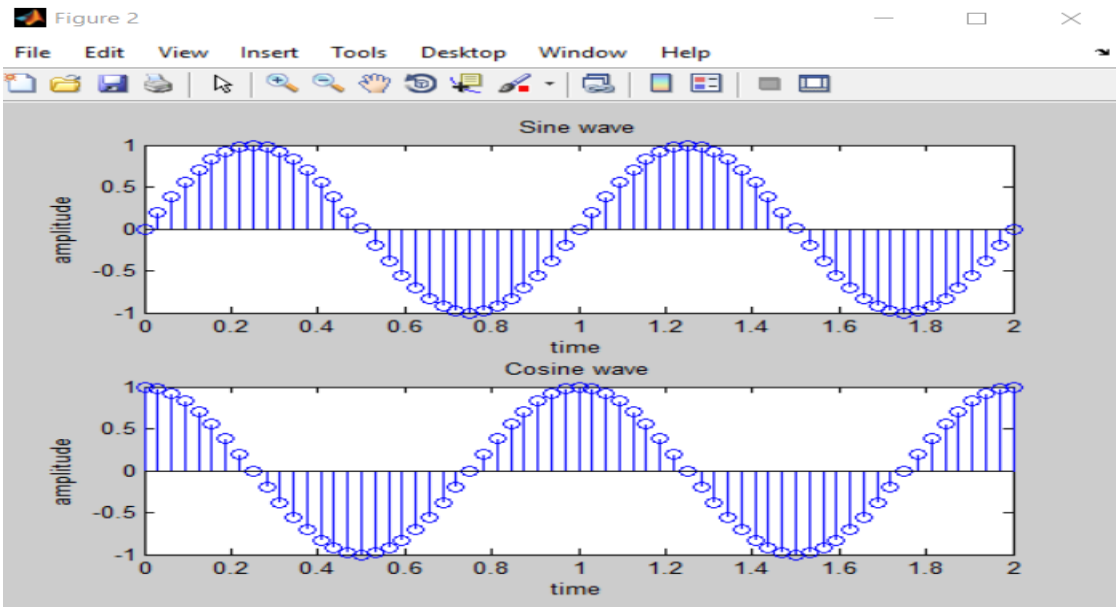
enter the value of N = 10

enter the value of N1 = 10

enterthelengthN2=6

enter the value of a = 3



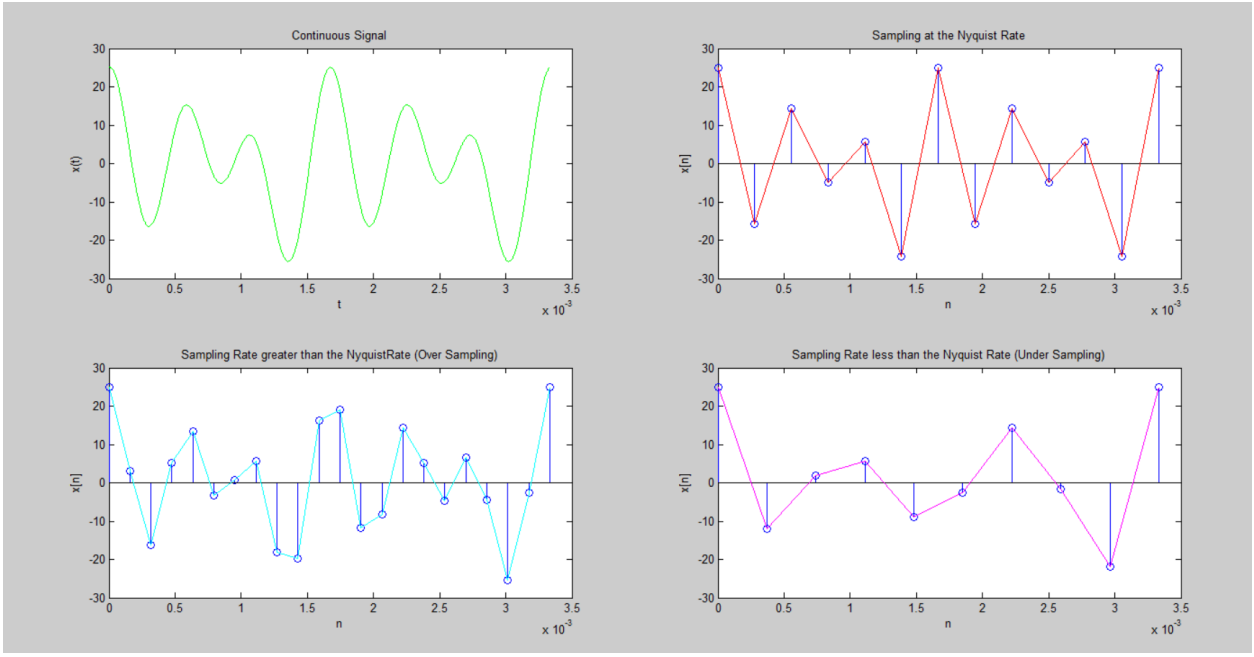


Lab-2:sampaling

```
clc;
close all;
f1=600;
f2=1200;
f3=1800;
fmax=max(max(f1,f2),f3);
T=1/min(min(f1,f2),f3);

t=0:0.001*T:2*T;


x=(5*sin(2*pi*f1*t))+(10*cos(2*pi*f2*t))+(15*cos(2*pi*f3*t));%Original Signal
subplot(2,2,1);
plot(t,x,'g');
title('Continuous Signal');
xlabel('t');
ylabel('x(t)');

%Sampling at the Nyquist Rate
fs1=2*fmax;%Nyquist Rate for sampling
n1=0:1/fs1:2*T;
x1=(5*sin(2*pi*f1*n1))+(10*cos(2*pi*f2*n1))+(15*cos(2*pi*f3*n1));
subplot(2,2,2);
stem(n1,x1);
hold on;
plot(n1,x1,'r');
title('Sampling at the Nyquist Rate');
xlabel('n');
ylabel('x[n]');

%Sampling rate greater than the Nyquist Rate(Over Sampling)
fs2=3.5*fmax;%Over sampling rate
n2=0:1/fs2:2*T;
x2=(5*sin(2*pi*f1*n2))+(10*cos(2*pi*f2*n2))+(15*cos(2*pi*f3*n2));
subplot(2,2,3);
stem(n2,x2);
hold on;
plot(n2,x2,'c');
title('Sampling Rate greater than the NyquistRate (Over Sampling)');
xlabel('n');
ylabel('x[n]');

%Sampling rate less than the Nyquist Rate (Under Sampling)
fs3=1.5*fmax;%under sampling rate
n3=0:1/fs3:2*T;
x3=(5*sin(2*pi*f1*n3))+(10*cos(2*pi*f2*n3))+(15*cos(2*pi*f3*n3));
subplot(2,2,4);
stem(n3,x3);
hold on;
plot(n3,x3,'m');
title('Sampling Rate less than the Nyquist Rate (Under Sampling)');
xlabel('n');
```

```
ylabel('x[n]');
```

output:

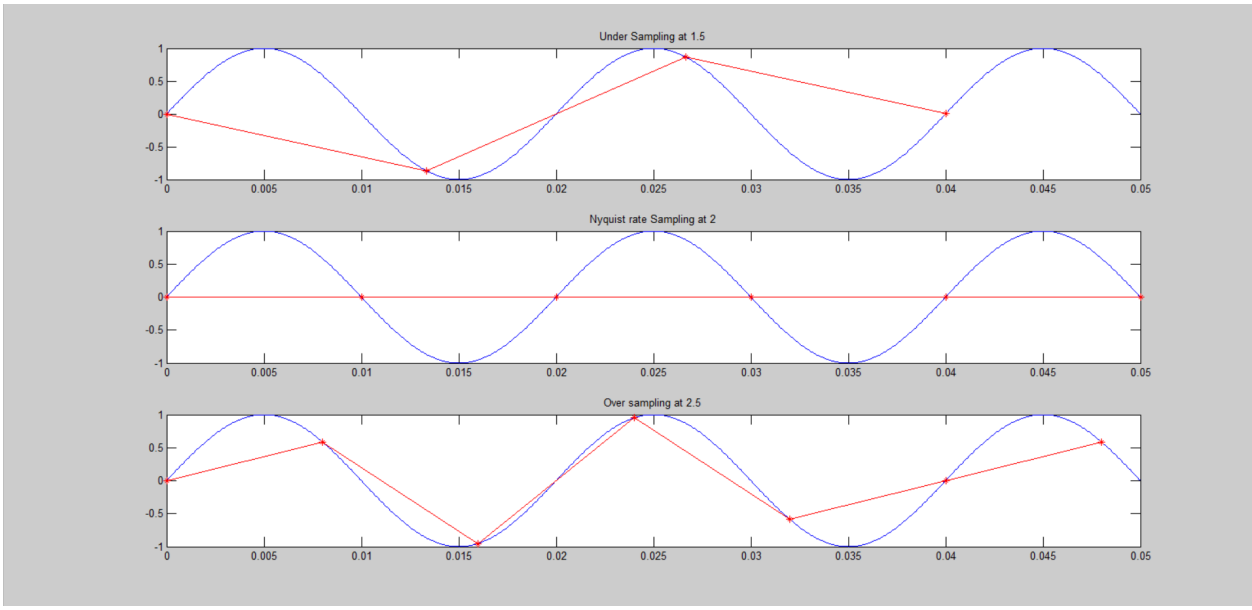


time:

```
clc;
close all;
tfinal = 0.05;
t= 0:0.00005: tfinal;%runs for .00005/0.05 = 1000 times
fd= input('Enter the analog frequency of the sine wave : ');
xt = sin(2*pi*fd*t);%original signal

fs1 = 1.5*fd;
n1= 0: 1/fs1: tfinal;
xn = sin(2*pi*n1*fd);
subplot(3,1,1);
plot(t,xt,'b',n1,xn,'r*-');
title('Under Sampling at 1.5');

fs2= 2*fd;
n2= 0:1/fs2:tfinal;
xn = sin(2*pi*n2*fd);
subplot(3,1,2);
plot(t,xt,'b',n2,xn,'r*-');
title('Nyquist rate Sampling at 2');

fs3 = 2.5*fd;
n3= 0:1/fs3:tfinal;
xn = sin(2*pi*n3*fd);
subplot(3,1,3);
plot(t,xt,'b',n3,xn,'r*-');
title('Over sampling at 2.5');
```

output:

Enter the analog frequency of the sine wave : 50



Autocorrelation:

```
clc;
clear all;
close all;
n = -5:5;
x = ones(1,11);
[r,lag] = xcorr(x, x);
disp ('Auto correlation sequence r(n) is ');
disp(r);
subplot(2,1,1);
stem (n, x);
xlabel('n');
ylabel('x(n)');
title('Plot of x(n)');
subplot(2,1,2);
stem(lag,r);
title('Autocorrelation output');
xlabel('n');
ylabel('r(n)');

%Verificaion of the auto correlation properties
Energy = sum(x.^2);
center_index= ceil(length(r)/2);
r_0=r(center_index);
if r_0==Energy
 disp('Rxx(0) gives energy -- proved');
else
```

```
 disp('Rxx(0) gives energy -- not proved');
end
```

output:

Auto correlation sequence r(n) is

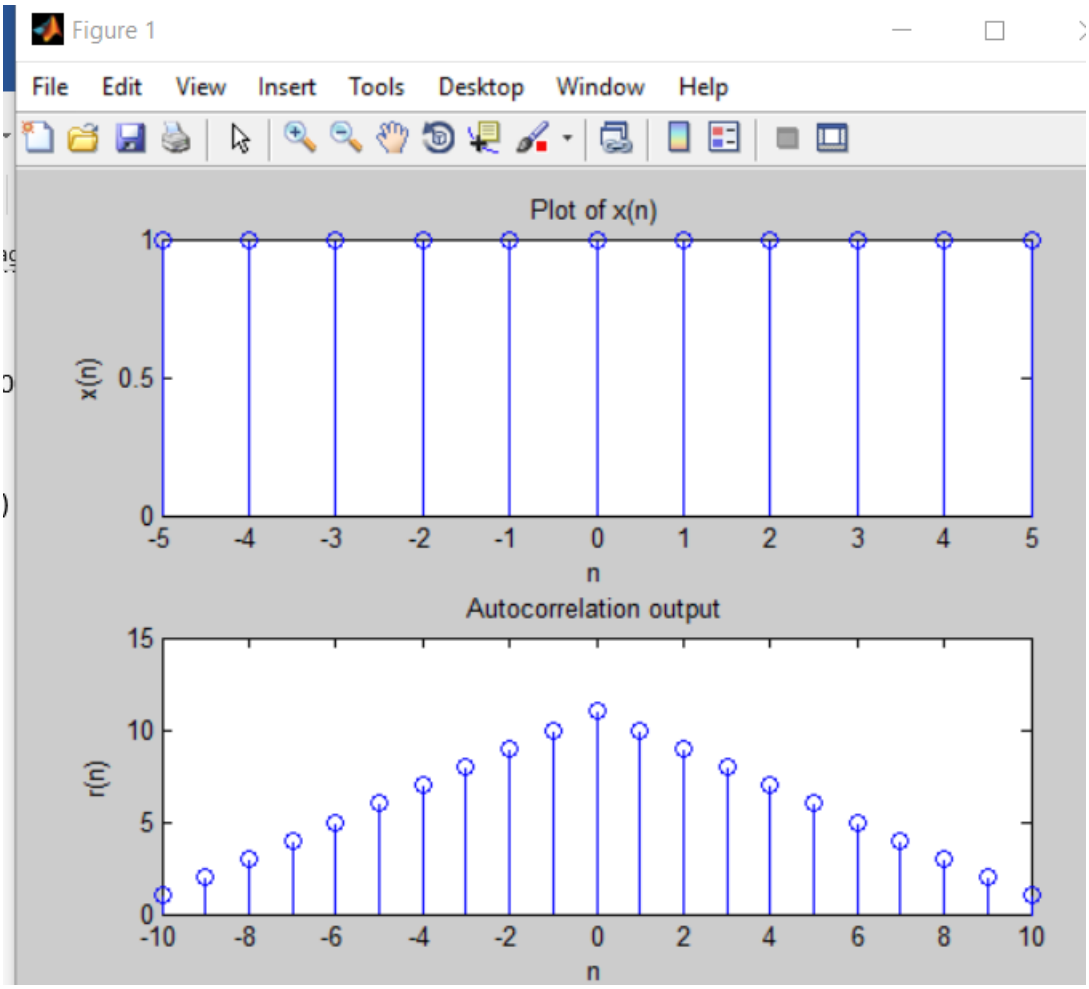
Columns 1 through 14

1.0000 2.0000 3.0000 4.0000 5.0000 6.0000 7.0000 8.0000 9.0000 10.0000 11.0000 10.0000 9.0000 8.0000

Columns 15 through 21

7.0000 6.0000 5.0000 4.0000 3.0000 2.0000 1.0000

Rxx(0) gives energy -- not proved



Auto correlation:

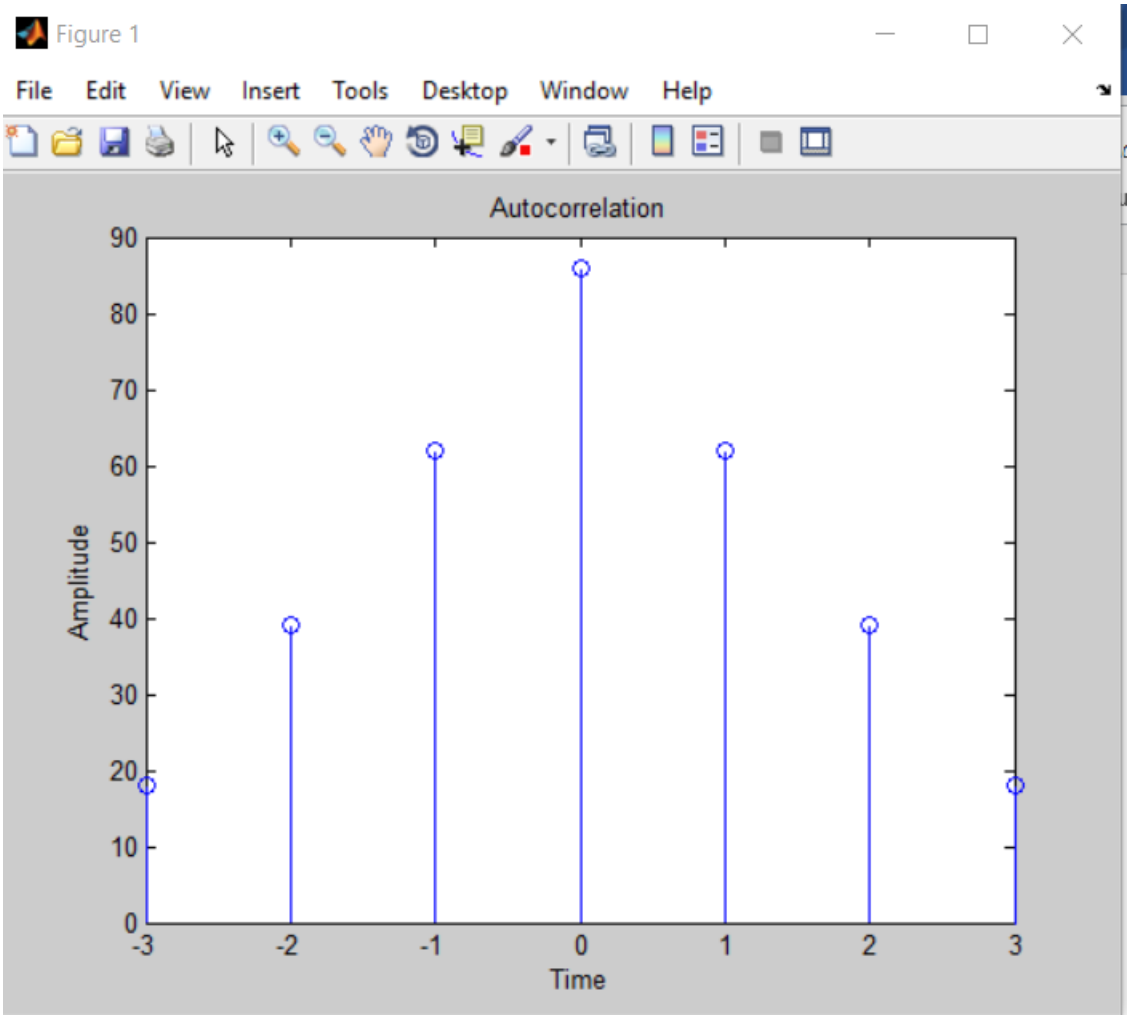
```
clc;
clear all;
close all;
x=input('Input Sequence');
Rxx=xcorr(x);
disp('Auto correlation values :');
disp(Rxx);
t=((-length(x)/2-1):length(x)-1);
stem(t,Rxx);
xlabel('Time');
ylabel('Amplitude');
title('Autocorrelation');
```

output:

Input Sequence[3 4 5 6]

Auto correlation values :

18.0000 39.0000 62.0000 86.0000 62.0000 39.0000 18.0000



Cross:

```
clc;
clear all;
close all;
x=input('First Input Sequence:');
y=input('Second Input Sequence:');
%% Autocorrelation of x
Rxx=xcorr(x);
disp('Auto Correlation Values of x :');
disp(Rxx);

%% Autocorrelation of y
Ryy=xcorr(y);
disp('Auto Correlation Values of y :');
disp(Ryy);

%% Autocorrelation of xy
Rxy=xcorr(x,y);
disp('Auto Correlation Values of xy :');
disp(Rxy);
```

```
%% Autocorrelation of yx
Ryx=xcorr(y,x);
disp('Auto Correlation Values of yx :');
disp(Ryx);

t=((-length(x)/2-1):1:length(x)-1);
stem(t,Rxy);
xlabel('Time');
ylabel('Amplitude');
title('Autocorrelation');
```

output:

First Input Sequence:[1 2 3 4]

Second Input Sequence:[5 6 7 8]

Auto Correlation Values of x :

4.0000 11.0000 20.0000 30.0000 20.0000 11.0000 4.0000

Auto Correlation Values of y :

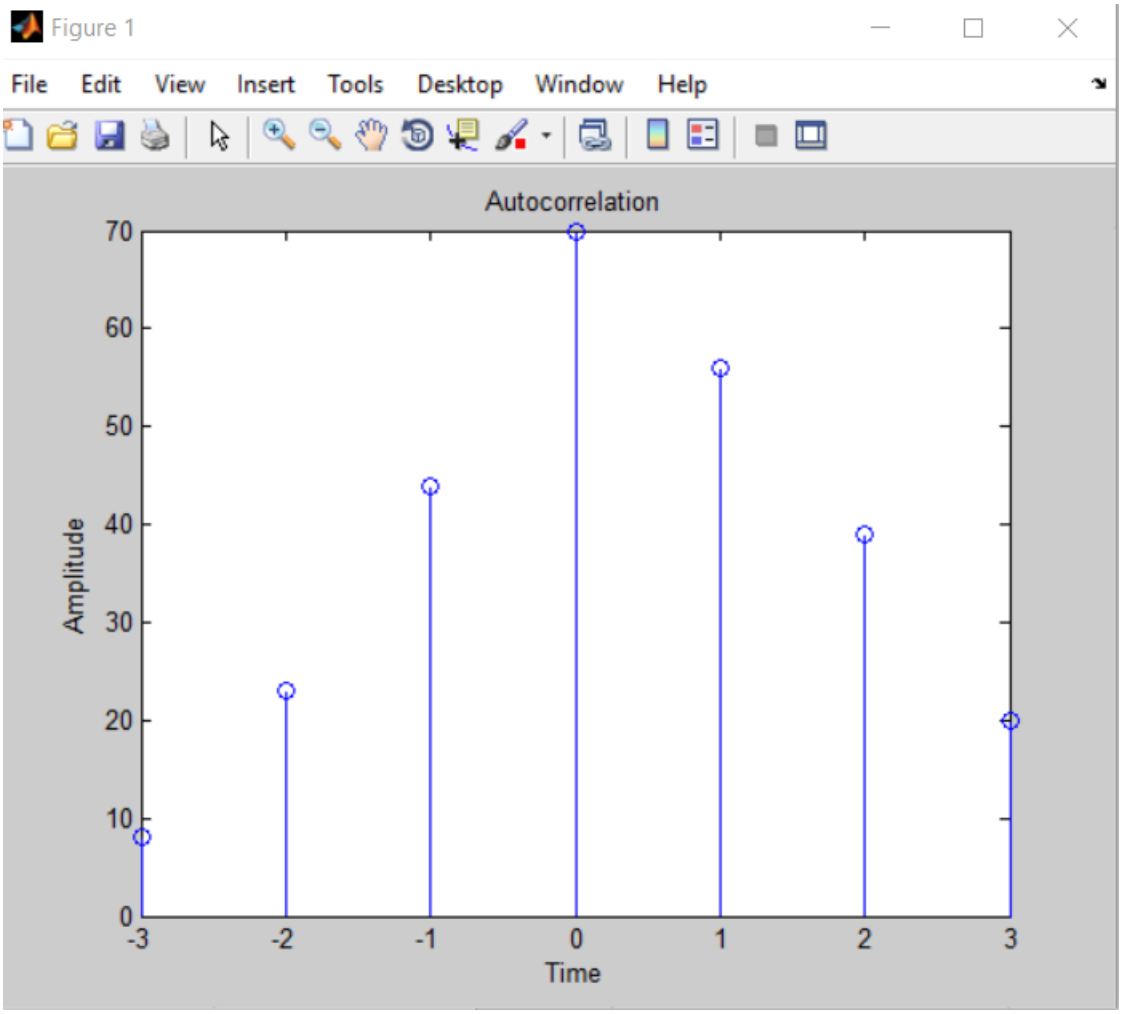
40 83 128 174 128 83 40

Auto Correlation Values of xy :

8.0000 23.0000 44.0000 70.0000 56.0000 39.0000 20.0000

Auto Correlation Values of yx :

20.0000 39.0000 56.0000 70.0000 44.0000 23.0000 8.0000




```
clc;
clear all;
close all;
x= [ 0 0 2 1 -4 -3 -2 -1 0 1 3 2 5 1 -4 -1 -1 -2 ];
y= [ 3 2 1 -6 -4 -3 -1 -2 1 1 2 3 1 4 6 2 1 0 ] ;
%% Autocorrelation of x
Rxx=xcorr(x);
disp('Auto Correlation Values of x :');
disp(Rxx);

%% Autocorrelation of y
Ryy=xcorr(y);
disp('Auto Correlation Values of y :');
disp(Ryy);

%% Autocorrelation of xy
Rxy=xcorr(x,y);
disp('Auto Correlation Values of xy :');
disp(Rxy);

%% Autocorrelation of yx
Ryx=xcorr(y,x);
```

```
disp('Auto Correlation Values of yx :');
disp(Ryx);

t=(-16:1:18);
stem(t,Rxx);
xlabel('Time');
ylabel('Amplitude');
title('Auto correlation X');
```

output:

Auto Correlation Values of x :

Columns 1 through 14

0.0000 0 -4.0000 -4.0000 5.0000 1.0000 9.0000 34.0000 20.0000 -8.0000 -23.0000 -36.0000 -43.0000 -36.0000

Columns 15 through 28

-7.0000 3.0000 45.0000 97.0000 45.0000 3.0000 -7.0000 -36.0000 -43.0000 -36.0000 -23.0000 -8.0000 20.0000 34.0000

Columns 29 through 35

9.0000 1.0000 5.0000 -4.0000 -4.0000 0 -0.0000

Auto Correlation Values of y :

Columns 1 through 14

0.0000 3.0000 8.0000 23.0000 20.0000 1.0000 -32.0000 -42.0000 -34.0000 -36.0000 -43.0000 -28.0000 -17.0000 2.0000

Columns 15 through 28

13.0000 51.0000 95.0000 153.0000 95.0000 51.0000 13.0000 2.0000 -17.0000 -28.0000 -43.0000 -36.0000 -34.0000 -42.0000

Columns 29 through 35

-32.0000 1.0000 20.0000 23.0000 8.0000 3.0000 0.0000

Auto Correlation Values of xy :

Columns 1 through 14

-0.0000 0.0000 0.0000 2.0000 5.0000 10.0000 3.0000 -26.0000 -32.0000 -23.0000 -24.0000 -15.0000 -6.0000 13.0000

Columns 15 through 28

30.0000 38.0000 32.0000 20.0000 46.0000 31.0000 -19.0000 -38.0000 -49.0000 -52.0000 -42.0000 -27.0000 -10.0000 36.0000

Columns 29 through 35

50.0000 29.0000 8.0000 -3.0000 -7.0000 -7.0000 -6.0000

Auto Correlation Values of yx :

Columns 1 through 14

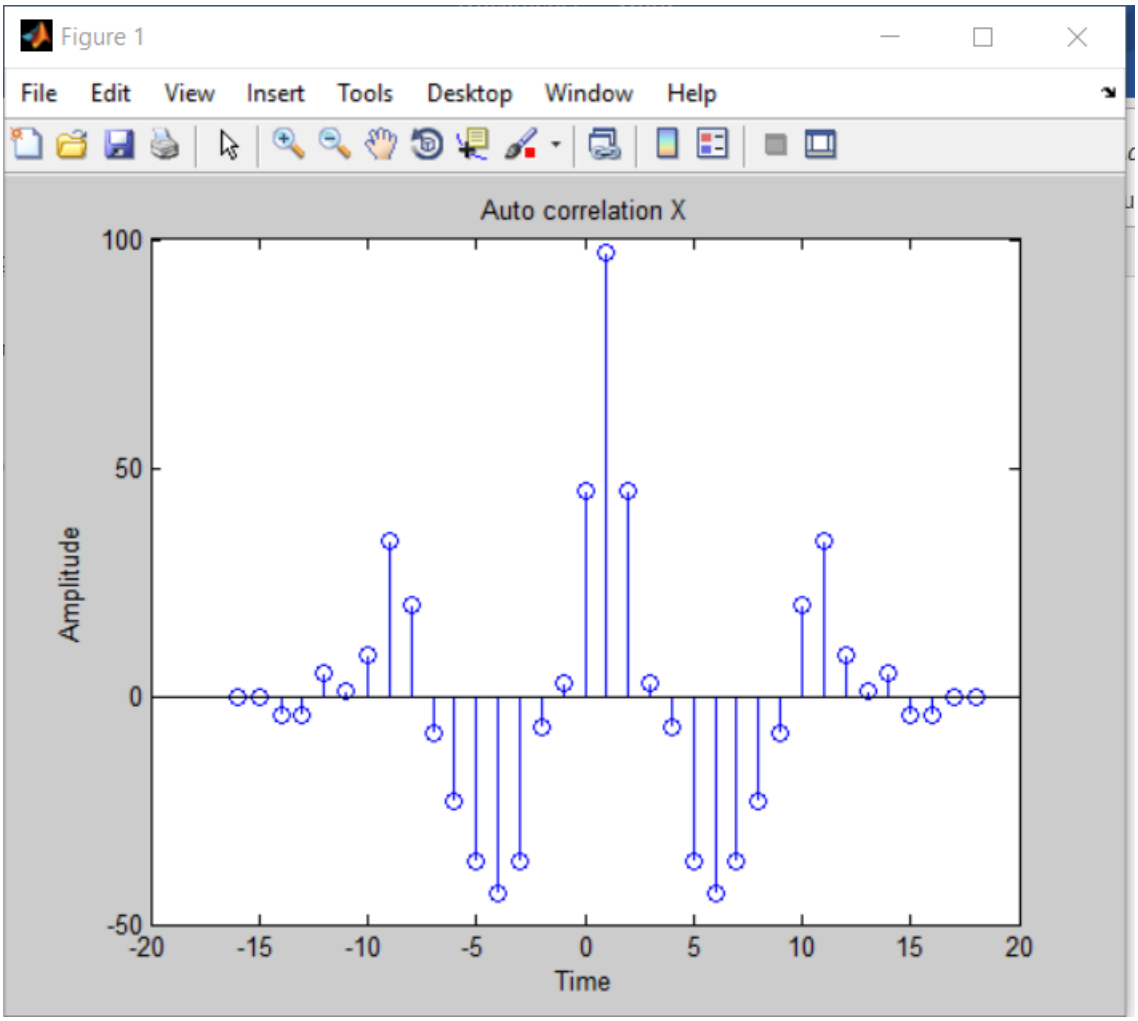
-6.0000 -7.0000 -7.0000 -3.0000 8.0000 29.0000 50.0000 36.0000 -10.0000 -27.0000 -42.0000 -52.0000 -49.0000 -38.0000

Columns 15 through 28

-19.0000 31.0000 46.0000 20.0000 32.0000 38.0000 30.0000 13.0000 -6.0000 -15.0000 -24.0000 -23.0000 -32.0000 -26.0000

Columns 29 through 35

3.0000 10.0000 5.0000 2.0000 0.0000 0.0000 0.0000




```
clc;
clear all;
close all;
x= [ 0 0 2 1 -4 -3 -2 -1 0 1 3 2 5 1 -4 -1 -1 -2 ];
y= [ 3 2 1 -6 -4 -3 -1 -2 1 1 2 3 1 4 6 2 1 0 ] ;
%% Autocorrelation of x
Rxx=xcorr(x);
disp('Auto Correlation Values of x :');
disp(Rxx);

%% Autocorrelation of y
Ryy=xcorr(y);
disp('Auto Correlation Values of y :');
disp(Ryy);
```

```
%% Autocorrelation of xy
Rxy=xcorr(x,y);
disp('Auto Correlation Values of xy :');
disp(Rxy);

%% Autocorrelation of yx
Ryx=xcorr(y,x);
disp('Auto Correlation Values of yx :');
disp(Ryx);

t=(-16:1:18);
stem(t,Ryy);
xlabel('Time');
ylabel('Amplitude');
title('Auto correlation Y');
```

output:

Auto Correlation Values of x :

Columns 1 through 14

0.0000 0 -4.0000 -4.0000 5.0000 1.0000 9.0000 34.0000 20.0000 -8.0000 -23.0000 -36.0000 -43.0000 -36.0000

Columns 15 through 28

-7.0000 3.0000 45.0000 97.0000 45.0000 3.0000 -7.0000 -36.0000 -43.0000 -36.0000 -23.0000 -8.0000 20.0000 34.0000

Columns 29 through 35

9.0000 1.0000 5.0000 -4.0000 -4.0000 0 -0.0000

Auto Correlation Values of y :

Columns 1 through 14

0.0000 3.0000 8.0000 23.0000 20.0000 1.0000 -32.0000 -42.0000 -34.0000 -36.0000 -43.0000 -28.0000 -17.0000 2.0000

Columns 15 through 28

13.0000 51.0000 95.0000 153.0000 95.0000 51.0000 13.0000 2.0000 -17.0000 -28.0000 -43.0000 -36.0000 -34.0000 -42.0000

Columns 29 through 35

-32.0000 1.0000 20.0000 23.0000 8.0000 3.0000 0.0000

Auto Correlation Values of xy :

Columns 1 through 14

-0.0000 0.0000 0.0000 2.0000 5.0000 10.0000 3.0000 -26.0000 -32.0000 -23.0000 -24.0000 -15.0000 -6.0000 13.0000

Columns 15 through 28

30.0000 38.0000 32.0000 20.0000 46.0000 31.0000 -19.0000 -38.0000 -49.0000 -52.0000 -42.0000 -27.0000 -10.0000 36.0000

Columns 29 through 35

50.0000 29.0000 8.0000 -3.0000 -7.0000 -7.0000 -6.0000

Auto Correlation Values of yx :

Columns 1 through 14

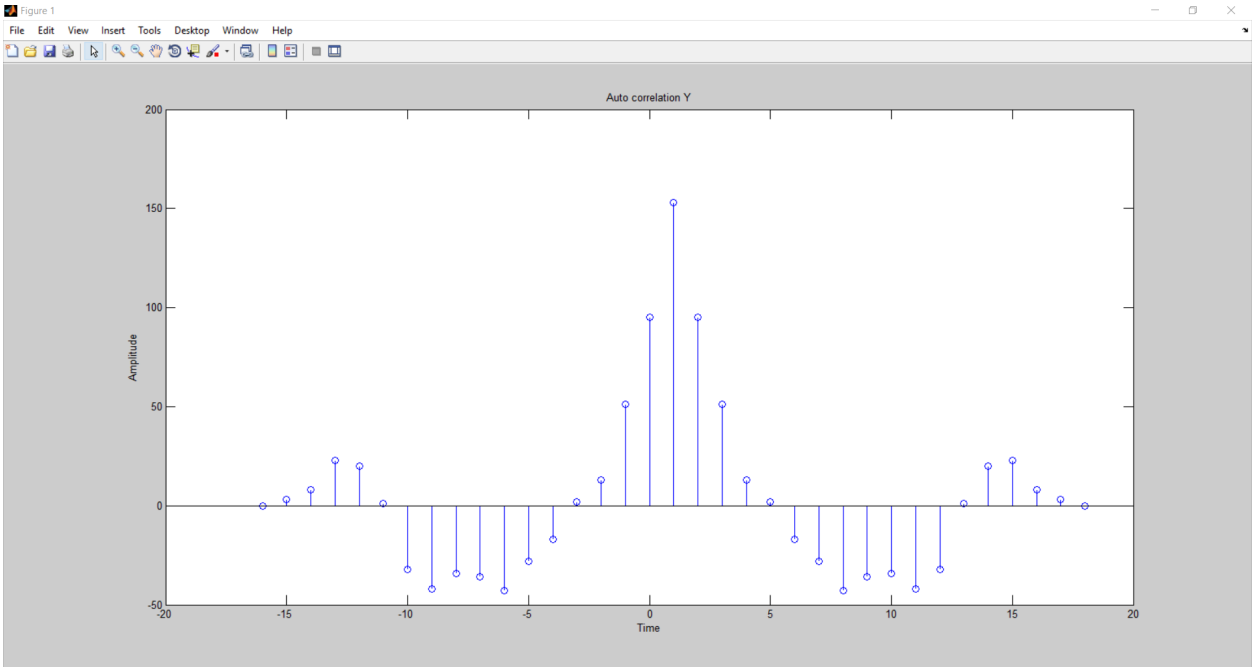
-6.0000 -7.0000 -7.0000 -3.0000 8.0000 29.0000 50.0000 36.0000 -10.0000 -27.0000 -42.0000 -52.0000 -49.0000 -38.0000

Columns 15 through 28

-19.0000 31.0000 46.0000 20.0000 32.0000 38.0000 30.0000 13.0000 -6.0000 -15.0000 -24.0000 -23.0000 -32.0000 -26.0000

Columns 29 through 35

3.0000 10.0000 5.0000 2.0000 0.0000 0.0000 0.0000




```
clc;
clear all;
close all;
x= [ 0 0 2 1 -4 -3 -2 -1 0 1 3 2 5 1 -4 -1 -1 -2 ];
y= [ 3 2 1 -6 -4 -3 -1 -2 1 1 2 3 1 4 6 2 1 0 ] ;
%% Autocorrelation of x
Rxx=xcorr(x);
disp('Auto Correlation Values of x :');
disp(Rxx);

%% Autocorrelation of y
Ryy=xcorr(y);
disp('Auto Correlation Values of y :');
disp(Ryy);

%% Autocorrelation of xy
```

```
Rxy=xcorr(x,y);
disp('Auto Correlation Values of xy :');
disp(Rxy);

%% Autocorrelation of yx
Ryx=xcorr(y,x);
disp('Auto Correlation Values of yx :');
disp(Ryx);

t=(-16:1:18);
disp(length(t));
stem(t,Rxy);
xlabel('Time');
ylabel('Amplitude');
title('Cross correlation');
```

output:

Auto Correlation Values of x :

Columns 1 through 14

0.0000 0 -4.0000 -4.0000 5.0000 1.0000 9.0000 34.0000 20.0000 -8.0000 -23.0000 -36.0000 -43.0000 -36.0000

Columns 15 through 28

-7.0000 3.0000 45.0000 97.0000 45.0000 3.0000 -7.0000 -36.0000 -43.0000 -36.0000 -23.0000 -8.0000 20.0000 34.0000

Columns 29 through 35

9.0000 1.0000 5.0000 -4.0000 -4.0000 0 -0.0000

Auto Correlation Values of y :

Columns 1 through 14

0.0000 3.0000 8.0000 23.0000 20.0000 1.0000 -32.0000 -42.0000 -34.0000 -36.0000 -43.0000 -28.0000 -17.0000 2.0000

Columns 15 through 28

13.0000 51.0000 95.0000 153.0000 95.0000 51.0000 13.0000 2.0000 -17.0000 -28.0000 -43.0000 -36.0000 -34.0000 -42.0000

Columns 29 through 35

-32.0000 1.0000 20.0000 23.0000 8.0000 3.0000 0.0000

Auto Correlation Values of xy :

Columns 1 through 14

-0.0000 0.0000 0.0000 2.0000 5.0000 10.0000 3.0000 -26.0000 -32.0000 -23.0000 -24.0000 -15.0000 -6.0000 13.0000

Columns 15 through 28

30.0000 38.0000 32.0000 20.0000 46.0000 31.0000 -19.0000 -38.0000 -49.0000 -52.0000 -42.0000 -27.0000 -10.0000 36.0000

Columns 29 through 35

50.0000 29.0000 8.0000 -3.0000 -7.0000 -7.0000 -6.0000

Auto Correlation Values of yx :

Columns 1 through 14

-6.0000 -7.0000 -7.0000 -3.0000 8.0000 29.0000 50.0000 36.0000 -10.0000 -27.0000 -42.0000 -52.0000 -49.0000 -38.0000

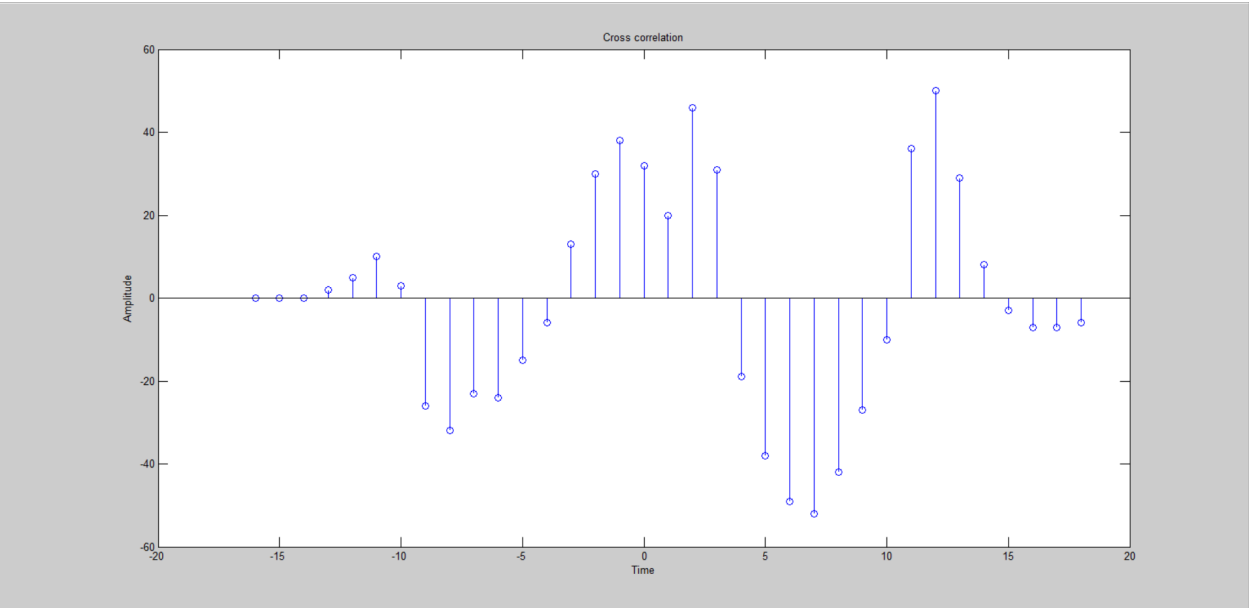
Columns 15 through 28

-19.0000 31.0000 46.0000 20.0000 32.0000 38.0000 30.0000 13.0000 -6.0000 -15.0000 -24.0000 -23.0000 -32.0000 -26.0000

Columns 29 through 35

3.0000 10.0000 5.0000 2.0000 0.0000 0.0000 0.0000

35



Ex:n-point DFT

```
clc;
clear all;
close all;
N= input('enter the N point=');
xn= input('enter the input sequence x(n)=');
Xk=fft(xn,N);
disp('N point DFT of x(n) is=');
disp(Xk);

figure(1);
n=0:1:length(xn)-1;
stem(n,xn);
xlabel('n');
ylabel('x(n)');
title('Original Signal');
```

```
figure(2);
k= 0:N-1;
stem(k,abs(Xk));
xlabel('k');
ylabel('x(k)');
title('Magnitute Spectrum');

figure(3);
stem(k,angle(Xk));
xlabel('k');
ylabel('<X(k)');
title('Phase Spectrum');
```

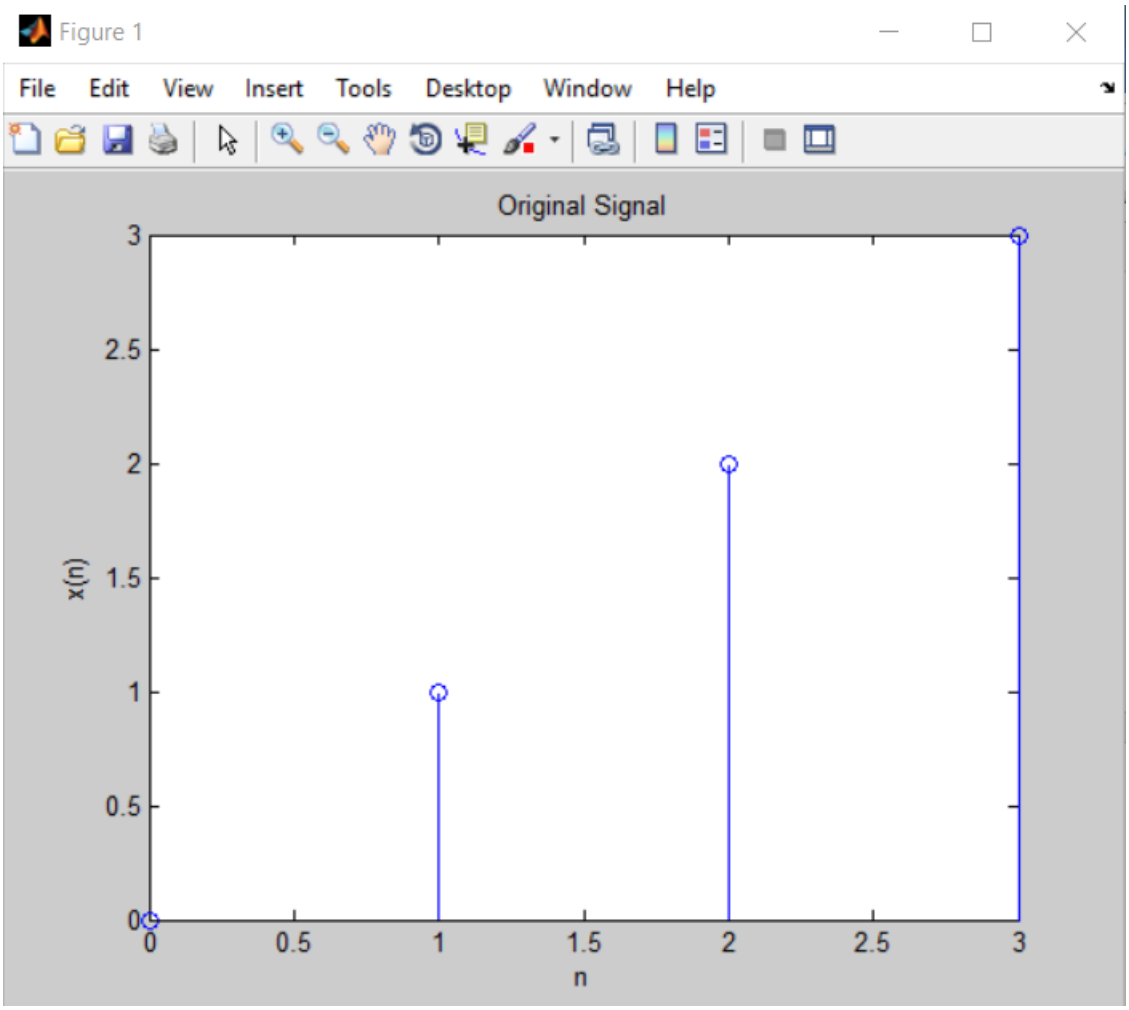
output:

enter the N point=4

enter the input sequence x(n)=[0 1 2 3]

N point DFT of x(n) is=

6.0000 + 0.0000i -2.0000 + 2.0000i -2.0000 + 0.0000i -2.0000 - 2.0000i



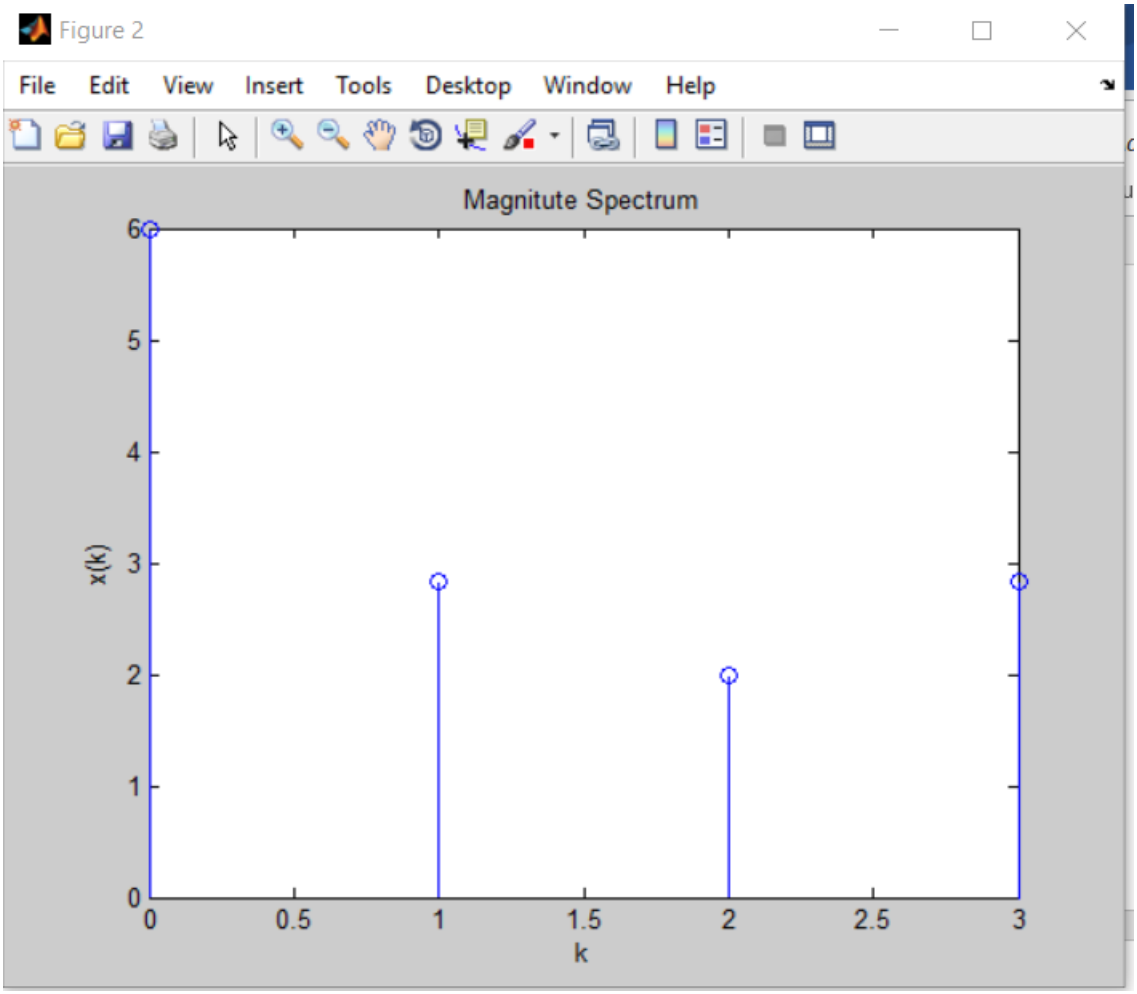


Figure 2
File Edit View Insert Tools Desktop Window Help
Magnitute Spectrum
x(k)
k
0
1
2
3
4
5
6
0
0.5
1
1.5
2
2.5
3

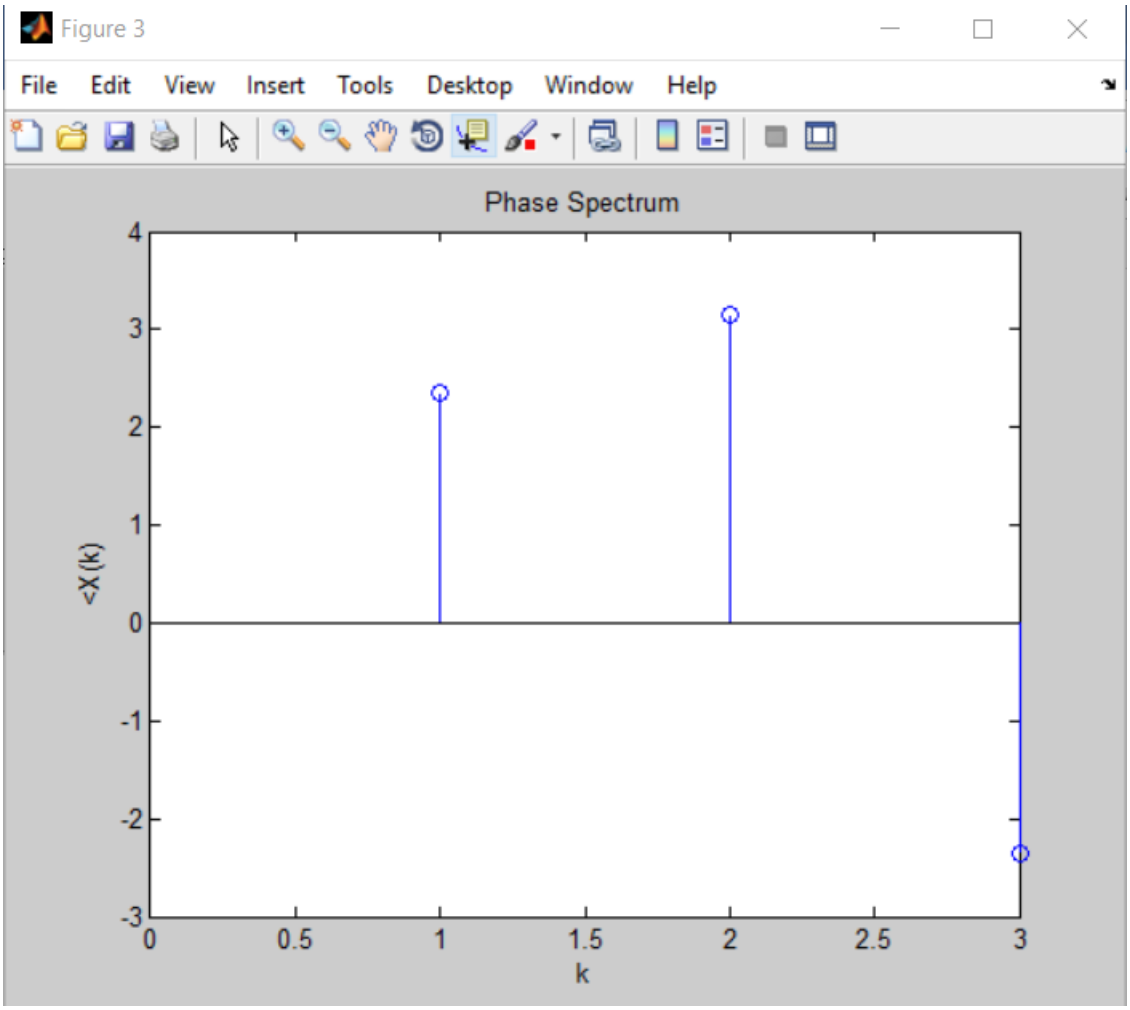


Figure 3
File Edit View Insert Tools Desktop Window Help
Phase Spectrum
<X(k)
k
4
3
2
1
0
-1
-2
-3
0
0.5
1
1.5
2
2.5
3