SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

R. V. S NAGAR CHITTOOR-517 127

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

LABORATORY MASTER MANUAL

LAB NAME	**:**	**SIGNALS AND SYSTEMS LAB**
LAB CODE	**:**	**20AEC06**
YEAR & SEMESTER	**:**	**II B.Tech-I Sem**
REGULATIONS	**:**	**R-20**

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SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)
R.V.S NAGAR, CHITTOOR, (AP)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION AND MISSION OF THE INSTITUTE

INSTITUTE VISION:

To carve the youth as dynamic, competent, valued and knowledgeable professionals who shall lead the Nation to a better future and to mould the institution into a Center of Academic Excellence and advanced Research.

INSTITUTE MISSION:

- To provide quality education, student-centered teaching-learning processes and state-of-art infrastructure for professional aspirants hailing from both rural and urban areas.
- To impart technical education that encourages independent thinking develops strong domain of knowledge, contemporary skills and positive attitudes towards holistic growth of young minds.

Department Vision & Mission

VISION

To become a centre of excellence in the field of electronics and communications offering higher order of learning and conducting contemporary research thereby producing globally competitive and ethically strong engineering professionals.

MISSION

- Establish a scintillating learning environment to produce quality graduates with passion for knowledge and creativity in the field of Electronics and Communication Engineering.
- Impart quality education through periodically updated curriculum to meet the challenges of the industry and research at the global level.
- Enhancing employability of the students by providing skills through comprehensive experiential learning.
- Developing professional etiquette and ethical integrity among the students to face real-time life challenges.
- Empower the faculty through continuous training in domain, research and pedagogy for enhancing learning outcomes of the students and Research output.

Program Educational Objectives (PEOs)

PEO1: Utilize knowledge, skills, and resources to enrich professional careers to pursue higher studies in the electronics and communication engineering and allied areas.

PEO2: Develop entrepreneurship skills to achieve professional success with start-ups.

PEO3: Develop attitude in lifelong learning and practice the profession with Integrity and responsibility.

Program Specific Outcomes (PSOs)

PSO1: Design and develop dedicated engineering circuits and systems using the concepts, principles and methodologies in electronics, communication and signal processing applications in relevance to industry and society.

PSO2: Use modern tools, techniques and methodologies to design, analyse and develop intelligent systems in VLSI, Embedded and modern Semiconductor technology for customized solutions.

PSO3: Appropriate principles and algorithms to implement secured communication systems for problem solving Using signals, images, information from radars and satellite, fiber optics, wired and wireless systems.

List of Experiments

(Minimum Twelve experiments to be conducted)

1. Basic operations on Matrices
2. Generation of Various signals and Sequences (Periodic and Aperiodic), Such as Unit Impulse, Unit Step, Square, Saw Tooth, Triangular, Sinusoidal, Ramp, sinc function.
3. Operations on Signals and Sequences such as Addition, Multiplication, Scaling, Shifting, Folding, Computation of Energy and Average power.
4. Finding the Even and Odd parts of Signal or Sequence and Real and Imaginary parts of Signal.
5. Convolution between Signals and Sequences.
6. Autocorrelation and Cross correlation between Signals and Sequences.
7. Verification of Linearity and Time Invariance properties of a Given Continuous / Discrete System.
8. Computation of Unit Sample, Unit Step and Sinusoidal Responses of the given LTI system and verifying its Physical Realizability and Stability properties.
9. Gibbs phenomenon.
10. Finding the Fourier Transform of a given Signal and plotting its Magnitude and phase Spectrum.
11. Waveform Synthesis using Laplace Transform.
12. Locating Zeros and poles, and plotting the Pole-Zero maps in S-Plane and Z-Plane for the given Transfer Functions.
13. Generation of Gaussian Noise (Real and Complex), Computation of its Mean, M.S. Values and its Skew, Kurtosis, and PSD, Probability Distribution Function.
14. Sampling Theorem Verification.

Course Outcomes:

After completion of the course students will be able to

CO1: Analyze various properties and processing of signals and systems using MATLAB.

CO2: Apply Fourier, Laplace and Z-transform techniques to analyze signals and systems using MATLAB

INDEX

S. No.	Date	Name of the Experiment	Remarks

Experiment No -1

BASIC OPERATIONS ON MATRICES

AIM: - Write a MATLAB program to perform some basic operations on matrices.

SOFTWARE REQURIED:- MATLAB R2014a

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/ Figure window

PROGRAM:-

```
clc;
close all;
clear all;
a=[1 2 -9 ; 2 -1 2; 3 -4 3];
b=[1 2 3; 4 5 6; 7 8 9];
disp('The matrix a= ');a
disp('The matrix b= ');b
% to find sum of a and b
c=a+b;
disp('The sum of a and b is ');c
% to find difference of a and b
d=a-b;
disp('The difference of a and b is ');d
%to find multiplication of a and b
e=a*b;
disp('The product of a and b is ');e
% to find size of matrix a
[f g]=size(a);
disp('the number of rows in matrix a is');f
disp('the number of columns in matrix a is');g
% to find rank of matrix a
h=rank(a);
disp('the rank of matrix a is');h
% to find transpose of matrix a
j=a';
disp('the transpose of matrix a is');j
% to find main diagnol elements of matrix a
k=diag(a);
disp('the main diagnol elements of matrix a is');k
% to find determinent of matrix a
m=det(a);
disp('the determinant of matrix a is');m
% to find inverse of matrix a
n=inv(a);
disp('the inverse of matrix a is');n
% to display 4x4 zeros matrix
```

```
o=zeros(4,4);
disp('the zeros matrix of size 4x4 s');o
% to display 4x4 ones matrix
p=ones(4,4);
disp('the oness matrix of size 4x4 s');p
% to display null matrix
q=[];
disp('the null matrix q is');q
```

OUTPUT:-

```
The matrix a=

a =

     1     2    -9
     2    -1     2
     3    -4     3

The matrix b=

b =

     1     2     3
     4     5     6
     7     8     9

The sum of a and b is

c =

     2     4    -6
     6     4     8
    10     4    12

The difference of a and b is

d =

     0     0   -12
    -2    -6    -4
    -4   -12    -6
```

```
The product of a and b is

e =

   -54   -60   -66
    12    15    18
     8    10    12

the number of rows in matrix a is

f =

     3

the number of columns in matrix a is

g =

     3

the rank of matrix a is

h =

     3

the transpose of matrix a is

j =

     1     2     3
     2    -1    -4
    -9     2     3

the main diagnol elements of matrix a is

k =

     1
    -1
     3

the determinant of matrix a is

m =

    50
```

```
the inverse of matrix a is

n =

    0.1000    0.6000   -0.1000
         0    0.6000   -0.4000
   -0.1000    0.2000   -0.1000

the zeros matrix of size 4x4 s

o =

     0     0     0     0
     0     0     0     0
     0     0     0     0
     0     0     0     0

the oness matrix of size 4x4 s

p =

     1     1     1     1
     1     1     1     1
     1     1     1     1
     1     1     1     1

the null matrix q is

q =

     []
```

RESULT:- Thus Matlab Program to perform some basic operations on matrices has been executed successfully.

Experiment No -2a

GENERATION OF DISCRETE TIME SIGNALS

AIM: - Write a MATLAB Program to generate of discrete time signals like unit impulse, unit step, unit ramp, exponential signal and sinusoidal signals.

SOFTWARE REQURIED :- MATLAB R2014a

PROCEDURE:-

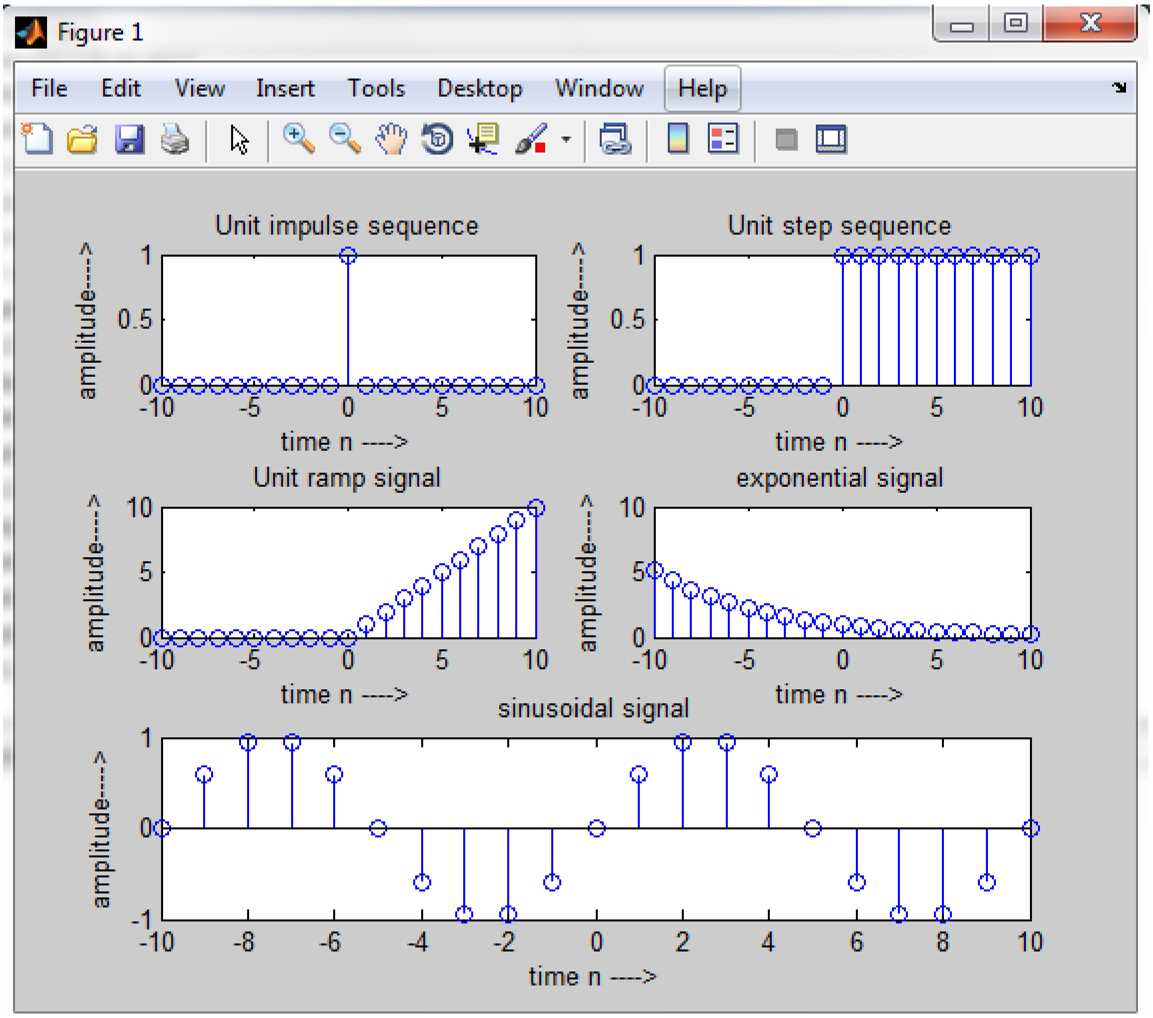
- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:-

```
clc;
clear all;
close all;
n=-10:1:10;
L=length(n);
for i=1:L
if n(i)==0
       impulse(i)=1;
else
        impulse(i)=0;
end;
if n(i)>=0
       step(i)=1;
       ramp(i)=n(i);
else
        step(i)=0;
        ramp(i)=0;
end;
end;
% to generate exponential sequence
a=0.85;
x4=a.^n;
% to generate sinusoidal sequence
f=0.1;
x5=sin(2*pi*f*n);
figure;
subplot(3,2,1);
stem(n,impulse);
xlabel('time n ---->');
ylabel('amplitude---->');
title('Unit impulse sequence');
subplot(3,2,2);
stem(n,step);xlabel('time n ---->');
```

```
ylabel('amplitude---->');
title('Unit step sequence')
subplot(3,2,3);
stem(n,ramp);
xlabel('time n ---->');
ylabel('amplitude---->');
title('Unit ramp signal');
subplot(3,2,4);
stem(n,x4);xlabel('time n ---->');
ylabel('amplitude---->');
title('exponential signal');
subplot(3,2,[5,6]);
stem(n,x5);
xlabel('time n ---->');
ylabel('amplitude---->');
title('sinusoidal signal');
```

OUTPUT:-



RESULT:- Thus discrete time signals like unit impulse, unit step,unit ramp, exponential signal and sinusoidal signals has been generated by using Matlab.

Experiment No -2b

GENERATION OF CONTINUOUS TIME SIGNALS

AIM: - Write a MATLAB Program to generate continuous time signals like unit step, sawtooth, triangular, Sinusoidal, ramp, and sinc function.

SOFTWARE REQURIED : MATLAB R2014a

.

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/Figure window

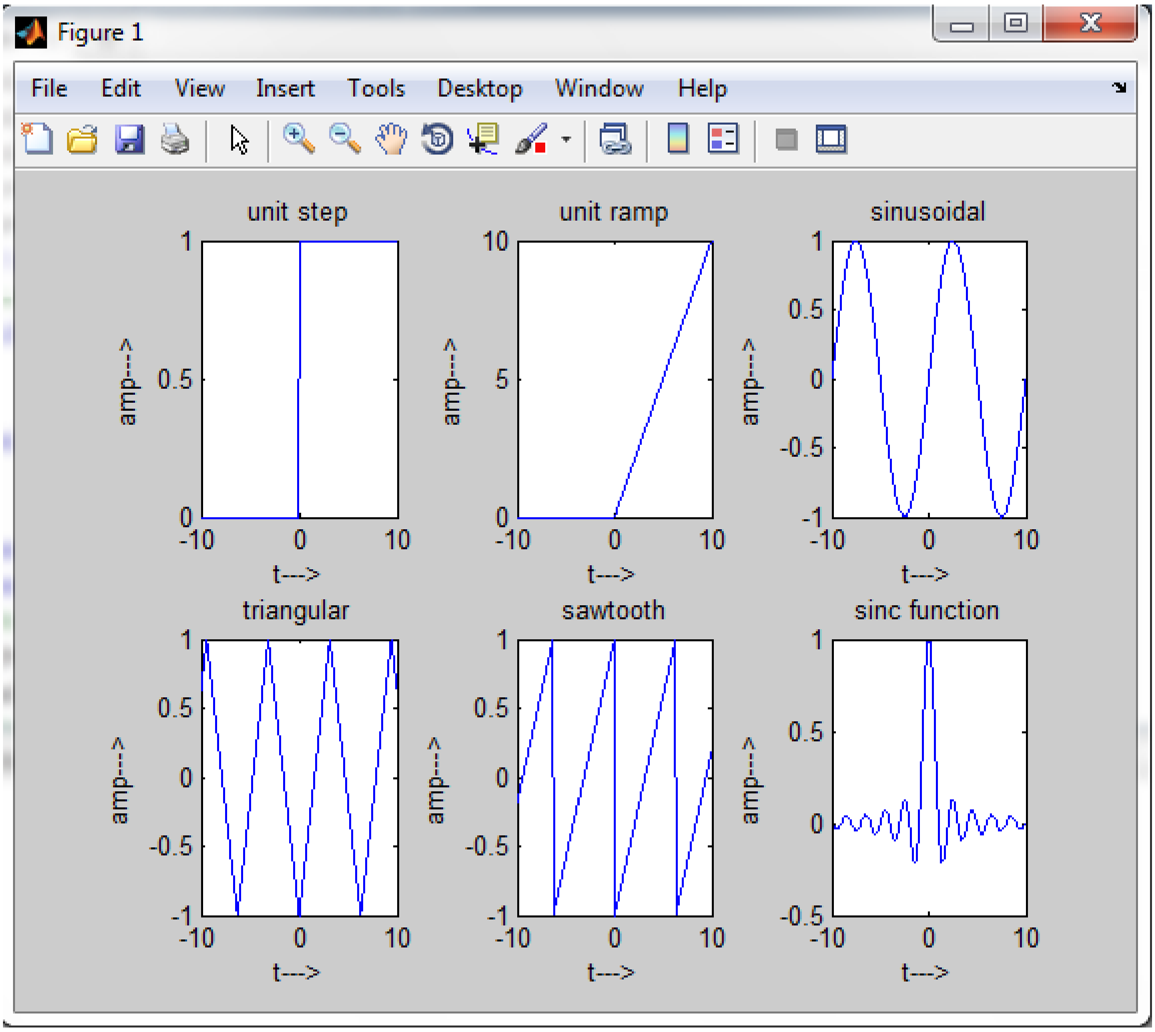
PROGRAM:-

```
clc;
clear all;
close all;
t=-10:0.01:10;
k=length(t);
for i=1:k
%to generate unit step and ramp function
if t(i)<0
        step(i)=0;
        ramp(i)=0;
else
        step(i)=1;
        ramp(i)=t(i);
end;
end;
%to generate sinusoidal function
f=0.1;
x=sin(2*pi*f*t);
%to generate triangular and sawtooth waveforms
y=sawtooth(t,0.5);
z=sawtooth(t);

%to generate sinc function
x6=sinc(t);
figure;
subplot(2,3,1);
plot(t,step);
xlabel('t--->');ylabel('amp--->');
title('unit step');
subplot(2,3,2);
plot(t,ramp);
xlabel('t--->');ylabel('amp--->');
title('unit ramp');
subplot(2,3,3);
```

```
plot(t,x);
xlabel('t--->');ylabel('amp--->');
title('sinusoidal');
subplot(2,3,4);
plot(t,y);
xlabel('t--->');ylabel('amp--->');
title('triangular');
subplot(2,3,5);
plot(t,z);
xlabel('t--->');ylabel('amp--->');
title('sawtooth');
subplot(2,3,6);
plot(t,x6);
xlabel('t--->');ylabel('amp--->');
title('sinc function');
```

OUTPUT:-



RESULT:- Thus continuous time signals like unit step, sawtooth,triangular, sinusoidal, ramp and sinc functions has been generated using Matlab.

Experiment No -03

OPERATIONS ON SIGNALS AND SEQUENCES

AIM: - Perform various operations on signals such as addition, multiplication, scaling, shifting and folding, computation of energy and average power using MATLAB.

SOFTWARE REQURIED :- MATLAB R2014a

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PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/ Figure window

PROGRAM:-

```
clc;
clear all;
close all;
% generating two input signals
t=0:.01:1;
x1=sin(2*pi*4*t);
x2=sin(2*pi*8*t);
subplot(2,2,1);
plot(t,x1);
xlabel('time');
ylabel('amplitude');
title('input signal 1');
subplot(2,2,2);
plot(t,x2);
xlabel('time');
ylabel('amplitude');
title('input signal 2');
% addition of signals
y1=x1+x2;
subplot(2,2,3);
plot(t,y1);
xlabel('time');
ylabel('amplitude');
title('addition of two signals');
% multiplication of signals
y2=x1.*x2;
subplot(2,2,4);
plot(t,y2);
xlabel('time');
ylabel('amplitude');
title('multiplication of two signals');
% scaling of a signal1
A=2;
```

```
y3=A*x1;
figure;
subplot(2,2,1);
plot(t,x1);
xlabel('time');
ylabel('amplitude');
title('input signal')
subplot(2,2,2);
plot(t,y3);
xlabel('time');
ylabel('amplitude');
title('amplified input signal');
% folding of a signal1
h=length(x1);
nx=0:h-1;
subplot(2,2,3);
plot(nx,x1);
xlabel('nx');
ylabel('amplitude');
title('input signal')
y4=fliplr(x1);
nf=-fliplr(nx);
subplot(2,2,4);
plot(nf,y4);
xlabel('nf');
ylabel('amplitude');
title('folded signal');
%shifting of a signal 1
figure;
subplot(3,1,1);
plot(t,x1);
xlabel('time t');
ylabel('amplitude');
title('input signal');
subplot(3,1,2);
plot(t+2,x1);
xlabel('t+2');
ylabel('amplitude');
title('right shifted signal');
subplot(3,1,3);
plot(t-2,x1);
xlabel('t-2');
ylabel('amplitude');
title('left shifted signal');
% program for energy of a sequence
z1=input('enter the sequence x(n)=');
e1=sum(abs(z1).^2);
disp('energy of given sequence is');e1
% program for power of a sequence
p1= (sum(abs(z1).^2))/length(z1);
disp('power of given sequence is');p1
```

OUTPUT:-

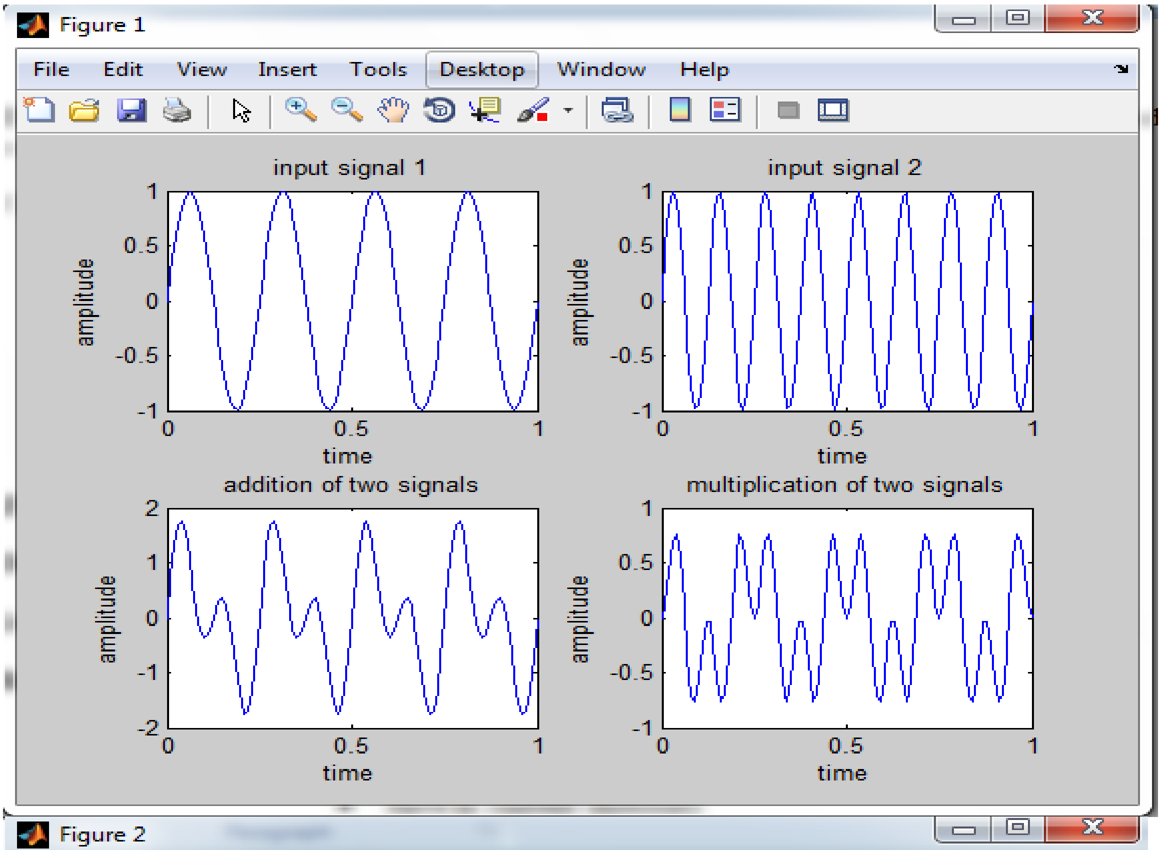


Figure 1
File Edit View Insert Tools Desktop Window Help
input signal 1
amplitude
time
input signal 2
amplitude
time
addition of two signals
amplitude
time
multiplication of two signals
amplitude
time
1
0.5
0
-0.5
-1
2
-2
0
0.5
1

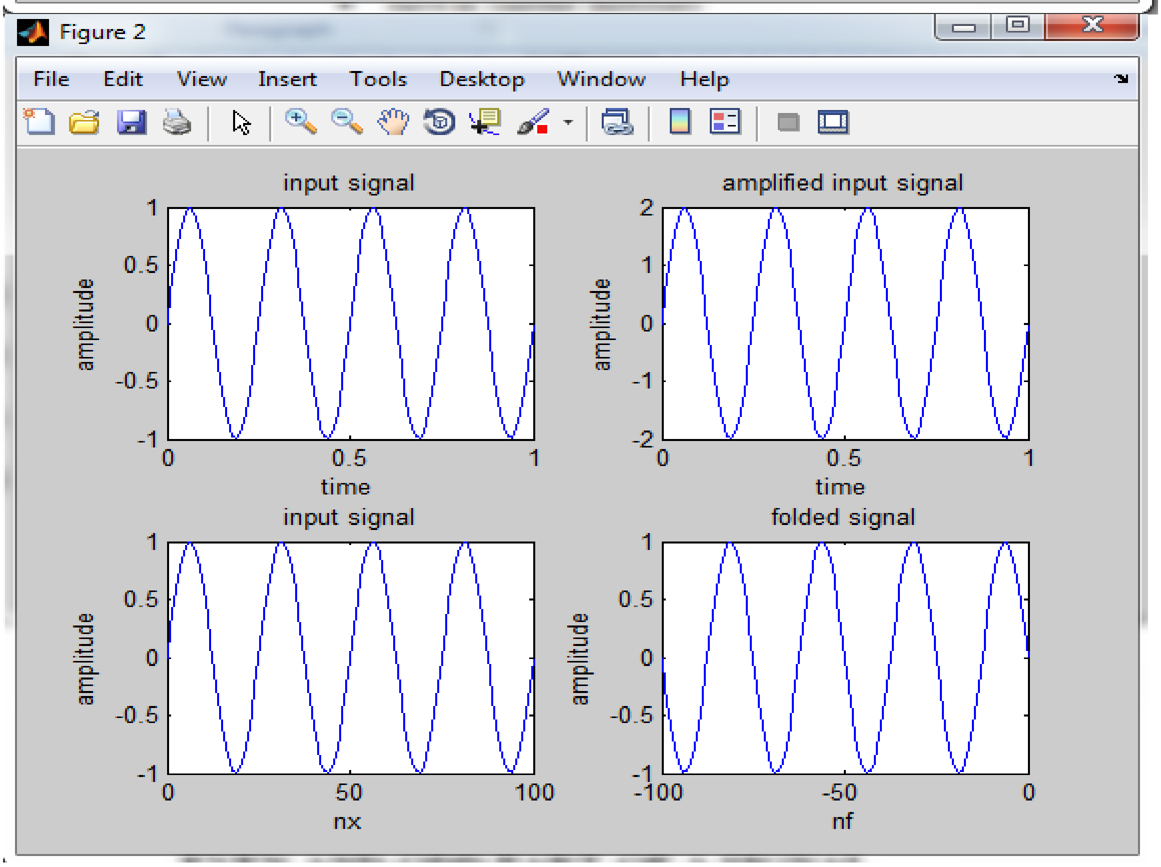
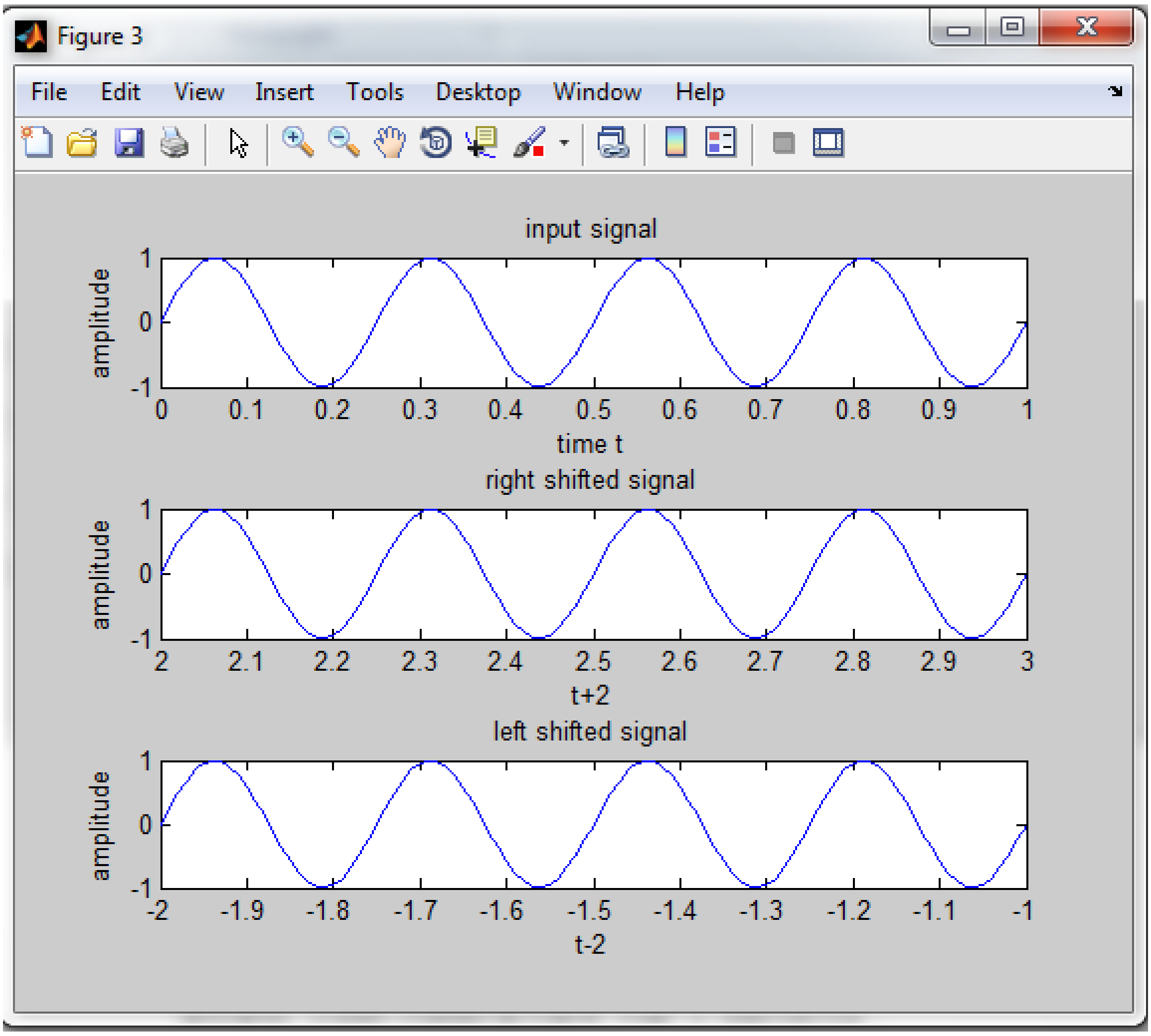


Figure 2
File Edit View Insert Tools Desktop Window Help
input signal
amplitude
time
amplified input signal
amplitude
time
input signal
amplitude
nx
folded signal
amplitude
nf
1
0.5
0
-0.5
-1
2
-2
0
0.5
1
50
100
-100
-50



```
enter the sequence x(n)=[2 -1.1 3.4 5.5 7 8.9 -0.5 2.1 5.5]
energy of given sequence is

e1 =   210.1400

power of given sequence is

p1 =  23.3489
```

RESULT: -Thus the MATLAB Program to perform various operations on signals has been executed.

Experiment No -4

EVEN AND ODD PART OF A SIGNAL

AIM: - Write a MATLAB program to plot even and odd parts of a signal.

SOFTWARE REQURIED :- MATLAB R2014a

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PROCEDURE:-

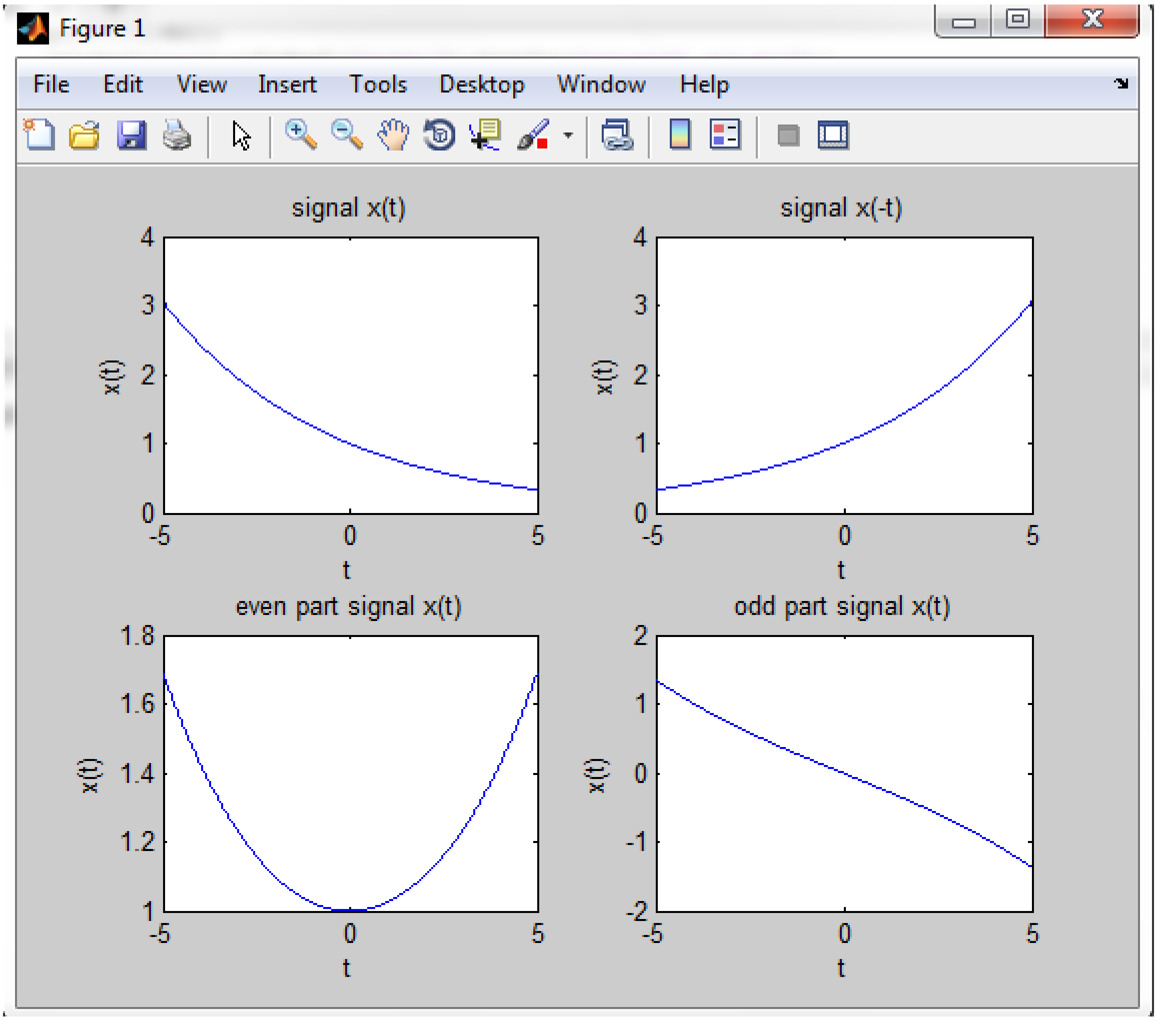
- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/ Figure window

PROGRAM:-

```
clc;
clear all;
close all;
t=-5:0.001:5;
A=0.8;
x1=A.^(t);
x2=A.^(-t);
if(x2==x1)
disp('The given signal is even signal');
else
if(x2==(-x1))
     disp('The given signal is odd signal');
else
     disp('The given signal is neither even nor odd');
end
end
xe=(x1+x2)/2;
xo=(x1-x2)/2;
subplot(2,2,1);
plot(t,x1);
xlabel('t');ylabel('x(t)');title('signal x(t)');
subplot(2,2,2);
plot(t,x2);
xlabel('t');ylabel('x(t)');title('signal x(-t)');
subplot(2,2,3);
plot(t,xe);
xlabel('t');ylabel('x(t)');title('even part signal x(t)');
subplot(2,2,4);
plot(t,xo);
xlabel('t');ylabel('x(t)');title('odd part signal x(t)');
```

OUTPUT:-

The given signal is neither even nor odd



RESULT:- Thus the MATLAB program to plot even and odd parts of the given signal has been executed.

Experiment No -5

CONVOLUTION OF TWO SEQUENCES

AIM: - Write a MATLAB program to find and plot the convolution of two sequences.

SOFTWARE REQURIED :- MATLAB R2014a

.

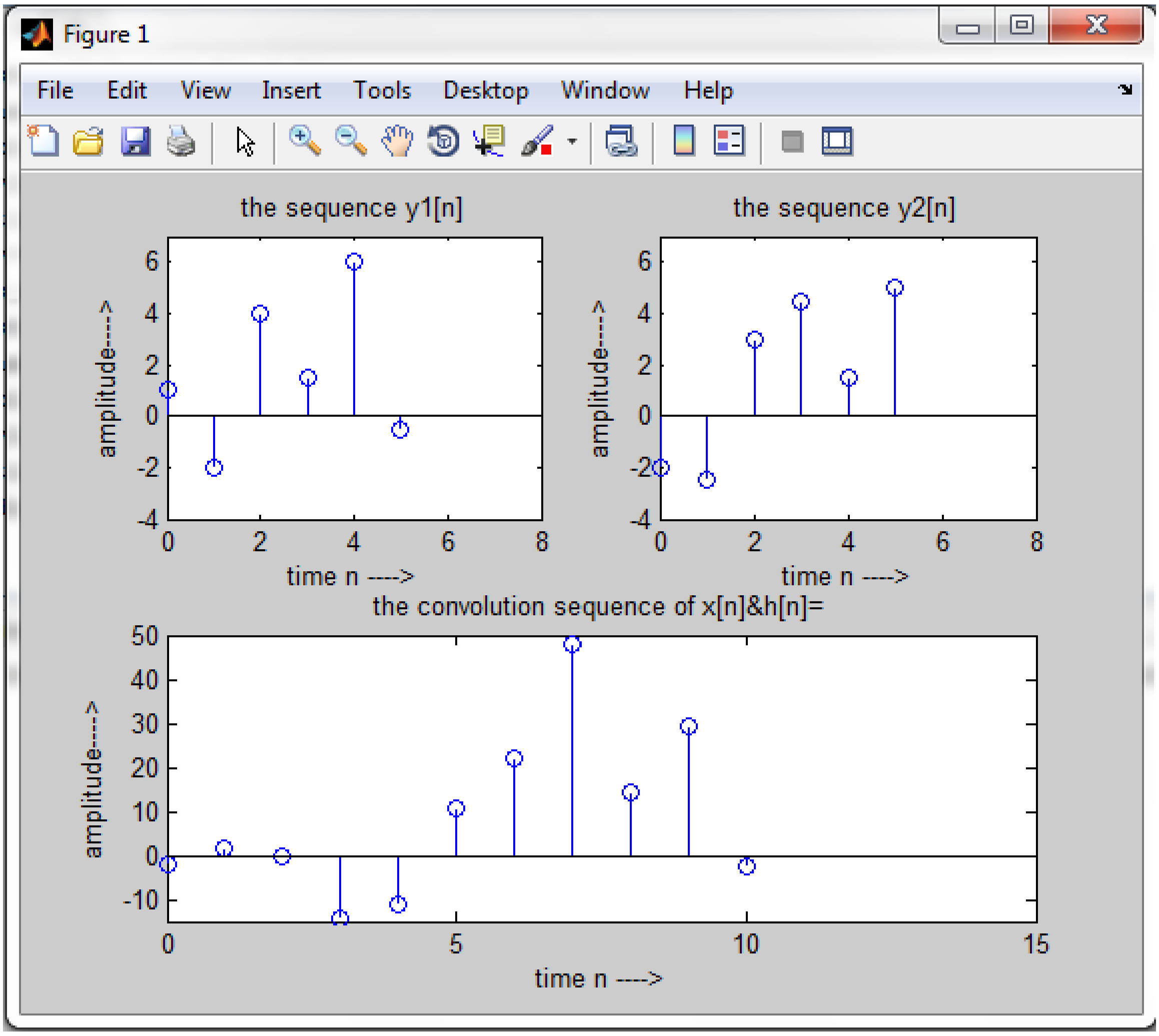
PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/Figure window

PROGRAM:-

```
clc;
clear all;
close all;
x=[1 -2 4 1.5 6 -0.5] ;
subplot(2,2,1);
stem(0:length(x)-1,x);
axis([0 8 -4 7]);
xlabel('time n ---->');
ylabel('amplitude---->');
title('the sequence y1[n]')
h=[-2 -2.5 3 4.5 1.5 5];
subplot(2,2,2);
stem(0:length(h)-1,h);
axis([0 8 -4 7]);
xlabel('time n ---->');
ylabel('amplitude---->');
title('the sequence y2[n]')
y=conv(x,h);
subplot(2,2,[3,4]);
stem(0:length(y)-1,y);
axis([0 15 -15 50]);
xlabel('time n ---->');
ylabel('amplitude---->');
title('the convolution sequence of x[n]&h[n]=');
```

OUTPUT:-



RESULT:- Thus the MATLAB Program to find and plot the convolution of two sequences has been executed successfully.

Experiment No -06

AUTO-CORRELATION AND CROSS-CORRELATION BETWEEN SIGNALS

AIM: - Write a matlab program to plot autocorrelation and cross correlation between signals.

SOFTWARE REQURIED :- MATLAB R2014a

.**PROCEDURE:**

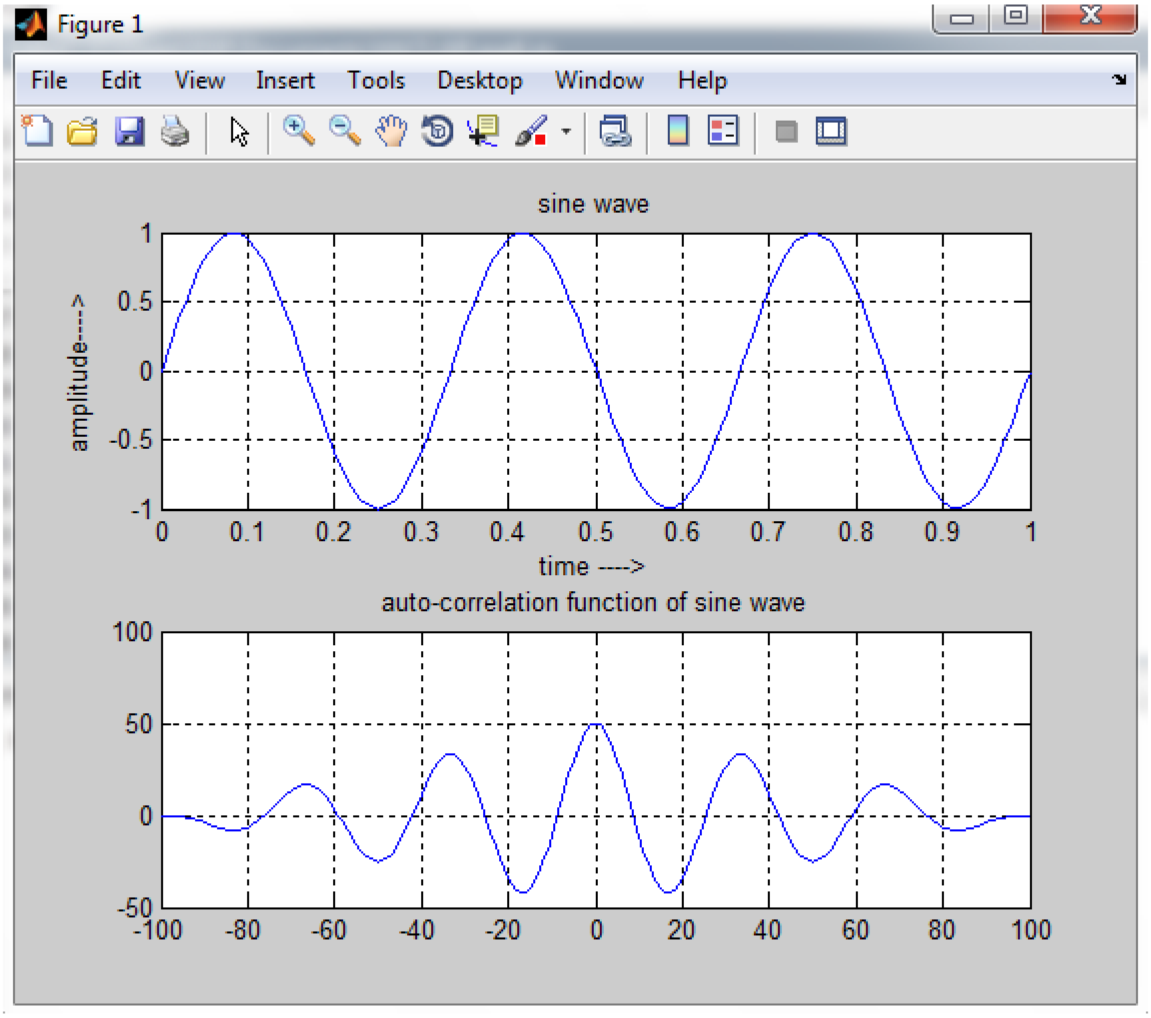
- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/ Figure window

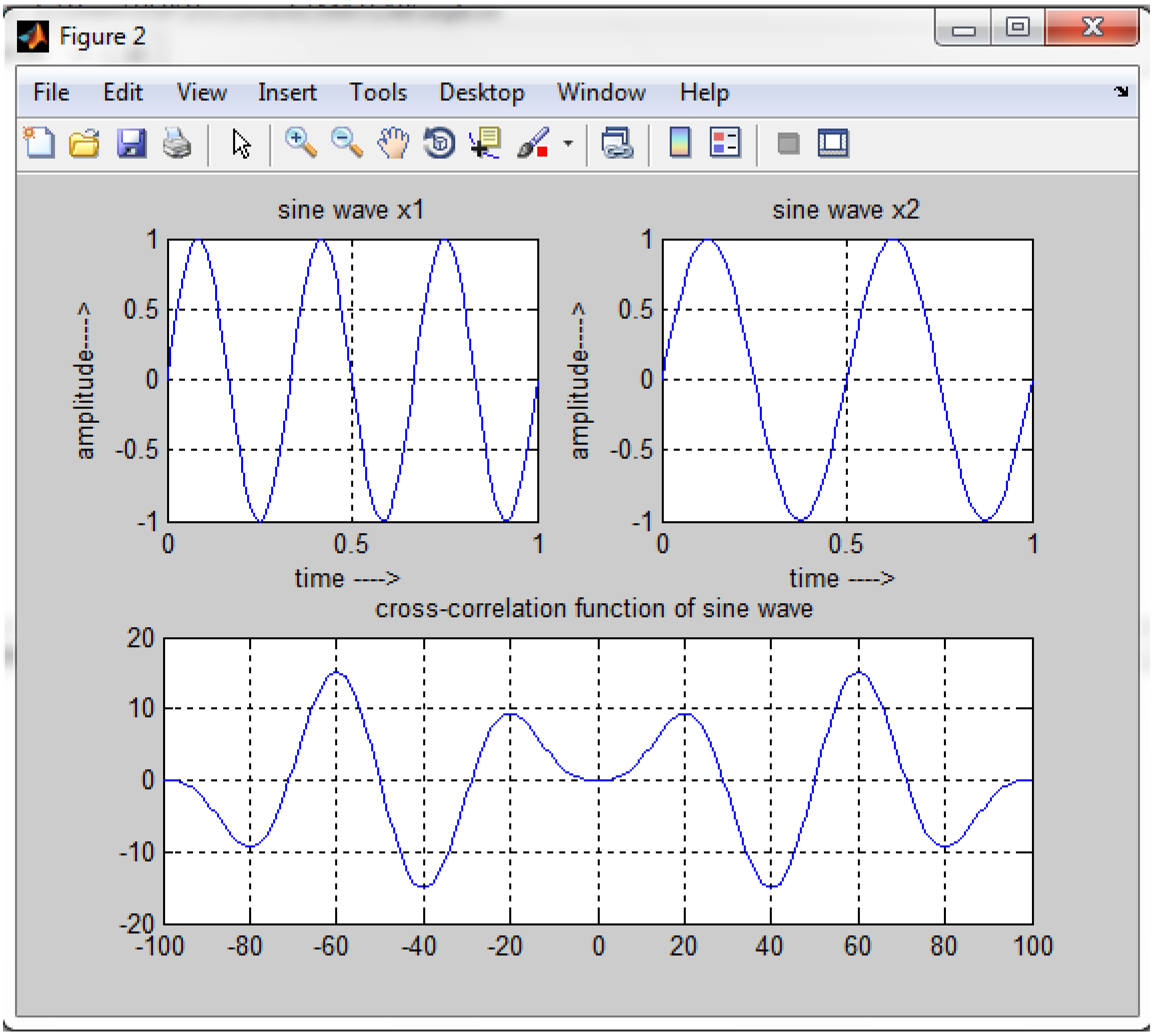
PROGRAM:

```
clc; clear all; close all;
t=0:0.01:1;
f1=3;
x1=sin(2*pi*f1*t);
figure;
subplot(2,1,1);
plot(t,x1);
title('sine wave');
xlabel('time ---->');
 ylabel('amplitude---->');
grid;
[rxx lag1]=xcorr(x1);
subplot(2,1,2);
plot(lag1,rxx);
grid;
title('auto-correlation function of sine wave');
figure;
subplot(2,2,1);
plot(t,x1);
title('sine wave x1');
xlabel('time ---->');
ylabel('amplitude---->');
grid;
f2=2;
x2=sin(2*pi*f2*t);
subplot(2,2,2);
plot(t,x2);
title('sine wave x2');
xlabel('time ---->');,ylabel('amplitude---->');
grid;
[cxx lag2]=xcorr(x1,x2);
subplot(2,2,[3,4]);
plot(lag2,cxx);
```

```
grid;
title('cross-correlation function of sine wave');
```

OUTPUT:





RESULT:- Thus the MATLAB Program to plot auto correlation and cross correlation between signals has been executed.

Experiment No -7(a)

LINEAR SYSTEM OR NON-LINEAR SYSTEM

AIM: - Write a matlab program to verify the given system is linear system or non-linear system.

SOFTWARE REQURIED :- MATLAB R2014a

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/ Figure window

PROGRAM:-

```
clc;
clear all;
close all;
n=0:10;
a1=input('enter the scaling factor a1=');
a2=input('enter the scaling factor a2=');
x1=cos(2*pi*0.1*n);
x2=cos(2*pi*0.4*n);
x3=a1*x1+a2*x2;
%y(n)=n.x(n);
y1=n.*x1;
y2=n.*x2;
y3=n.*x3;
yt=a1*y1+a2*y2;
yt=round(yt);
y3=round(y3);
if y3==yt
disp('given system [y(n)=n.x(n)]is Linear');
else
disp('given system [y(n)=n.x(n)]is non Linear');
end
%y(n)=x(n).^2
x1=[1 2 3 4 5];
x2=[1 4 7 6 4];
x3=a1*x1+a2*x2;
y1=x1.^2;
y2=x2.^2;
y3=x3.^2;
yt=a1*y1+a2*y2;
if y3==yt
disp('given system [y(n)=x(n).^2 ]is Linear');
else
disp('given system is [y(n)=x(n).^2 ]non Linear');
end
```

OUTPUT:-

```
enter the scaling factor a1=2
enter the scaling factor a2=3
given system [y(n)=n.x(n)]is Linear
given system is [y(n)=x(n).^2 ]non Linear
```

RESULT:- Thus the MATLAB Program to verify the given system is linear system or non-linear system has been executed.

Experiment No -07(b)

TIME-INVARIANT OR TIME-VARIANT SYSTEM

AIM: - Write a matlab program to verify the given system is Time-invariant system or Time-variant system.

SOFTWARE REQURIED :- MATLAB R2014a

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/ Figure window

PROGRAM:-

```
% Verification of Time Invariance of a Discrete System
% a)y=x(n)^2(n) b) y=nx(n)
clc;
clear all;
close all;
x=[1 2 3 4 5 6 7 8 9];
n=0:length(x)-1;
d=3; % time delay
xd=[zeros(1,d),x];%x(n-k)
y=x.^2;
yd=[zeros(1,d),y];%y(n-k)
disp('delayed response signal:');disp(yd)
yxd=xd.^2; % T[x(n-k)]
disp('response to delayed input:');disp(yxd)
if yxd==yd;
disp('given system [y(n)=x(n).^2 ]is time invariant');
else
disp('given system is [y(n)=x(n).^2 ]not time invariant');
end
y=n.*x;
yd=[zeros(1,d),y];
disp('delayed response signal');disp(yd);
n1=1:length(xd);
yxd=n1.*xd;
disp('response to delayed input::');disp(yxd);
if yxd==yd;
disp('given system [y(n)=nx(n)]is a time invariant');
else
disp('given system [y(n)=nx(n)]not a time invariant');
end
```

OUTPUT:-

```
delayed response signal:
     0     0     0     1     4     9    16    25    36    49    64    81

response to delayed input:
     0     0     0     1     4     9    16    25    36    49    64    81

given system [y(n)=x(n).^2 ]is time invariant

delayed response signal
     0     0     0     0     2     6    12    20    30    42    56    72

response to delayed input::
     0     0     0     4    10    18    28    40    54    70    88   108

given system [y(n)=nx(n)]not a time invariant
```

RESULT:- Thus the MATLAB Program to verify the system is Time-invariant system or Time-variant system has been executed successfully..

Experiment No -08

IMPULSE RESPONSE AND STEP RESPONSE

AIM: - Write a matlab program to compute the Unit sample, unit step and sinusoidal response of the given LTI system and verify its stability.

SOFTWARE REQURIED :- MATLAB R2014a

.**PROCEDURE:-**

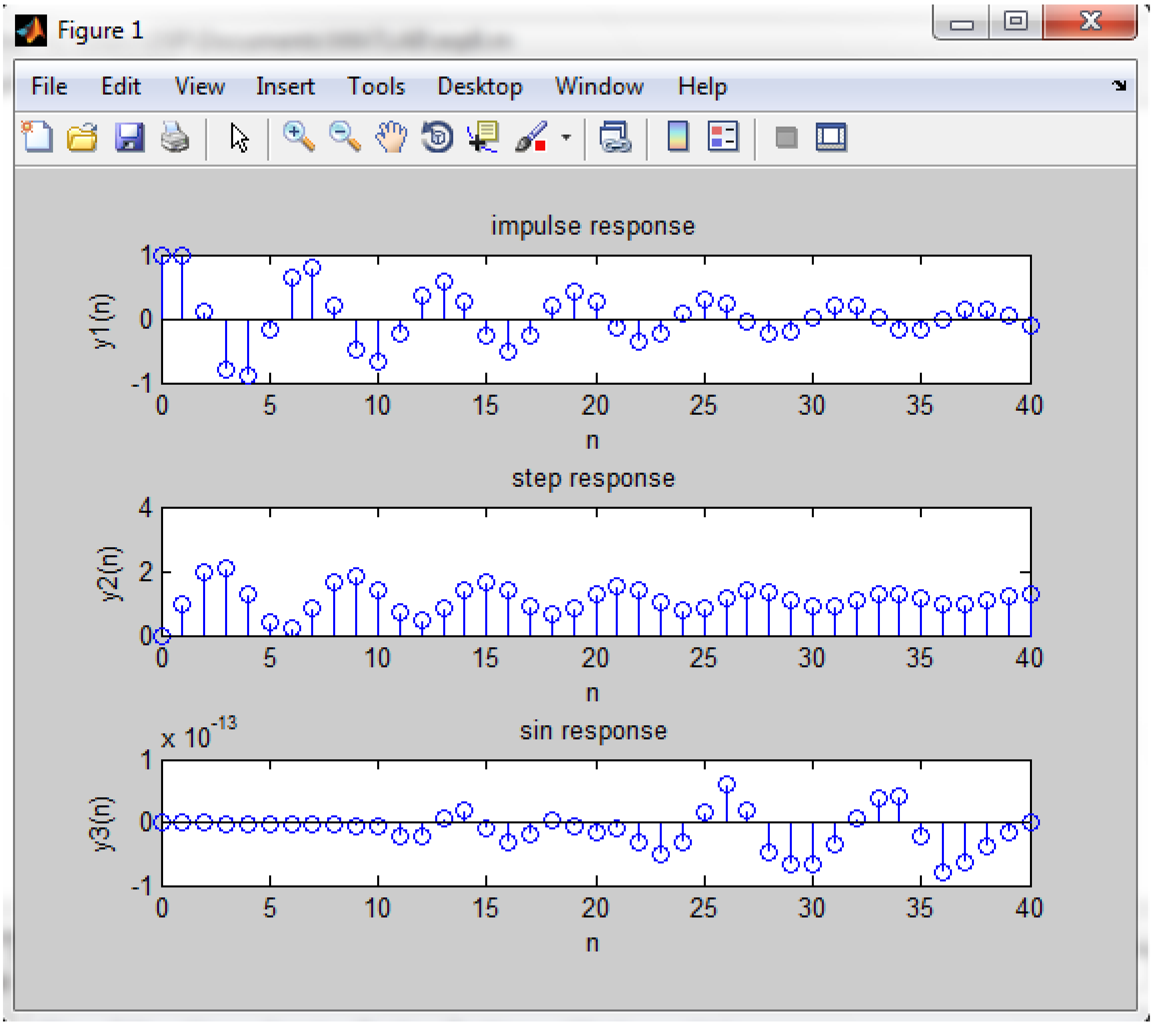
- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window/Figure window

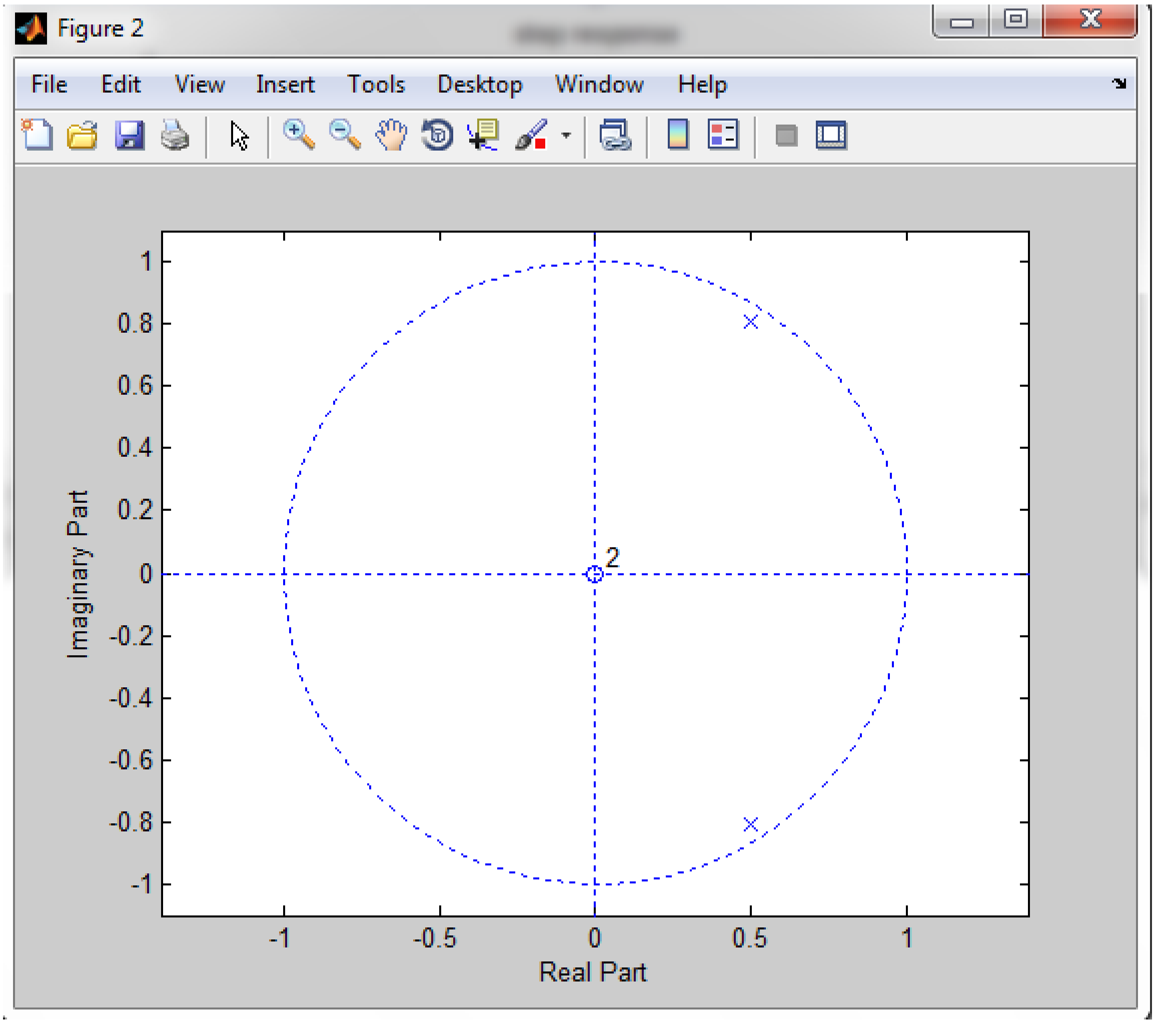
PROGRAM:-

```
%given difference equation y(n)-y(n-1)+.9y(n-2)=x(n);
clc;
clear all;
close all;
b=[1];
a=[1,-1,.9];
n =0:40;
%generating impulse signal
x1=(n==0);
%impulse response
y1=filter(b,a,x1);
subplot(3,1,1);
stem(n,y1);
xlabel('n');
ylabel('y1(n)');
title('impulse response');
%generating step signal
x2=(n>0);
% step response
y2=filter(b,a,x2);
subplot(3,1,2);
stem(n,y2);
xlabel('n');
ylabel('y2(n)')
title('step response');
%generating sinusoidal signal
x3=sin(2*pi*2*n);
% sinusoidal response
y3=filter(b,a,x3);
subplot(3,1,3);
stem(n,y3);
xlabel('n');
ylabel('y3(n)');
title('sin response');
% verifing stability
```

```
figure;
zplane(b,a);
[p z]=pzmap(b,a);
if max(abs(p))>=1
    disp('the given system is not a stable system');
else
    disp('the given system is a stable system');
end;
```

OUTPUT:-





the given system is a stable system

RESULT: -Thus Matlab program to compute the Unit sample, unit step and sinusoidal response of the given LTI system and verify its stability has been executed.

Experiment No -9

GIBBS PHENOMENON

AIM: - Write a MATLAB program to demonstrate Gibbs phenomenon.

SOFTWARE REQURIED :- MATLAB R2014a

.**PROCEDURE:-**

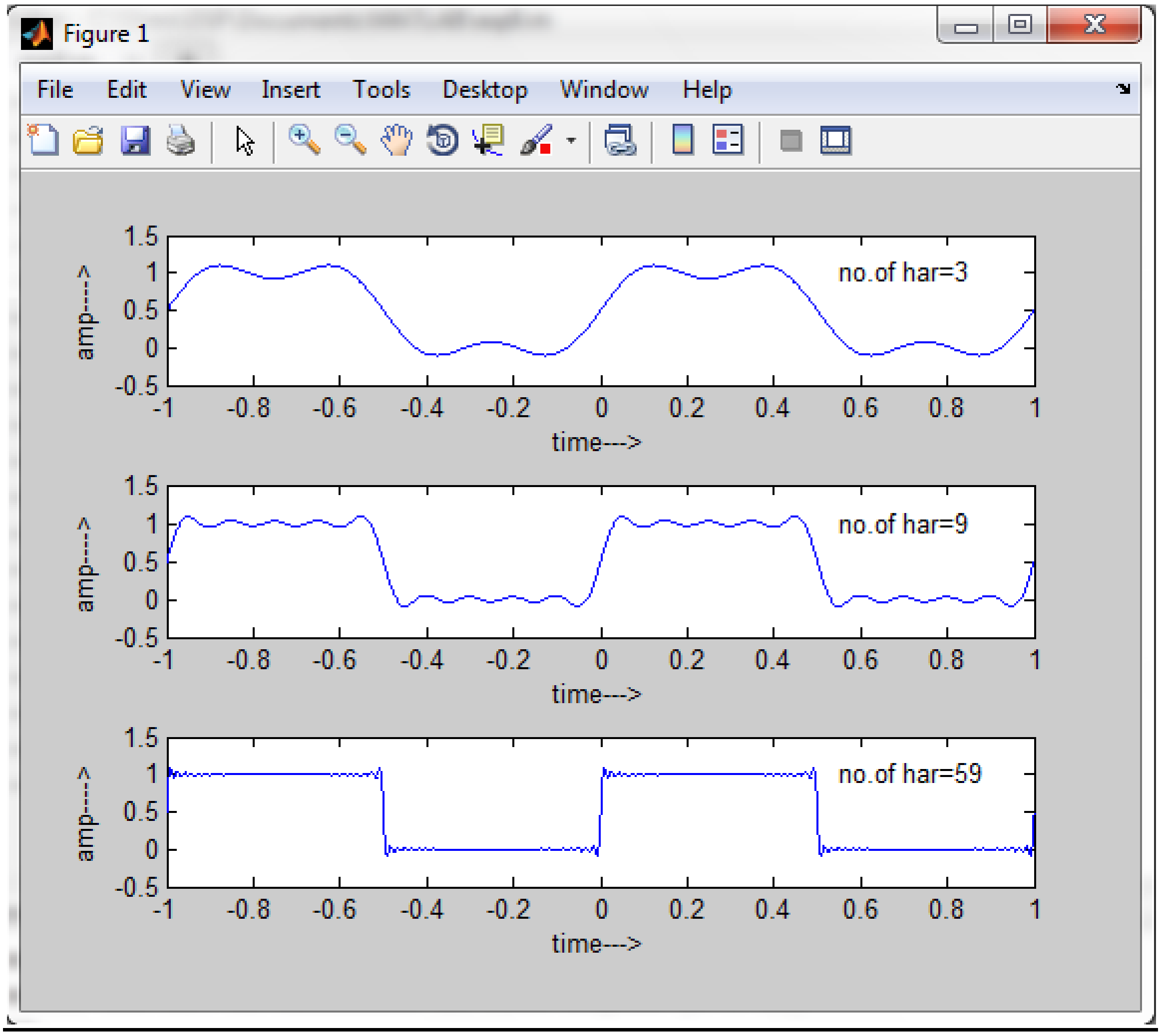
- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:-

```
clc;
clear all;
 close all;
N=input('enter the no. of signals to reconstruct=');
n_har=input('enter the no. of harmonics in each signal=');
t=-1:0.001:1;
omega_0=2*pi;
for k=1:N
    x=0.5;
for n=1:2:n_har(k)
b_n=2/(n*pi);
        x=x+b_n*sin(n*omega_0*t);
end
    subplot(N,1,k);
    plot(t,x);
    xlabel('time--->');
    ylabel('amp---->');
    axis([-1 1 -0.5 1.5]);
    text(0.55,1.0,['no.of har=',num2str(n_har(k))]);
end
```

OUTPUT:-

```
enter the no. of signals to reconstruct=3
enter the no. of harmonics in each signal=[3 9 59]
```



RESULT:- Thus Gibbs phenomenon have been demonstrated using MATLAB.

Experiment no -10

MAGNITUDE AND PHASE SPECTRUM OF FOURIER TRANSFORM

AIM: -.Write a MATLAB to find Fourier transform of the given signal and to plot its magnitude and phase spectrum.

SOFTWARE REQURIED :- MATLAB R2014a

PROCEDURE:-

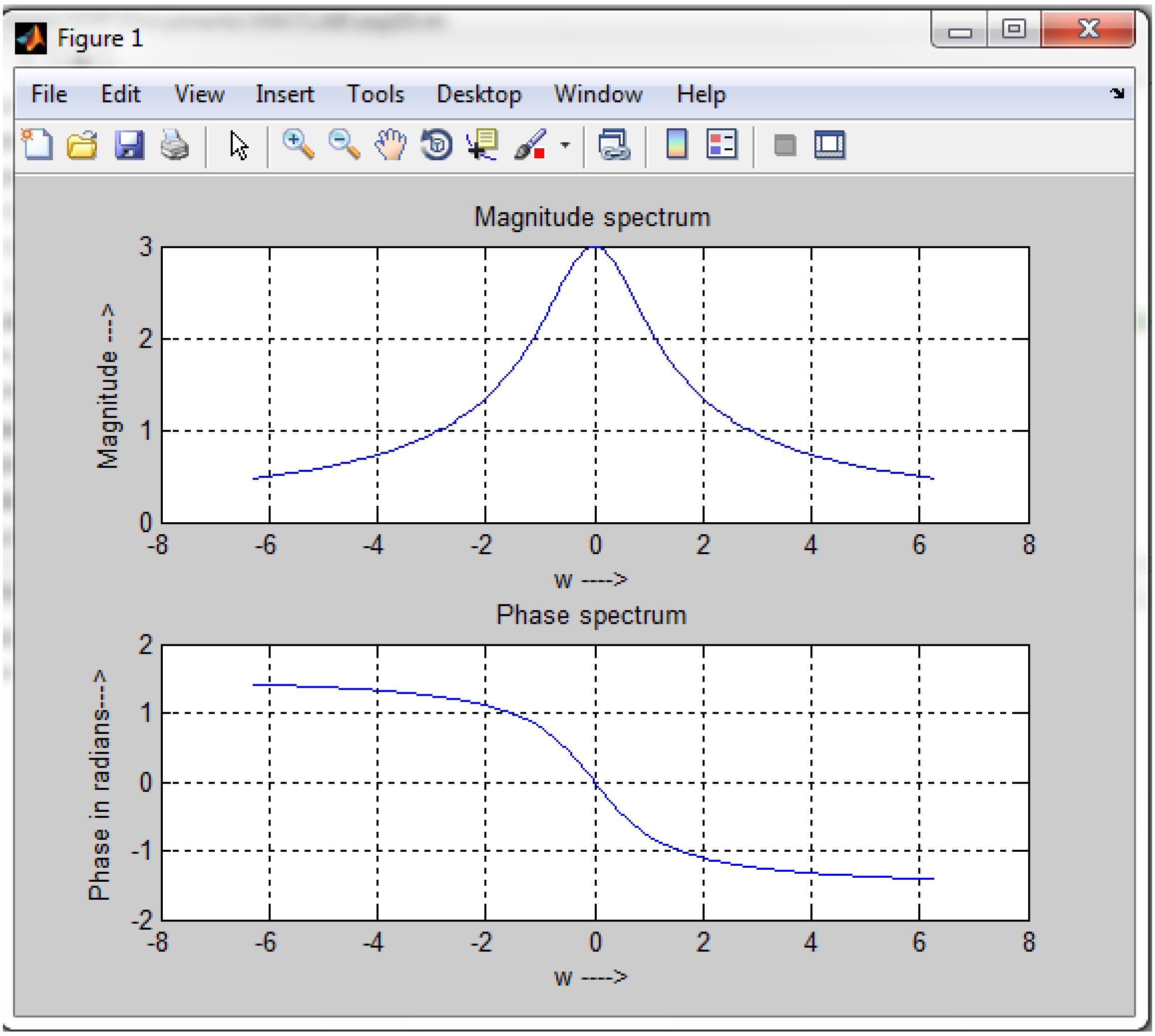
- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:-

```
clc; clear all; close all;
syms t s ;
syms w float;
f=3*exp(-t)*heaviside(t);           % given function
F=fourier(f);                      % to find Fourier Transform
disp('the fourier transform of 3*exp(-t)*u(t) =');
disp(F);                      % to display the result in the command window
w=-2*pi:pi/50:2*pi;
F1=subs(F,w);              % substitute w in F function
Fmag=abs(F1);              % to find magnitude
Fphas=angle(F1);         % to find phase
subplot(2,1,1);
plot(w,Fmag);
xlabel('w ---->');
ylabel('Magnitude --->');
title('Magnitude spectrum');
grid;
subplot(2,1,2);
plot(w,Fphas);
xlabel('w ---->');
ylabel('Phase in radians--->');
title('Phase spectrum');
grid;
```

OUTPUT:-

```
the fourier transform of 3*exp(-t)*u(t) =
 3/(w*i + 1)
```



RESULT: -Thus MATLAB program to find Fourier transform and plot its magnitude and Phase spectrums has been executed.

Experiment no -11

LAPLACE TRANSFORM

AIM: -.MATLAB program to plot the given waveform using waveform synthesis method by applying Laplace transform.

SOFTWARE REQURIED :- MATLAB R2014a

.

PROCEDURE:-

- Open MATLAB Software
- Open new M-file
- Type the program
- Save in current directory
- Run the program
- For the output see command window/ Figure window.

PROGRAM:-

```
clc;
close all;
syms s;
F =(1/(s^2))*(1-exp(-s)-(1/2)*exp(-3*s)+(1/2)*exp(-5*s));
f=ilaplace(F);
pretty(simplify(f))
ezplot(f,[0,5]);
grid;
```

OUTPUT:-

```
                                  heaviside(t - 3) (t - 3)    heaviside(t - 5) (t - 5)
t - heaviside(t - 1) (t - 1)   -   ------------------------ +  ------------------------
                                              2                          2
```

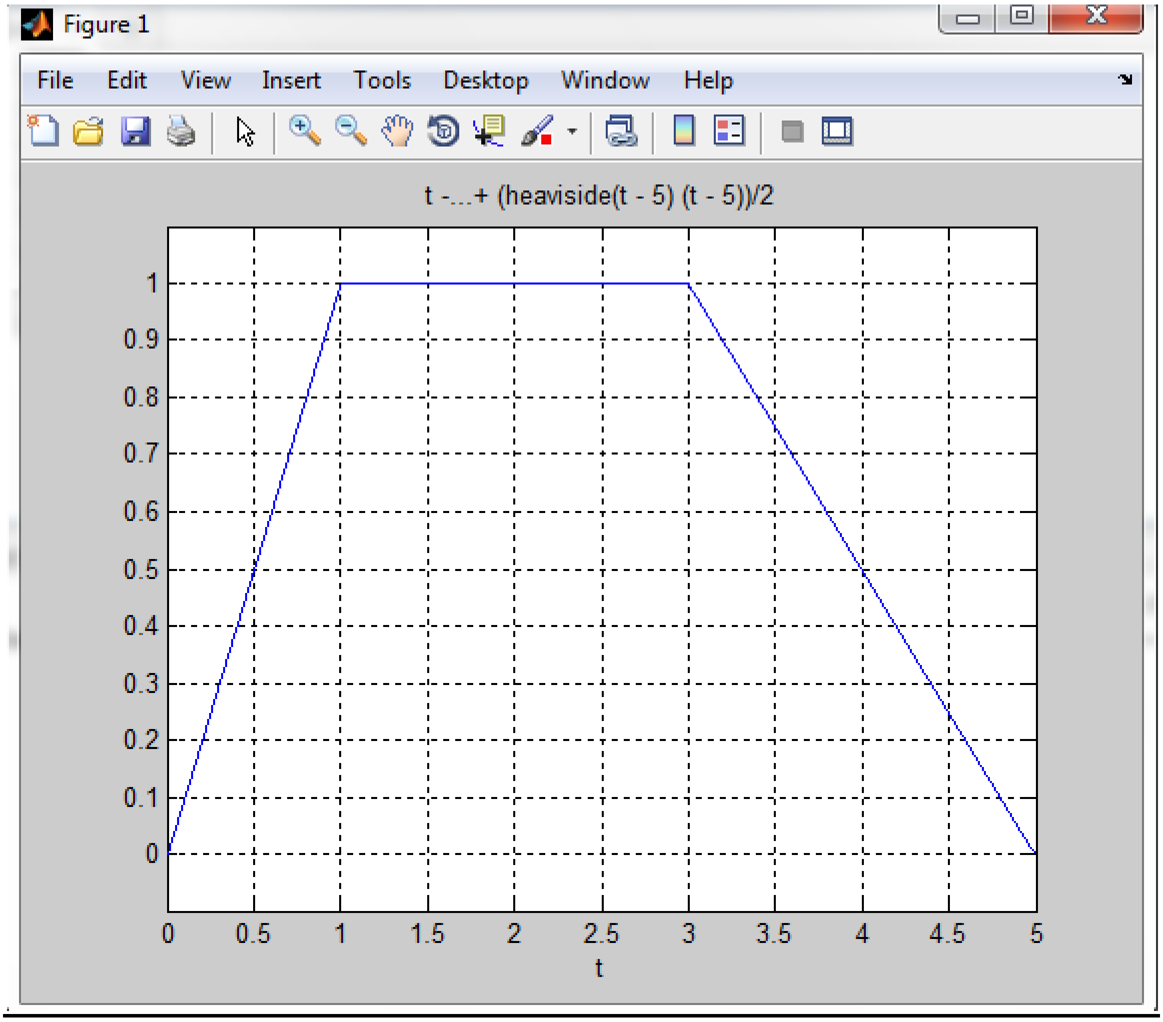


Figure 1
File Edit View Insert Tools Desktop Window Help
t -...+ (heaviside(t - 5) (t - 5))/2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
t

RESULT: - Thus the MATLAB program to plot waveform using waveform synthesis method by applying Laplace Transform has been executed.

Experiment No -12(a)

ZEROS AND POLES IN S- PLANE

AIM: -.Write a MATLAB program to plot Poles and Zeros in S-Plane

SOFTWARE REQURIED :- MATLAB R2014a

.

PROCEDURE:-

- Open MATLAB Software
- Open new M-file
- Type the program
- Save in current directory
- Run the program
- For the output see command window\ Figure window.

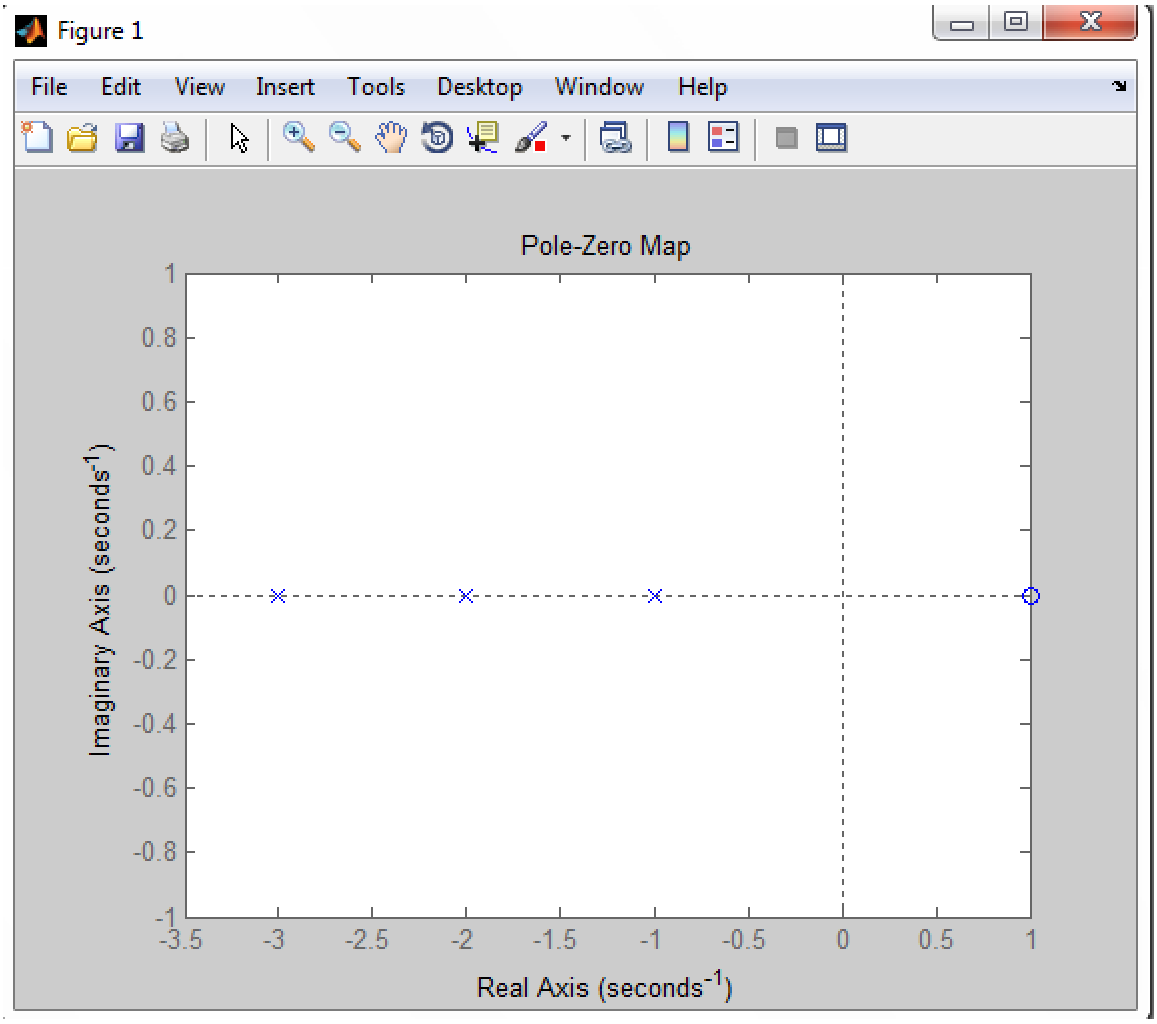
PROGRAM:-

```
clc; clear all; close all;
num=input('enter the numerator polynomial vector\n');    % [1 -2 1]
den=input('enter the denominator polynomial vector\n');    % [1 6 11 6]
H=tf(num,den)
[p z]=pzmap(H);
disp('zeros are at ');
disp(z);
disp('poles are at ');
disp(p);
pzmap(H);
if max(real(p))>=0
    disp(' All the poles do not lie in the left half of S-plane ');
    disp(' the given LTI systen is not a stable system ');
else
    disp('All the poles lie in the left half of S-plane ');
    disp(' the given LTI systen is a stable system ');
end;
```

OUTPUT:-

```
enter the numerator polynomial vector
[1 -2 1]
enter the denominator polynomial vector
[1 6 11 6]


H =

     s^2 - 2 s + 1
  ----------------------
  s^3 + 6 s^2 + 11 s + 6

Continuous-time transfer function.
```

```
zeros are at
     1
     1

poles are at
   -3.0000
   -2.0000
   -1.0000

All the poles lie in the left half of S-plane
 the given LTI systen is a stable system
```



RESULTS: -Thus MATLAB program to plot poles and zeros in S-plane has been executed.

Experiment no -12(b)

ZEROS AND POLES IN Z- PLANE

AIM: -.To Write a MATLAB program to plot Poles and Zeros in Z-Plane

SOFTWARE REQURIED :-MATLAB R2014a

.

PROCEDURE:-

- Open MATLAB Software
- Open new M-file
- Type the program
- Save in current directory
- Run the program
- For the output see command window/ Figure window.

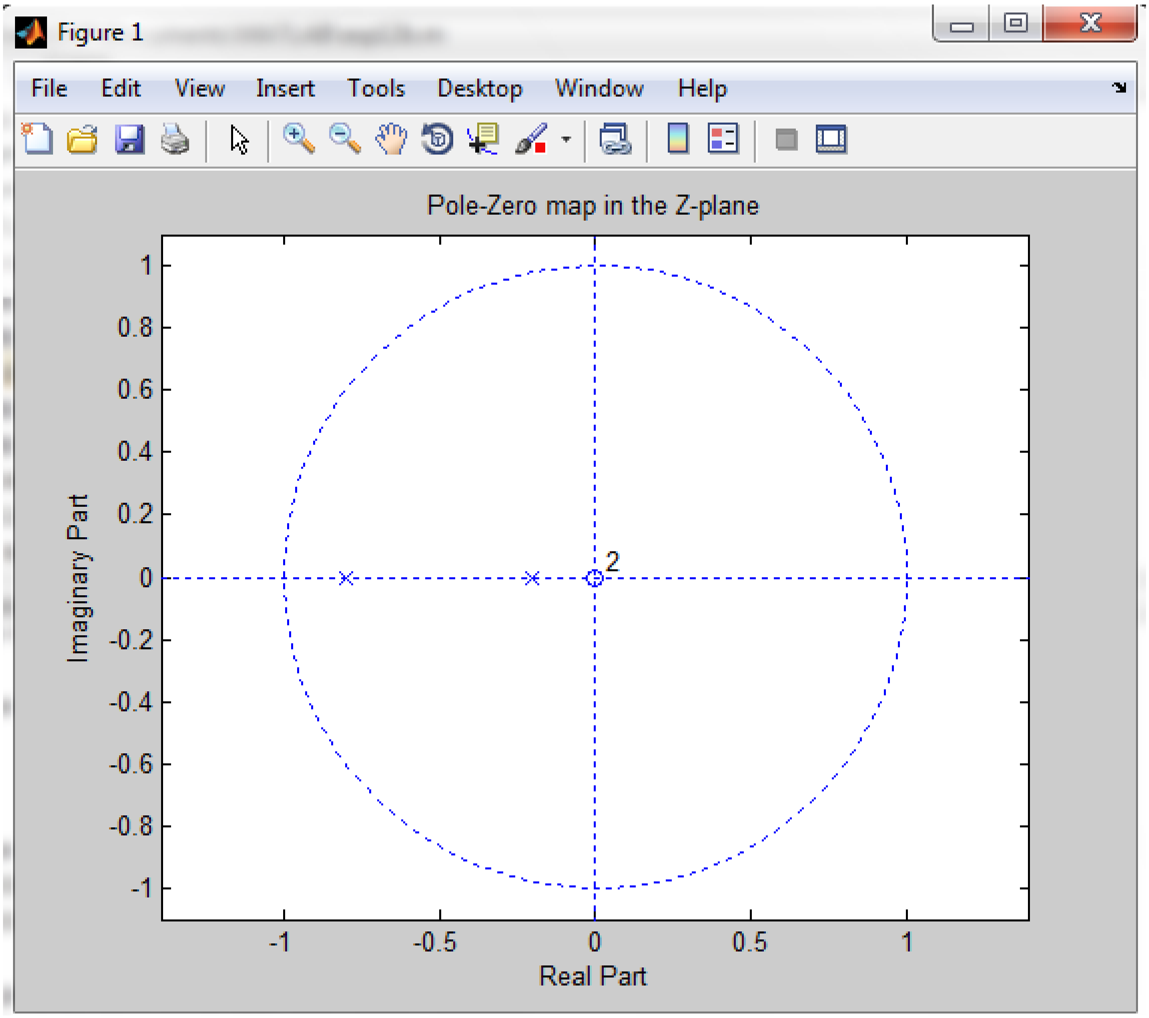
PROGRAM:-

```
clc; clear all; close all;
num=input('enter the numerator polynomial vector \n'); %[1 0 0]
den=input('enter the denominator polynomial vector \n');%[1 1 0.16]
H=filt(num,den)
z=zero(H);
disp('the zeros are at ');
disp(z);
[r p k]=residuez(num,den);
disp('the poles are at ');
disp(p);
zplane(num,den);
title('Pole-Zero map in the Z-plane');
if max(abs(p))>=1
    disp('all the poles do not lie with in the unit circle');
    disp('hence the system is not stable');
else
    disp('all the poles lie with in the unit circle');
    disp('hence the system is stable');
end;
```

OUTPUT:-

```
enter the numerator polynomial vector
[1 0 0]
enter the denominator polynomial vector
[1 1 0.16]


H =

        1
  --------------------
  1 + z^-1 + 0.16 z^-2
```

```
Sample time: unspecified
Discrete-time transfer function.

the zeros are at
     0
     0

the poles are at
   -0.8000
   -0.2000

all the poles lie with in the unit circle
hence the system is stable
```



RESULTS: -Thus the MATLAB program to plot poles and zeros in z-plane has been executed.

Experiment no -13

GAUSSIAN NOISE

AIM: -.Write a MATLAB program to generate a Gaussian noise and compute its Mean, Mean Square Value, Skew, Kurtosis and to plot Probability Density function.

SOFTWARE REQURIED :- MATLAB R2014a
.
PROCEDURE:-

- Open MATLAB Software
- Open new M-file
- Type the program
- Save in current directory
- Run the program
- For the output see command window\ Figure window.

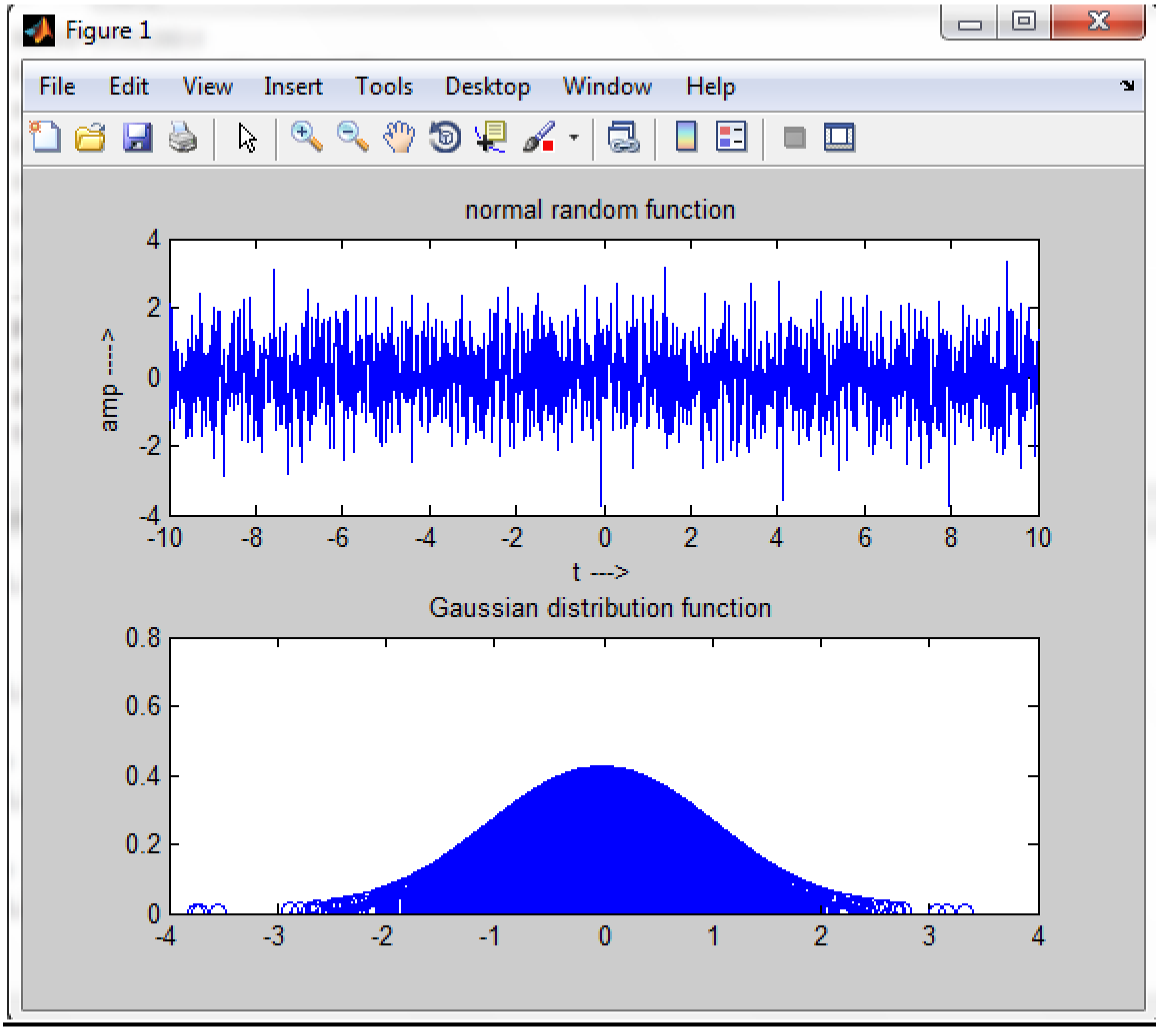
PROGRAM:-

```
clc; clear all; close all;
t=-10:0.01:10;
L=length(t);
n=randn(1,L);
subplot(2,1,1);
plot(t,n);
xlabel('t --->'),ylabel('amp ---->');
title('normal random function');
nmean=mean(n);
disp('mean=');disp(nmean);
nmeansquare=sum(n.^2)/length(n);
disp('mean square=');disp(nmeansquare);
nstd=std(n);
disp('std=');disp(nstd);
nvar=var(n);
disp('var=');disp(nvar);
nskew=skewness(n);
disp('skew=');disp(nskew);
nkurt=kurtosis(n);
disp('kurt=');disp(nkurt);
p=normpdf(n,nmean,nstd);
subplot(2,1,2);
stem(n,p)
title('Gaussian distribution function');
```

OUTPUT:-

```
mean=    -0.0146

mean square=     0.9862
```

```
std=     0.9932

var=     0.9865

skew=     0.0155

kurt=     3.0762
```



RESULTS: -Thus Matlab program to generate Gaussian noise and compute its Mean, Mean Square Value,Skew, Kurtosis and to plot its Probability density function has been executed successfully.

Experiment No -14

SAMPLING THEOREM

AIM: -.Write a MATLAB Program to verify sampling theorem**.**

SOFTWARE REQURIED :-MATLAB R2014a

.

PROCEDURE:-

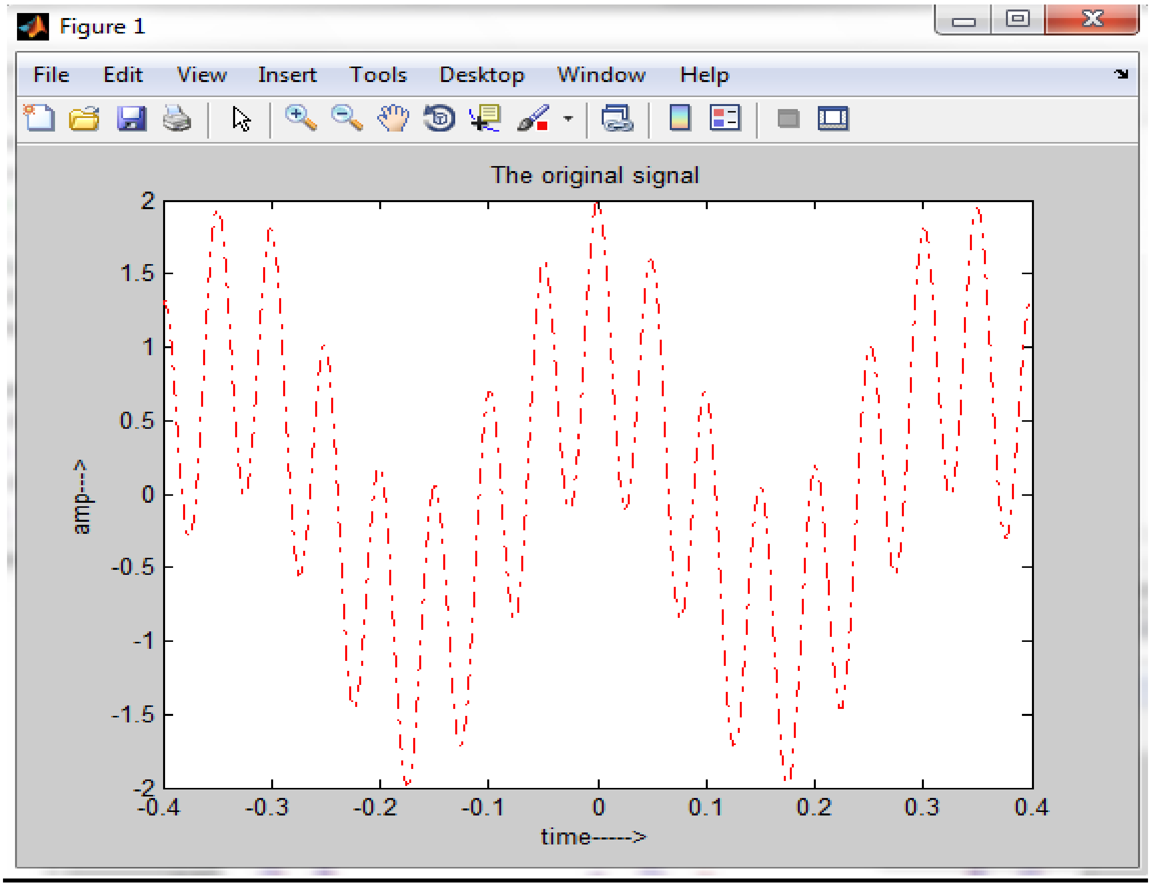
- Open MATLAB Software
- Open new M-file
- Type the program
- Save in current directory
- Run the program
- For the output see command window/ Figure window.

PROGRAM:-

```
clc;
close all;
clear all;
f1=3;
f2=20;
t=-0.4:0.0001:0.4;
x=cos(2*pi*f1*t)+cos(2*pi*f2*t);
figure(1);
plot(t,x,'-.r');
xlabel('time----->');
ylabel('amp--->');
title('The original signal');
%case 1: (fs<2fm)
fs1=1.4*f2;
ts1=1/fs1;
t1=-0.4:ts1:0.4;
xs1=cos(2*pi*f1*t1)+cos(2*pi*f2*t1);
figure(2);
plot(t1,xs1);
hold on;
plot(t,x,'-.r');
hold off;
legend('fs<2fm');
%case 2: (fs=2fm)
fs2=2*f2;
ts2=1/fs2;
t2=-0.4:ts2:0.4;
xs2=cos(2*pi*f1*t2)+cos(2*pi*f2*t2);
figure(3);
plot(t2,xs2);
hold on;
plot(t,x,'-.r');
hold off;
legend('fs=2fm');
%case 3: (fs>2fm)
```

```
fs3=8*f2;
ts3=1/fs3;
t3=-0.4:ts3:0.4;
xs3=cos(2*pi*f1*t3)+cos(2*pi*f2*t3);
figure(4);
plot(t3,xs3);
hold on;
plot(t,x,'-.r');
hold off;
legend('fs>2fm');
```

OUTPUT: -



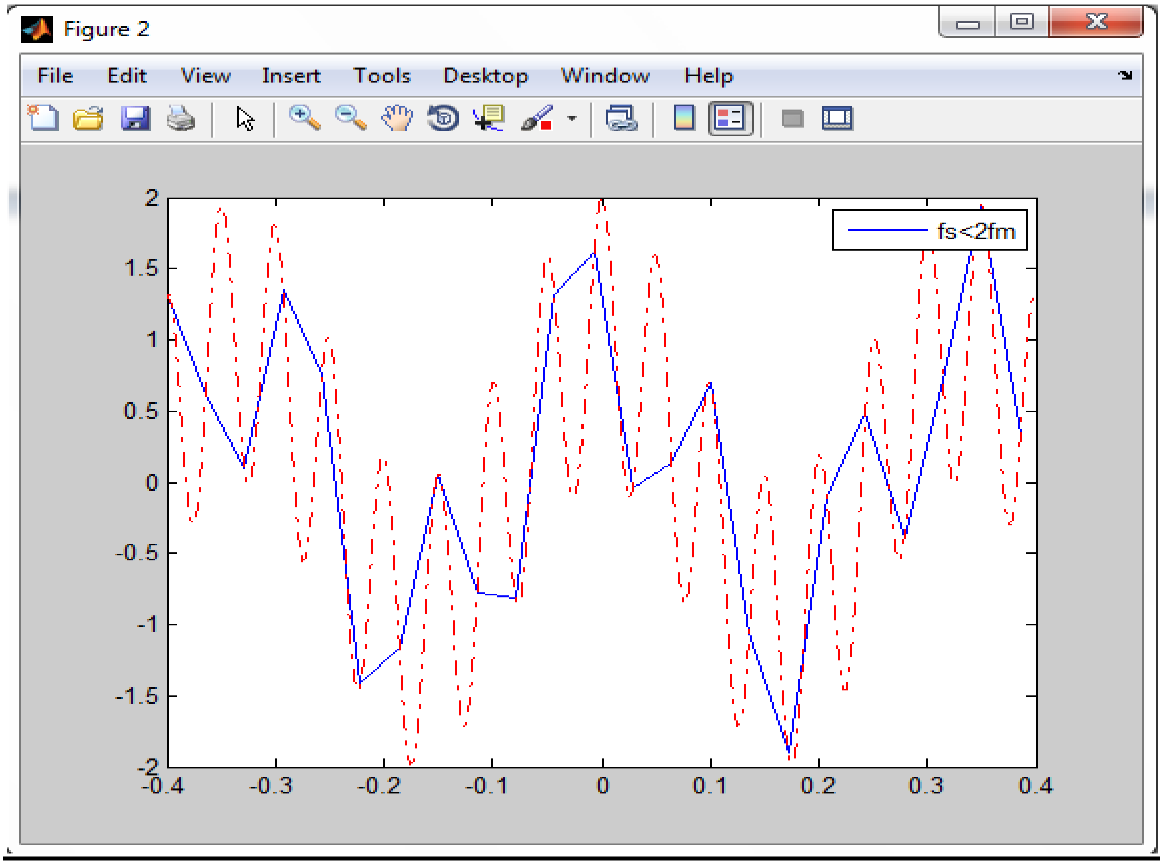


Figure 2
File Edit View Insert Tools Desktop Window Help
fs<2fm
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4

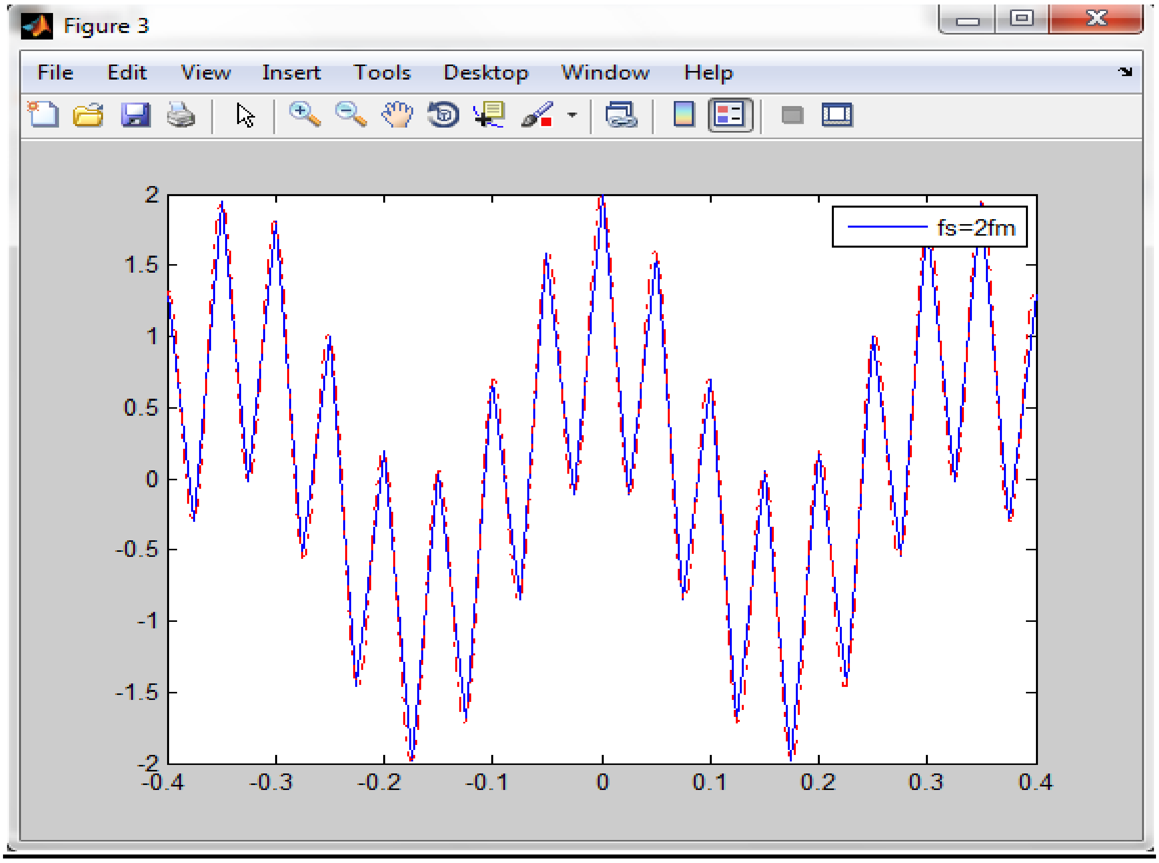
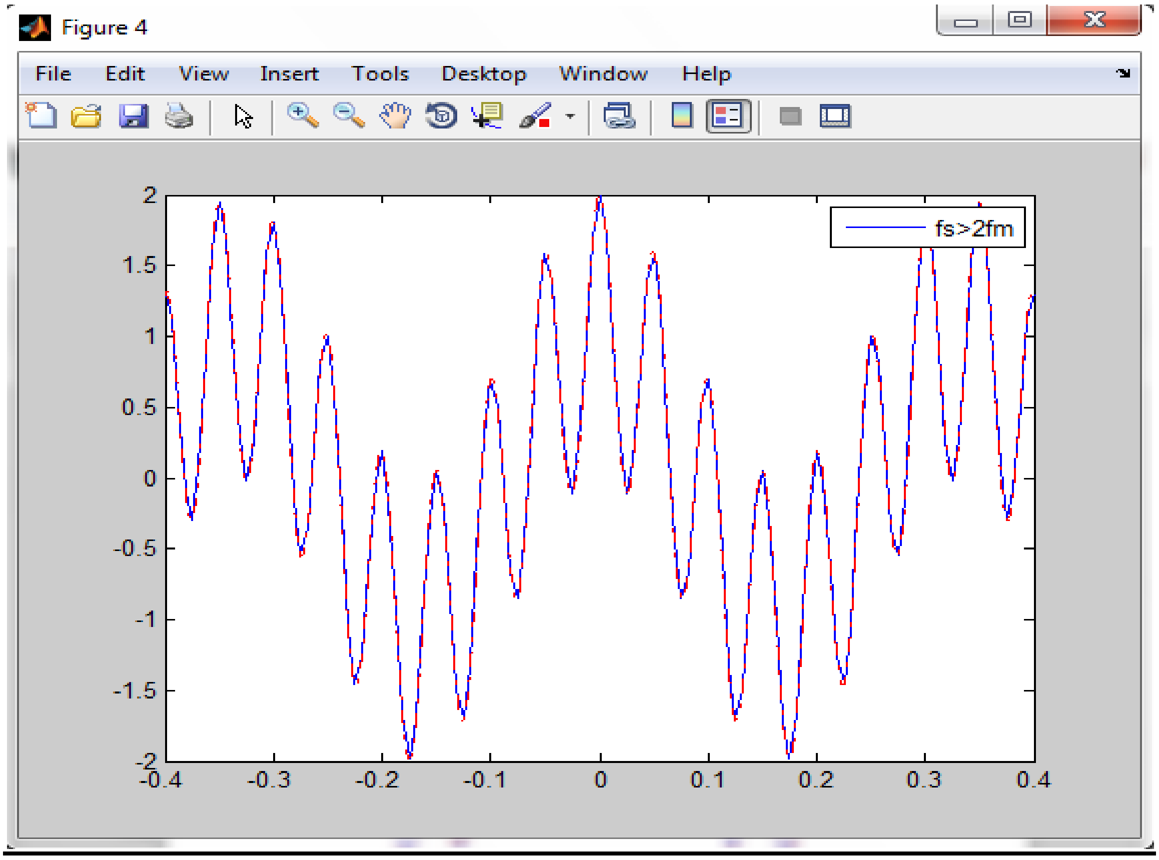


Figure 3
File Edit View Insert Tools Desktop Window Help
fs=2fm
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4



RESULTS:- Thus the MATLAB program to verify Sampling theorem has been executed.

Experiment no -15

Detection of periodic signal masked by noise using correlation

AIM: -.Write a MATLAB program to detect the periodic signal by masked byNoise using Correlation method.

SOFTWARE REQURIED :- MATLAB R2014a

.

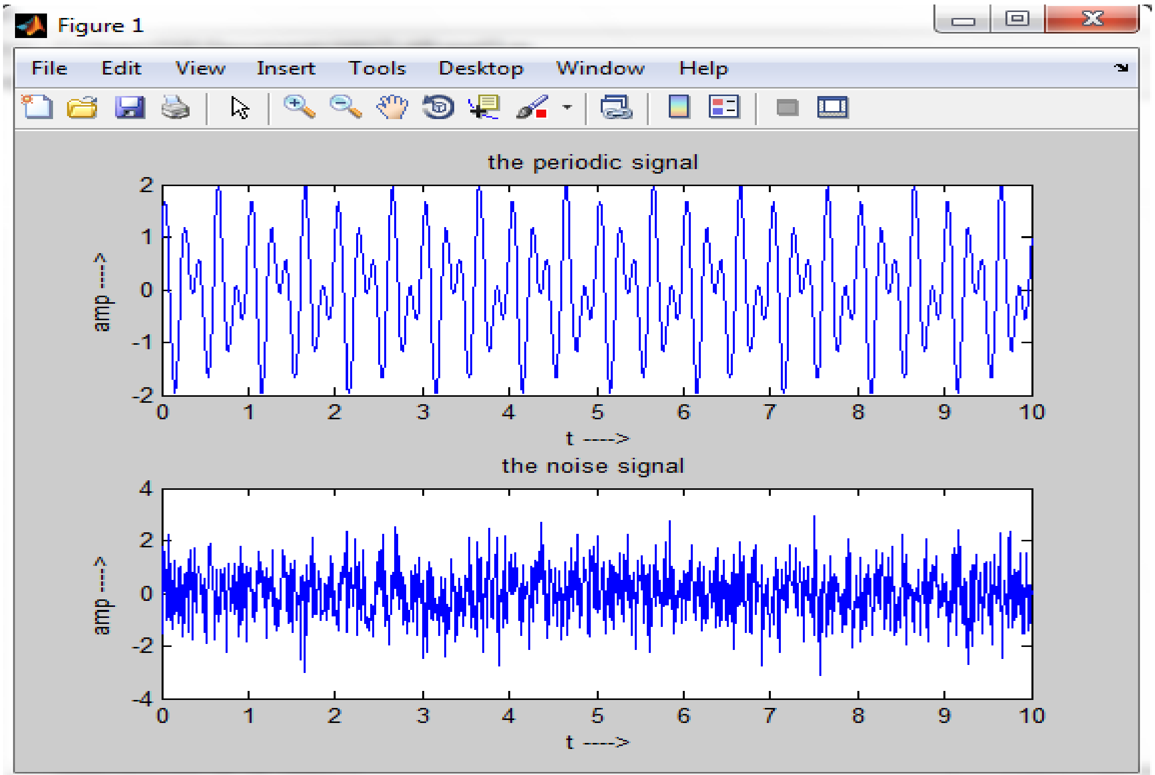
PROCEDURE:-

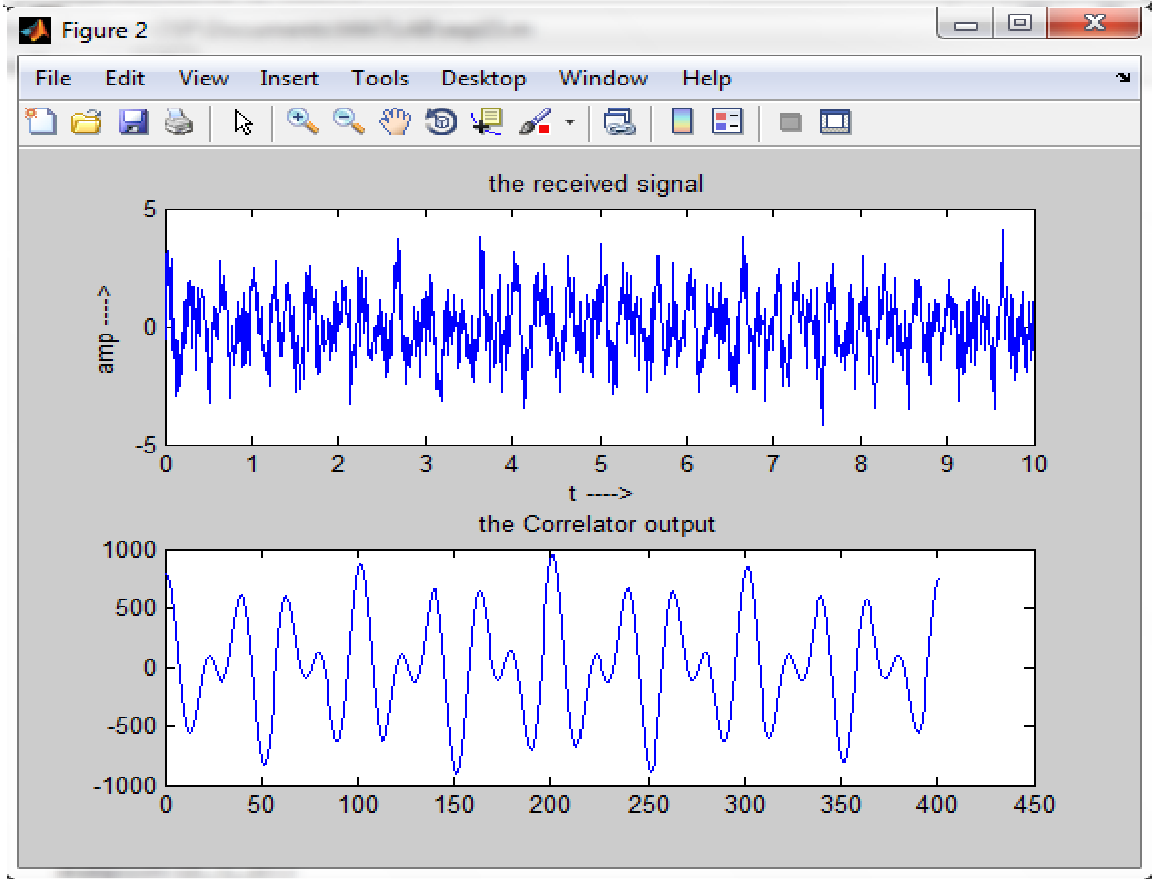
- Open MATLAB Software
- Open new M-file
- Type the program
- Save in current directory
- Run the program
- For the output see command window\ Figure window.

PROGRAM:-

```
clc;
clear all;
close all;
t=0:0.01:10;
s=cos(2*pi*3*t)+sin(2*pi*5*t);  % periodic signal
figure;
subplot(2,1,1);
plot(t,s);
axis([0 10 -2 2]);
xlabel(' t ---->'),ylabel(' amp ----> ');
title('the periodic signal');
L=length(t);
n=randn(1,L);  % noise signal
subplot(2,1,2);
plot(t,n);
xlabel(' t ---->'),ylabel(' amp ----> ');
title('the noise signal');
L=length(t);
f=s+n;  % received signal
figure;
subplot(2,1,1);
plot(t,f);
xlabel(' t ---->'),ylabel(' amp ----> ');
title('the received signal');
rxx=xcorr(f,s,200);
subplot(2,1,2);
plot(rxx);
title('the Correlator output');
```

OUTPUT





RESULTS: - Thus MATLAB Program to detect the periodic signal masked by noise using Auto Correlation and Cross Correlation method has been executed.

Viva Questions with Avswers

1.Define a signal.
A signal is defined as a single-valued function of one or more independent variables which contain some information.

2.What is signal modeling?
The representation of a signal by mathematical expression is known as signal modeling.

3.What is one dimensional signal?
A signal which depends on only one independent variable is called a one dimensional signal.

4.What are the basic operations on signals?
The basic operations on signals are
Time shifting
Time reversal
Time scaling
Amplitude scaling
Signal addition
Signal multiplication

5.How are signals classified?
Signals are classified according to their characteristics. Some of them are:
Continuous- time and discrete-time signals
Deterministic and random signals
Periodic and aperiodic signals
Energy and power signals
Even and odd signals
Causal and non-causal signals

6.Distinguish between deterministic and random signals.
A deterministic signal is a signal exhibiting no uncertainty of its magnitude and phase at any given instant of time. It can be represented by a mathematical equation. Whereas a random signal is a signal characterized by uncertainty about its occurrence. It cannot be represented by a mathematical equation.

7.Distinguish between energy and power signals.
An energy signal is one whose total energy E = finite value and whose average power $P = 0$, whereas a power signal is the one whose average power P = finite value and total energy $E = \infty$.

8.Are all sinusoidal signals periodic?
In the case of continuous-time signals, all sinusoidal signals are periodic. But in the case of discrete-time signals, not all sinusoidal signals are periodic.

9.What is the condition to be satisfied for a discrete-time sinusoidal sequence to be periodic?
For the discrete-time sinusoidal sequence to be periodic, the condition to be satisfied is,
the fundamental frequency ω must be rational multiple of 2π

10.What is an analog signal?

Continuous-time signals are also called analog signals.

11.What are digital signals?

The signals that are discrete in time and quantized in amplitude are called digital signal.

12. Distinguish between causal and non-causal signals.

A continuous-time signal is said to be causal, if x(t) = 0 for t < 0. Otherwise the signal is non-causal.

A discrete-time signal is said to be causal, if x(n) =0 for n< 0, otherwise the signal is non-causal.

13.Do all the signals belong to either energy signal or power signal category?

No, some signals may not correspond to either energy signal type or power signal type. Such signals are neither power signals nor energy signals.

14.Can every signal be decomposed into even or odd parts?

Yes, every signal can be decomposed into even and odd parts.

15. What are the different types of representing discrete-time signals?

There are four different types of representation of discrete-time signals. They are:

Graphical representation

Functional representation

Tabular representation

Sequence representation

16.Define System

A system is defined as a physical device that generates a response or output signal for agiven input signal

17.How are systems classified?

Continuous-time and discrete-time systems

Lumped parameter and distributed parameter systems

Static and dynamic systems

Causal and non-causal systems

Time-invariant and time varying systems

Stable and unstable systems

Invertible and non-invertible system

18.Define Continuous Time system

A continuous time system is a system which transforms continuous-time input signals into continuous-time output signals.

19. Define Discrete Time system

A discrete time system is a system which transforms discrete -time input signals into discrete -time output signals.

20.Define Static System

A static or memory- less system is a system in which the response at any instant is due to present input alone. i.e. for a static or memory-less system, the output at any instant t (or n) depends only on the input applied at that instant t (or n) but not on the past or future values of input.

21.Define Dynamic System

A dynamic or memory system is a system in which the response at any instant depends upon past or future inputs.

22.Define Unstable System

An unstable system is a system which produces an unbounded output for a bounded input.

23.Define Bounded Input Bounded Output Stable System

A bounded input-bounded output stable system is a system which produces a bounded input for every bounded output.

24.Define Linear System

A linear system is a system which obeys the principle of superposition and principle of homogeneity

25.Define Time-invariant System

A time - invariant (or shift-invariant) system is a system whose input / output characteristics do not change with time, i.e. a system for which a time shift in the input results in a corresponding time shift in the output.

26.Define Time-variant System

A time -variant (or shift-invariant) system is a system whose input / output characteristics change with time, i.e. a system for which a time shift in the input does not result in a corresponding time shift in the output.

27. Define Causal System

A causal (or non-anticipative) system is a system whose output at any time t depends onthe present and past values of the input but not on the future inputs.42.

28.Define non-Causal System

A non-causal (anticipative) system is a system whose output at any time t depends on the future inputs

29. What are the conditions for a system to be LTI system?

The conditions for a system to be LTI system are,

i) the system must possesses Linearity and

ii) time invariant property

Linearity:

An LTI system is a system that possesses the important property of superposition that is the output of the system to a weighted sum of inputs is equal to the weighted sum of the outputs corresponding to each of the individual inputs.

Time Invariant:

A system is said to be time-invariant if its input-output characteristics do not change with time.

30. What are the three important classes of transformation methods available for continuous-time systems?

The three important classes of transformation methods available for continuous-time systems are: Fourier series, Fourier transform, Laplace transform.

31. What is generalized Fourier series representation?

Representation of a function x(t) by a set of infinite mutually orthogonal functions is called generalized Fourier series representation.

32. What are the three important classes of Fourier series available?

The three important classes of Fourier series methods available are

Trigonometric form

Cosine form

Exponential form

33. What is Fourier spectrum?

The Fourier spectrum of a periodic signal is a plot of its Fourier coefficients versus frequency ω. It is in two parts: (a) the amplitude spectrum and (b) The phase spectrum. The plot of the amplitude of Fourier coefficients versus frequency is known as the amplitude spectra, and the plot of the phase of

Fourier coefficients versus frequency is known as the phase spectra. The two plots together are known as Fourier frequency of spectra of x(t).

34. What are the limitations of Fourier transform?

The limitations of the Fourier transform are as follows

There are many functions for which the Laplace transform exists, but the Fourier transform does not exist.

It is less powerful than Laplace transform

35. What is the importance of impulse response?

The importance of impulse response of an LTI system is that, the characteristics of anLTI system are completely characterized by its impulse response.

36. Define Impulse Response of a system

The impulse response of a system is defined as:

The output of the system when the input is applied as a unit impulse.Or The inverse Laplace transform (or the inverse Fourier transform) of the transfer function of the system.

37. Define Transfer Function of a system

The ratio of the Laplace transform of the output variable to the Laplace transform ofthe input variable

38. What is signal bandwidth?

The band of frequencies that contain most of the signal energy is known as the bandwidth of the signal.

39. What is system bandwidth?

The bandwidth of a system is defined as the range of frequencies over which the magnitude $|H(\omega)|$ remains within$^1/_{\sqrt{2}}$ times (within 3 dB) of its value at the mid-band

40. What is meant by convolution?

Convolution is a mathematical operation which is used to express the input andoutput relationship of an LTI system.

41. What is meant by correlation?

Correlation is an operation between signals and it gives us the degree of similarity between the two signals. Correlation is of two types: cross correlation and autocorrelation. Cross correlation is a measure of similarity between one signal and time delayed version of another signal. Autocorrelation is a measure of similarity between a signal and time delayed version of same signal.

42. What are the two theorems of convolution associated with Fourier transform?

The two theorems of convolution associated with Fourier transform are
Time convolution theorem
Frequency convolution theorem

43. Define spectral Density

The Spectral Density is defined as the distribution of power or energy of a signal per unit bandwidth as a function of frequency.

44. Define Normalized energy

The Normalized Energy of a signal is defined as the energy dissipated by a voltage signal applied across 1Ω resistor (or current flowing through a 1Ω resistor)..

45. Define Energy Spectral Density

Energy spectral density is defined as the distribution of energy of a signal in frequency domain.

46. What is meant by Power Spectral Density?

The distribution of average power of the signal in the frequency domain is called power spectral density.

47. State Parseval’s power theorem.

The Parseval’s power theorem defines the power of a signal in terms of its Fourier series coefficients. It states that the power of a signal is equal to the sum of square of the magnitudes of various harmonics present in the discrete spectrum.

48. What is the relation between convolution and correlation?

The relation between convolution and correlation is that the cross correlation of x1(t) and x2(t) is same as the convolution of x1(t) and x2(-t).

49. What is sampling?

Sampling is a process of converting a continuous-time signal into a discrete time signal.

50. What is sampling period?

The sampling period or sampling interval is the time interval between successive samples.

51. What is sampling frequency?

The sampling frequency is the reciprocal of sampling period. It indicates the number of samples per second.

52. State sampling theorem.

A continuous time signal can be completely represented in its samples and recovered back if the sampling frequency is twice of the highest frequency content of the signal .i.e., fs ≥2fm

53. What is aliasing?

Aliasing is defined as the phenomenon in which a high frequency component inthe frequency spectrum of signal takes identity of a lower frequency component in thespectrum of the sampled signal.

54. What is anti-aliasing filter?

The LPF used for band-limiting a signal before sampling is generally referred toas anti-aliasing filter. It is primarily used for preventing aliasing. Hence that name.

55. When does aliasing occur? How it can be avoided?

Aliasing can occur if either of the following condition exists.

The sampling rate is too low.

The signal is not band-limited to a finite range

56. Why the Fourier transform of a discrete-time signal is called signal spectrum?

By taking Fourier transform of a discrete-time signal x(t) it is decomposed into its frequency components. Hence the Fourier transform is called signal spectrum.

57. Define Fourier transform of a discrete-time signal

The Fourier transform of discrete-time signal x(n) is define as

$F\{x(n)\} = X(\omega) = \sum_{n=-\infty}^{\infty} e^{-j\omega n}$

58. Define inverse discrete-time Fourier transform?

The inverse Fourier transform of discrete-time signal $X(\omega)$ is define as

$$F^{-1}\{X(\omega)\} = x(n) = \int_{-\pi}^{\pi} X(\omega)e^{j\omega n}d\omega$$

59. Write the convolution property of the Z-transform.

It states that if $Z\ \{x1(n)\} = X1(z)$ and $Z\ \{x2(n)\} = X2(z)$ then

$Z\ \{x1(n) * x2(n)\} = X1(z).X2(z)$

60. Write the final value theorem.

Final value theorem of Z-transform states that if x (n) is casual Z{x (n)} =X (Z) then

$$x(\infty) = \lim_{z\to 1}(z-1)X(z)$$

61. What is ROC in Z-transform?

This is defined as, the values of z for which X(z) converges is called ROC

The region of converges (ROC) of X (z) attains a finite value.

62. What are the advantages of Z-transform?

Advantages of Z-transform:

They convert the difference equations of a discrete-time system into linear algebraic equations. So, that the analysis become easy and simple.

Convolution in time domain is converted into multiplication in z-domain

Z-transforms exists for most of the signals for which DTFT does not exist.

63. Define Impulse Response of a system

The impulse response of a system is defined as the output of the system when the input applied signal is a unit impulse.

64. What is the relation between impulse response and transfer function of a system?

The impulse response is the inverse Fourier transform of the transfer function H(ω) in frequency domain.

Or

The impulse response is the inverse Laplace transform of the transfer function in s-domain

65. What is the Conditions for a discrete-time LTI system to be causal?

A discrete-time LTI system with rational system function H(z) is causal if and only if the ROC is the exterior of a circle outside the outermost pole

66. what is the Conditions for a discrete-time LTI system to be stable?

A discrete-time LTI system is stable if and only if the ROC of its system function H(z)includes the unit circle |z|=1.

67. What are the methods used to find inverse z-transform?

- Long division method (or) Power series expansion
- Residue method
- Partial fraction method
- Convolution method

68. Define Lapalce transform of x(t)?

The Lapalce transform of x(t) is denoted by X(s) and is defined as

$$L\{x(t)\} = X(s) = \int_{-\infty}^{\infty} x(t)e^{-st}dt$$

69. What is the Laplace transform of $\boldsymbol{\delta(t)}$?

Laplace transform of $\delta(t)$ =1; ROC is the entire s-plane

70. What is the Laplace transform of u(t)?

The Laplace transform of u(t) = 1/s; ROC is Re{s}>0

71. What is the Laplace transform of $\boldsymbol{e^{-at}\sin(\omega_0 t)\, u(t)}$?

$$\frac{\omega_0}{(s+a)^2 + {\omega_0}^2}$$

72. What is the Laplace transform of $\boldsymbol{e^{-at}\cos(\omega_0 t)\, u(t)}$?

$$\frac{(s+a)}{(s+a)^2 + {\omega_0}^2}$$