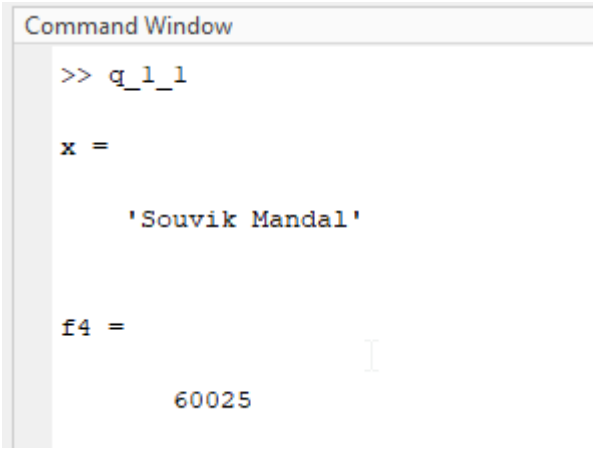
*Name: Souvik Mandal* *Roll. No: 2001106*

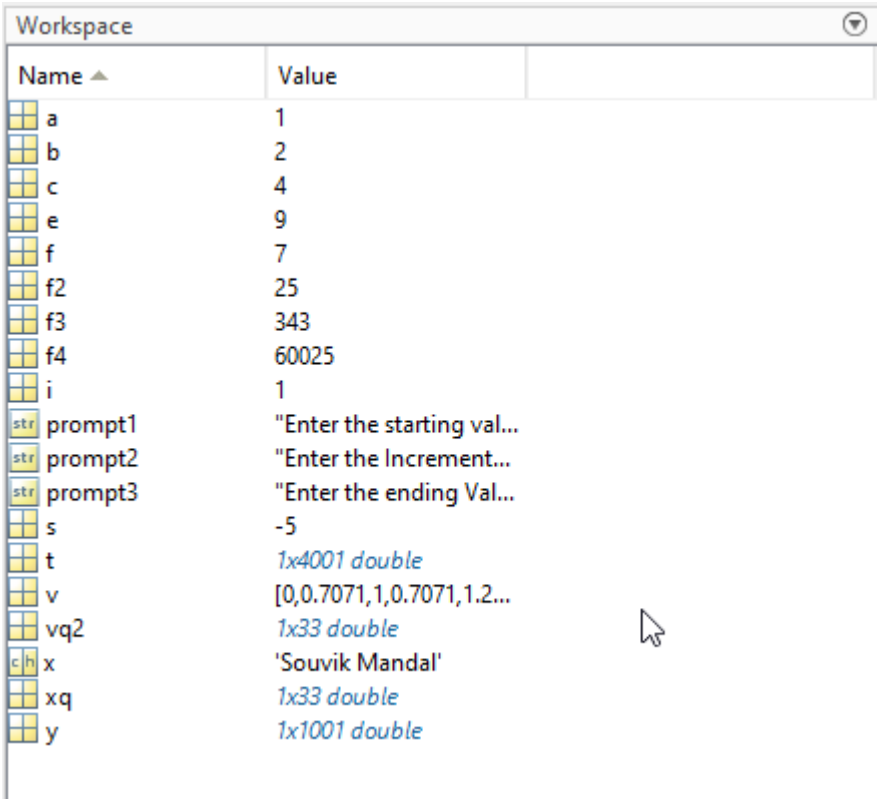
1. Write MATLAB code to solve/plot:

**i)** Y= (a+b-c) * (a-b-c) ^2 * (a+b+c)^ 3 , where a=1, b=2, c=4

```
a=1;
b=2;
c=4;
x='Souvik Mandal';
f=(a+b+c);
f3=(a+b+c)*(a+b+c)*(a+b+c);
f2=(a-b-c)*(a-b-c);
f4=f*f2*f3;
display(x);
display(f4);
```

**OUTPUT:**



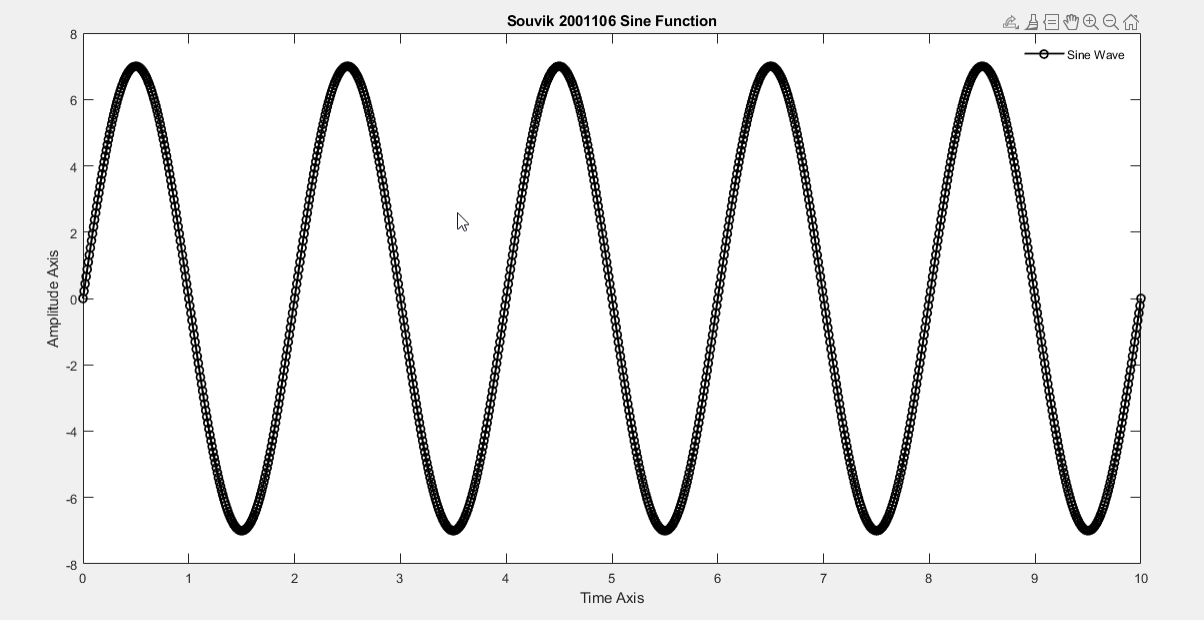



**ii)** Sine Wave

```
clc;
close all; clear all;
t = 0:0.01:10;
a=7;
f=0.5;
figure;
hold on;
y = a*sin(2*pi*f*t);
```

```
plot(t,y,"k-o","LineWidth",1.3);
title('Souvik 2001106 Sine Function');
xlabel('Time Axis');
ylabel('Amplitude Axis');
legend("Sine Wave");
box on;
legend("boxoff");
hold off;
```

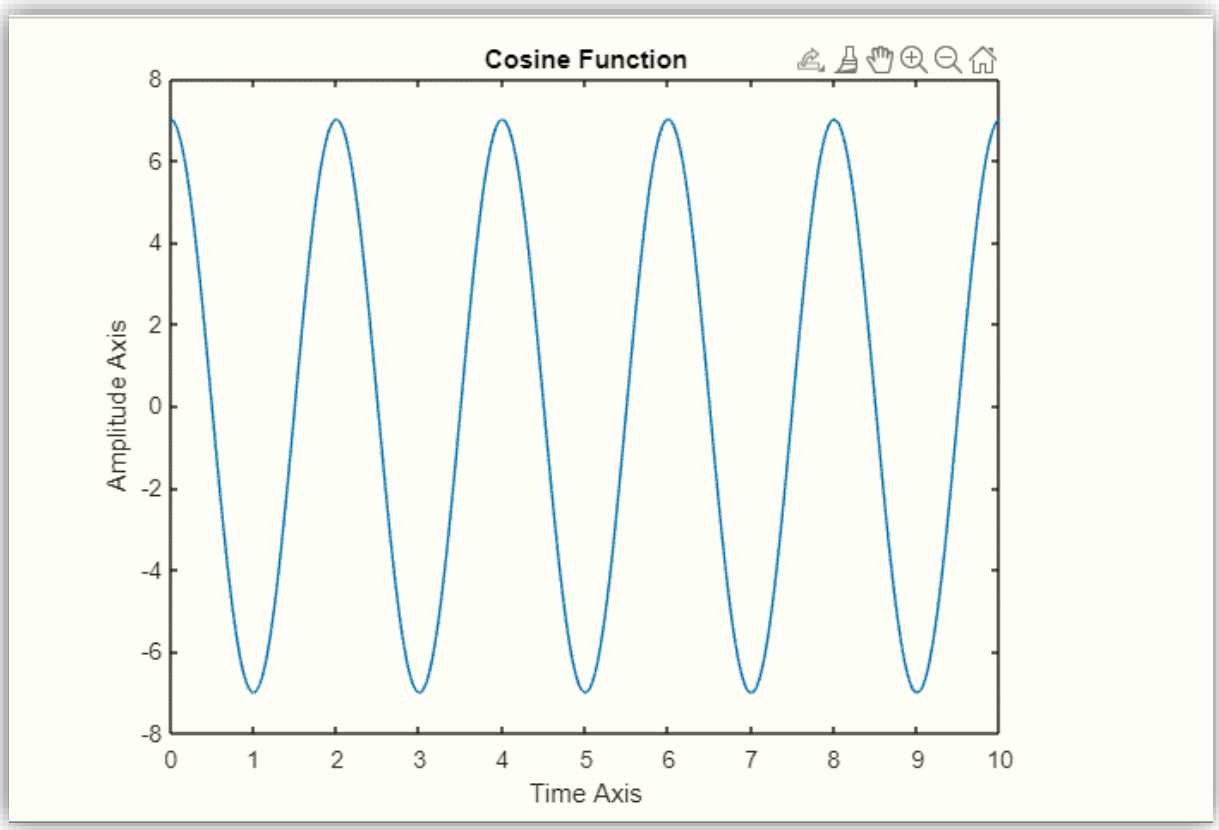
**OUTPUT:**




**iii)** Cosine Wave

```
clc;
close all; clear all;
t = 0:0.01:10; a=7;

f=0.5;
y = a*cos(2*pi*f*t); plot(t,y);
title('Cosine Function');
xlabel('Time Axis');
ylabel('Amplitude Axis');
```

**OUTPUT:**

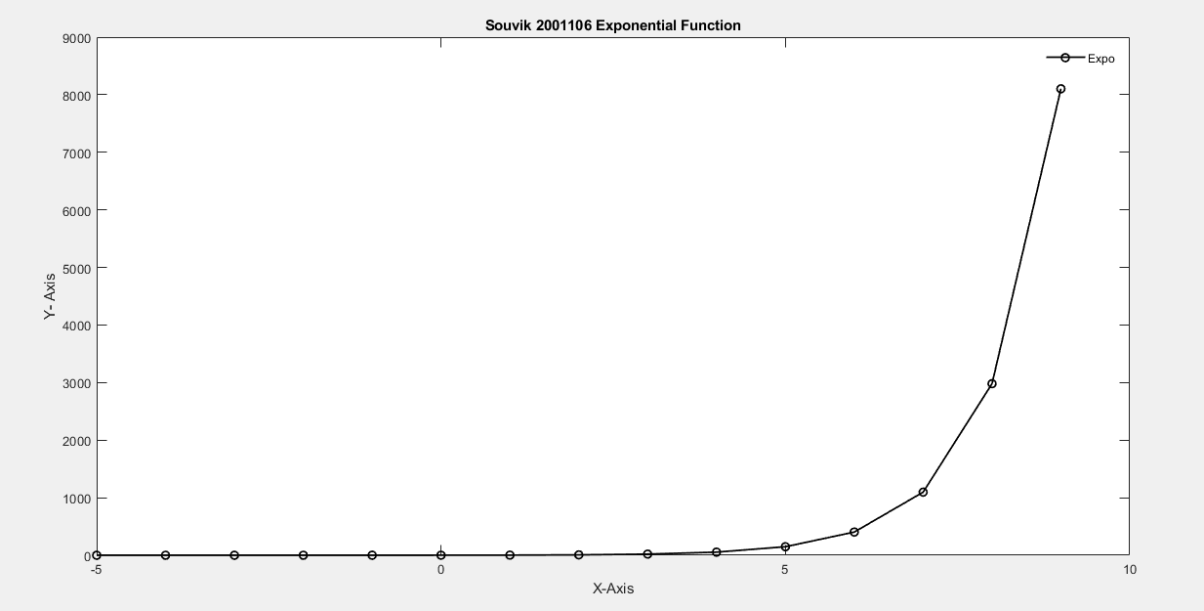



**iv)** $e^x$

```
clc;
clear all;
close all;
x = -5:1:9
figure;
hold on;
y= exp(x);
plot(x,y,"k-o","LineWidth",1.3);
title('Souvik 2001106 Exponential Function');
xlabel('X-Axis');
ylabel('Y- Axis');
legend("Expo");
box on;
```

```
legend("boxoff");
hold off;
```

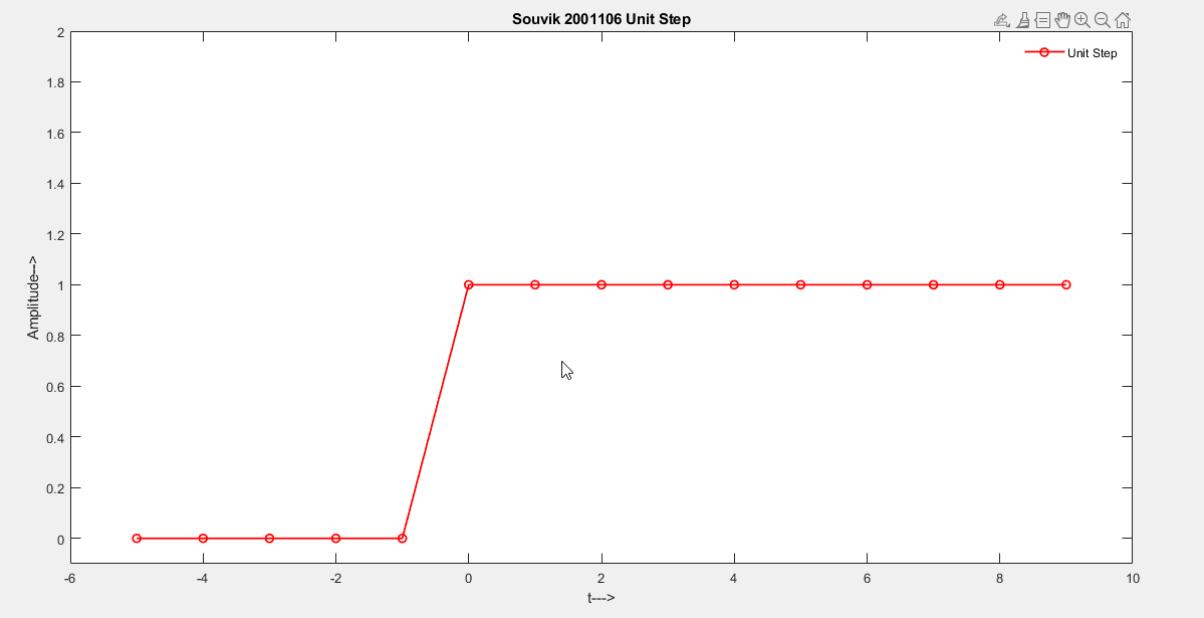
**OUTPUT:**




**v)** Unit Step

```
 clc;
 clear all;
 close all;
 t= ( -5 : 1 : 9) ;
figure;
hold on;
x = (t>=0);
plot(t,x,"r-o","LineWidth",1.3);
xlim([t(1)-1 t(end)+1]);
ylim([min(x)-0.1 max(x)+1]);
xlabel("t--->");
ylabel("Amplitude-->");
title("Souvik 2001106 Unit Step")
legend("Unit Step");
box on;
legend("boxoff");
hold off;
```

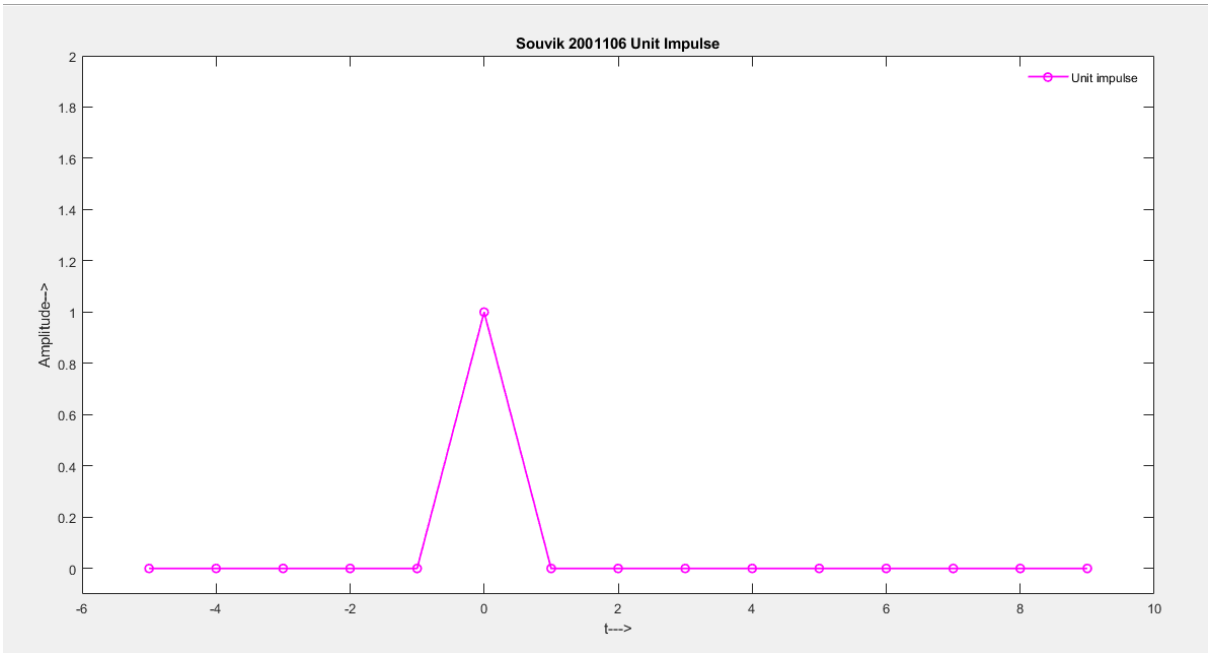
***Output:-***




**vi)** Unit Impulse

```
clc;
clear all;
close all;
t=(-1:0.01:1);
figure;
hold on
x = (t==0);
plot(t,x,"m-o","LineWidth",1.3);
xlim([t(1)-1 t(end)+1]);
ylim([min(x)-0.1 max(x)+1]);
xlabel("t--->");
ylabel("Amplitude-->");
title("Souvik 2001106 Unit Impulse")
legend("Unit impulse");
box on;
legend("boxoff");
hold off;
```

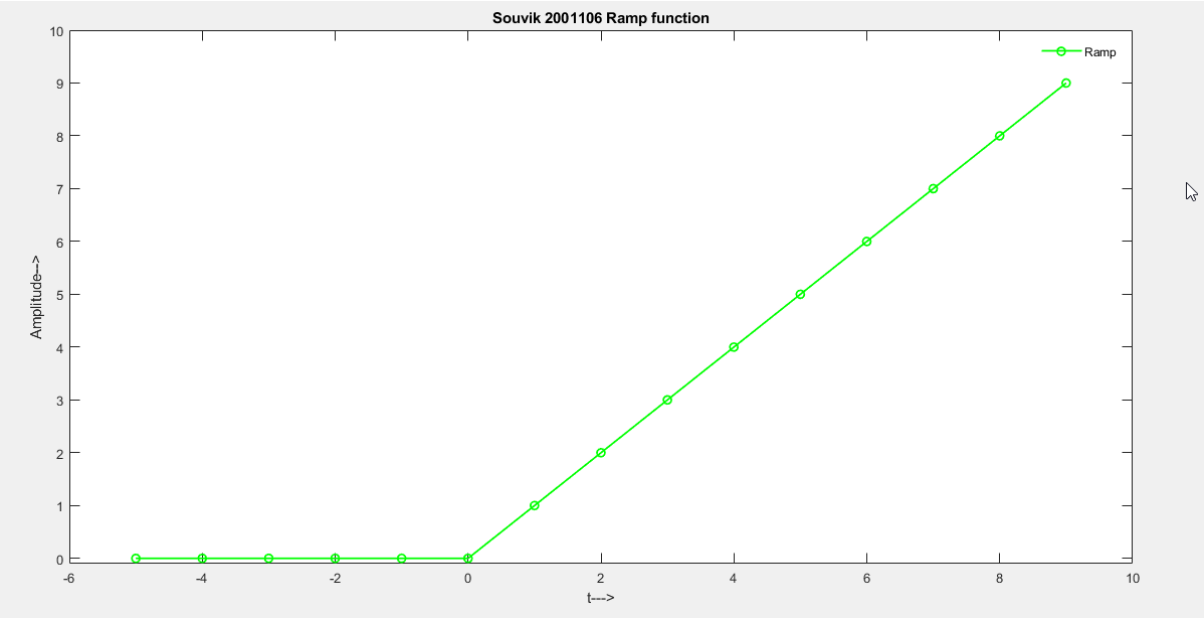
**OUTPUT:-**




**vii)** Ramp Function

```
clc;
clear all; close all;
t= (-5:1:9) ;
figure;
hold on
x =t.*(t>=0);
```

```
plot(t,x,"g-o","LineWidth",1.3);
xlim([t(1)-1 t(end)+1]);
ylim([min(x)-0.1 max(x)+1]);
xlabel("t--->");
ylabel("Amplitude-->");
title("Souvik 2001106 Ramp function")
legend("Ramp");
box on;
legend("boxoff");
hold off;
```

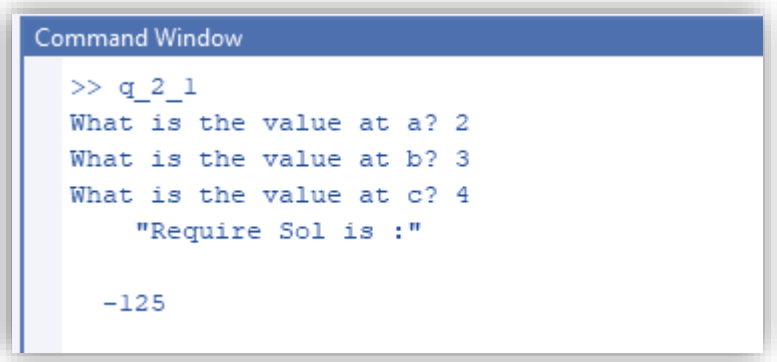


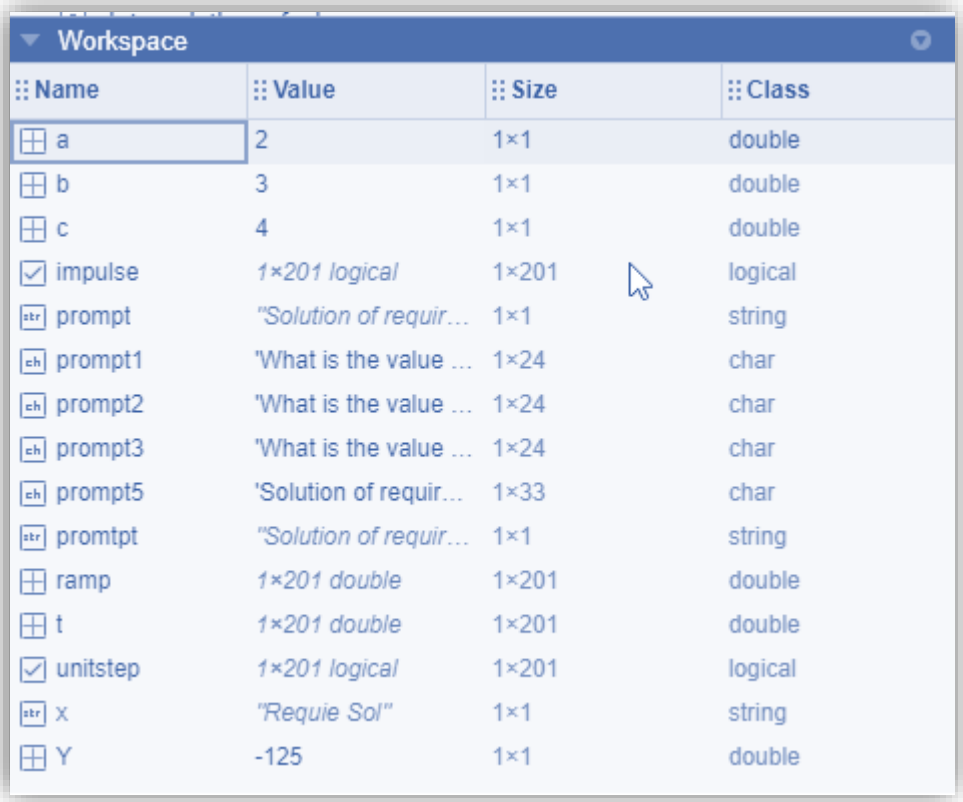

2. Write MATLAB function to solve/plot:

i) Y= (a-b-c) 3, where a=2, b=3, c=4

```
 %Y= (a-b-c)^3 , where a=2, b=3, c=4
prompt1 = 'What is the value at a? ' ;
prompt2 = 'What is the value at b? ' ;
prompt3 = 'What is the value at c? ' ;
a=input(prompt1);
b=input(prompt2);
c=input(prompt3);
display("Require Sol is :");
display((a-b-c) *(a-b-c) *(a-b-c))
```

**OUTPUT:**





Workspace

| Name | Value | Size | Class |
|---|---|---|---|
| a | 2 | 1×1 | double |
| b | 3 | 1×1 | double |
| c | 4 | 1×1 | double |
| impulse | *1×201 logical* | 1×201 | logical |
| prompt | *"Solution of requir…* | 1×1 | string |
| prompt1 | 'What is the value … | 1×24 | char |
| prompt2 | 'What is the value … | 1×24 | char |
| prompt3 | 'What is the value … | 1×24 | char |
| prompt5 | 'Solution of requir… | 1×33 | char |
| promtpt | *"Solution of requir…* | 1×1 | string |
| ramp | *1×201 double* | 1×201 | double |
| t | *1×201 double* | 1×201 | double |
| unitstep | *1×201 logical* | 1×201 | logical |
| x | *"Requie Sol"* | 1×1 | string |
| Y | -125 | 1×1 | double |

ii) Sine Wave

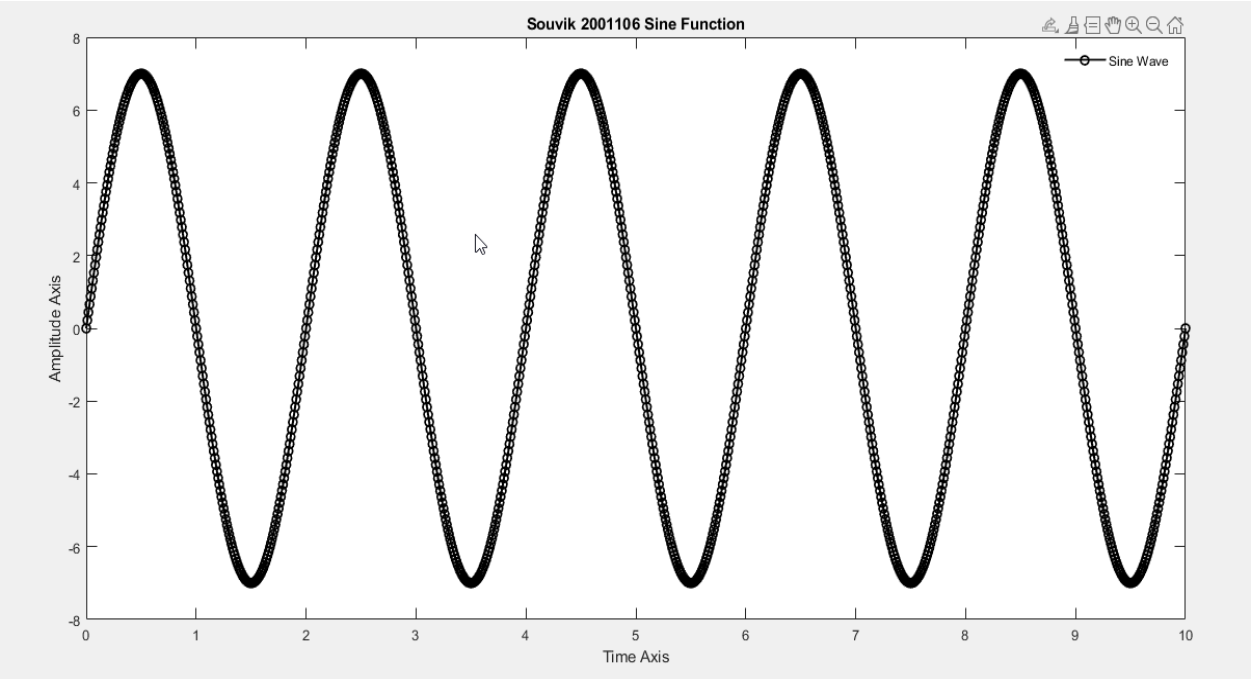
```
clc;
close all;
clear all;
prompt1 = "Enter the starting value of time range:
";
prompt2 = "Enter the Increments Value: ";
prompt3 = "Enter the ending Value of time range: ";
s = input(prompt1);
i = input(prompt2);
e = input(prompt3);
t = s:i:e;
prompt4 = "Enter the amplitude: ";
prompt5 = "Enter the freq: ";
a=input(prompt4);
f=input(prompt5);
%Calling Sine Wave Plot Function
plotSineWave(t,a,f)
```

***% Sine Wave Plot Function Code***

```
function [] =plotSineWave(t,a,f)
figure;
hold on;
y = a*sin(2*pi*f*t);
plot(t,y,"k-o","LineWidth",1.3);
title(' Souvik 2001106 Sine Function');
xlabel('Time Axis');
ylabel('Amplitude Axis');
legend("Sine Wave");
box on;
legend("boxoff");
hold off;
fprintf("Run the sin wave plot function")
end
```

**OUTPUT:**

```
Command Window
Enter the starting value of time range: 0
Enter the Increments Value: 0.01
Enter the ending Value of time range: 10
Enter the amplitude: 7
Enter the freq: 0.5
fx Run the sin wave plot function>>
```




iii) $3e^{x}$

```
clc;
clear all;
close all;
prompt1 = "Enter the starting value of x
range: ";
```

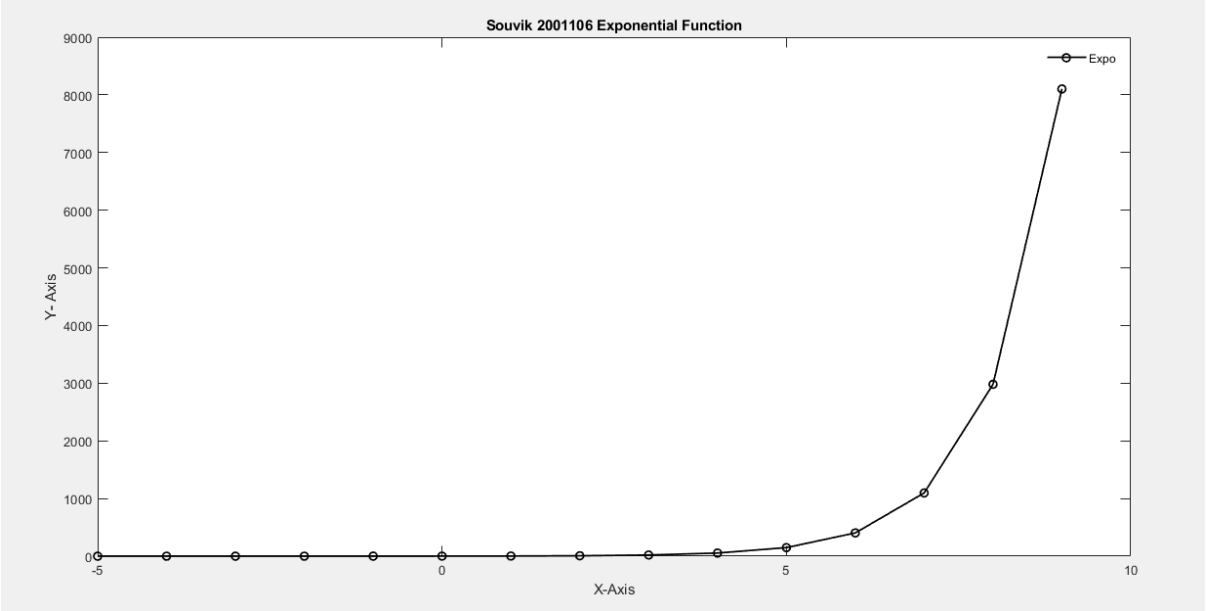
```
prompt2 = "Enter the Increments Value: ";
prompt3 = "Enter the ending Value of x range:
";
s = input(prompt1);
i = input(prompt2);
e = input(prompt3);
x = s:i:e;
%Calling Exponential Function
exponential(x)
```

***% Exponential Plot Function Code.***

```
function [] = exponential(x)
figure;
hold on;
y= exp(x);
plot(x,y,"k-o","LineWidth",1.3);
title(' Souvik 2001106 Exponential Function');
xlabel('X-Axis');
ylabel('Y- Axis');
legend("Expo");
box on;
legend("boxoff");
hold off;
fprintf("Run the Exponential function")
end
```

**OUTPUT:**

```
Command Window
Enter the starting value of x range: -5
Enter the Increments Value: 1
Enter the ending Value of x range: 9
Run the Exponential function>>
```



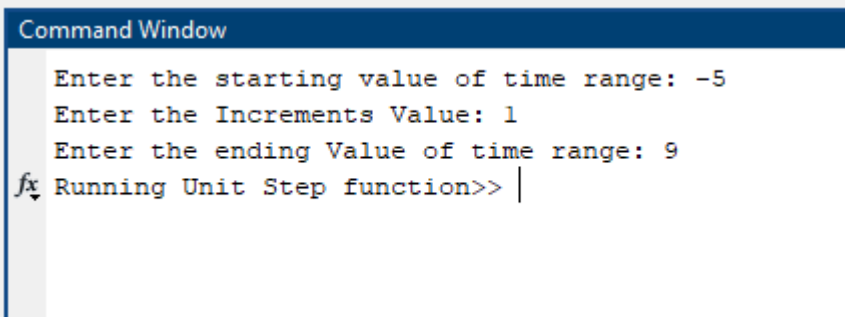

## iv) Unit Step

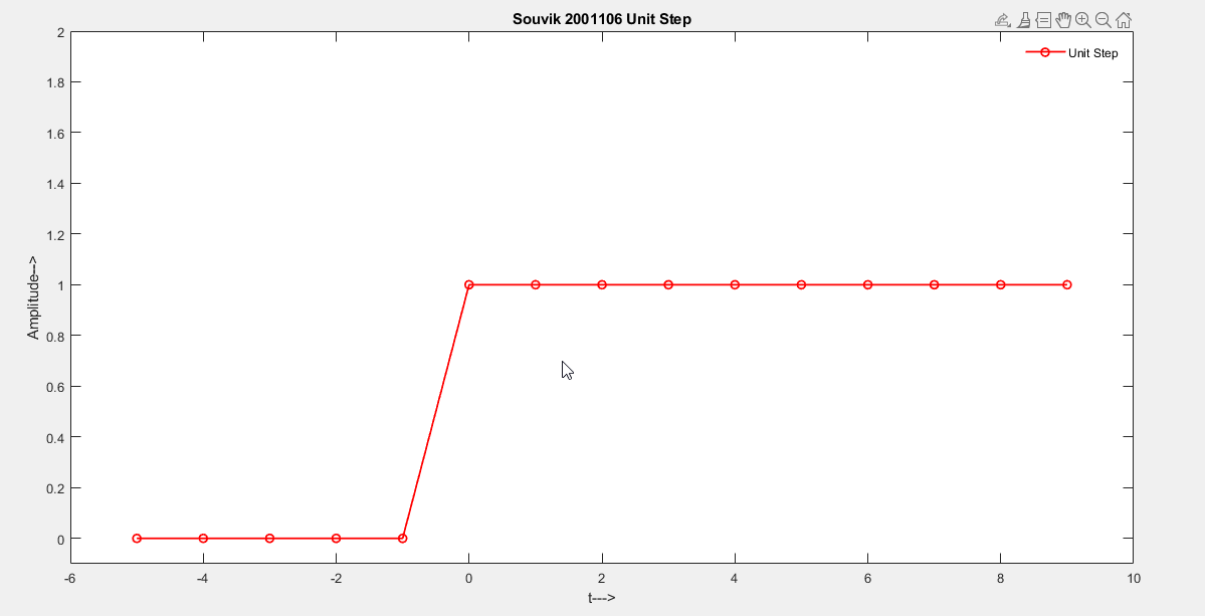
```
clc;
clear all;
close all;
prompt1 = "Enter the starting value of time range:
";
prompt2 = "Enter the Increments Value: ";
prompt3 = "Enter the ending Value of time range: ";
s = input(prompt1);
i = input(prompt2);
e = input(prompt3);
t = s:i:e;
% Calling Unit step Plot Function;
unitStepPlot(t)
```

## *% Unit Step Plot Function Code.*

```
function []=unitStepPlot(t)
figure;
hold on;
x = (t>=0);
plot(t,x,"r-o","LineWidth",1.3);
xlim([t(1)-1 t(end)+1]);
ylim([min(x)-0.1 max(x)+1]);
xlabel("t--->");
ylabel("Amplitude-->");
title("Souvik 2001106 Unit Step")
legend("Unit Step");
box on;
legend("boxoff");
hold off;
fprintf("Running Unit Step function")
end
```

**OUTPUT:**






## v) Unit Impulse

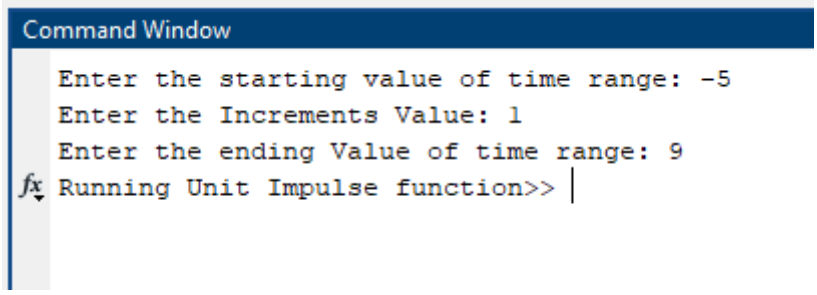
```
clc;
clear all;
close all;
prompt1 = "Enter the starting value of time
range: ";
prompt2 = "Enter the Increments Value: ";
prompt3 = "Enter the ending Value of time
range: ";
s = input(prompt1);
i = input(prompt2);
e = input(prompt3);
t = s:i:e;
%calling unit impulse function
UnitImpulseSignalPlot(t)
```

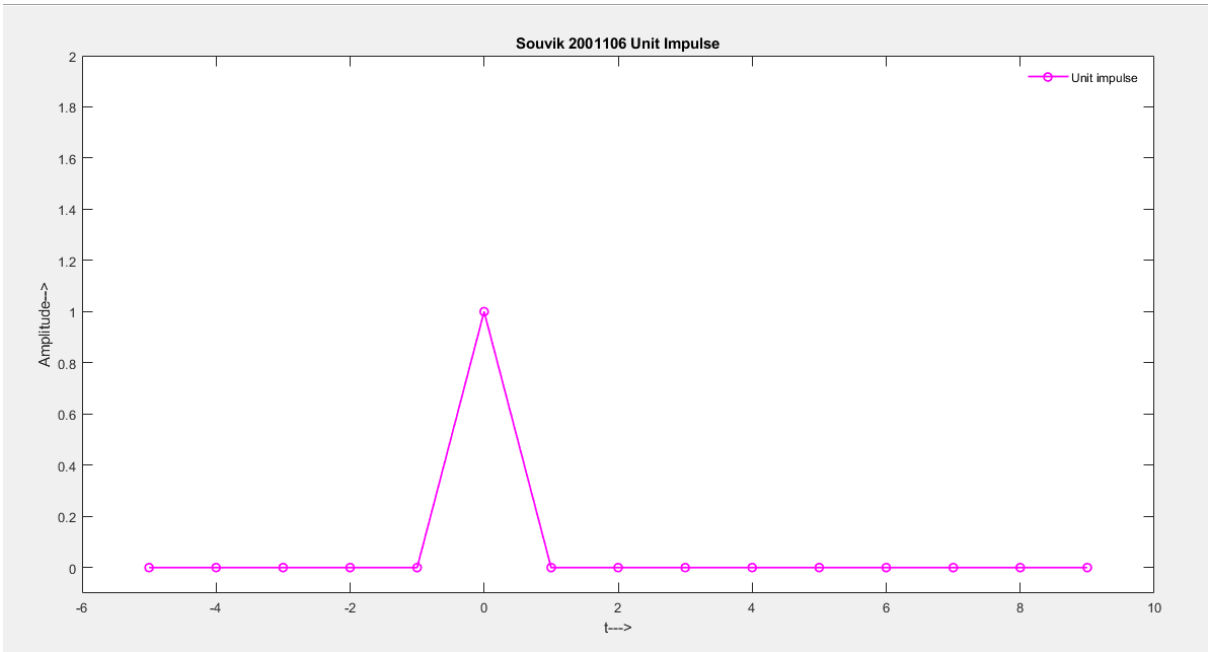
***% Unit Impulse Plot Function Code.***

```
function [] = UnitImpulseSignalPlot(t)
```

```
figure;
hold on
x = (t==0);
plot(t,x,"m-o","LineWidth",1.3);
xlim([t(1)-1 t(end)+1]);
ylim([min(x)-0.1 max(x)+1]);
xlabel("t--->");
ylabel("Amplitude-->");
title("Souvik 2001106 Unit Impulse")
legend("Unit impulse");
box on;
legend("boxoff");
hold off;
fprintf("Running Unit Impulse function")
end
```

**OUTPUT:**





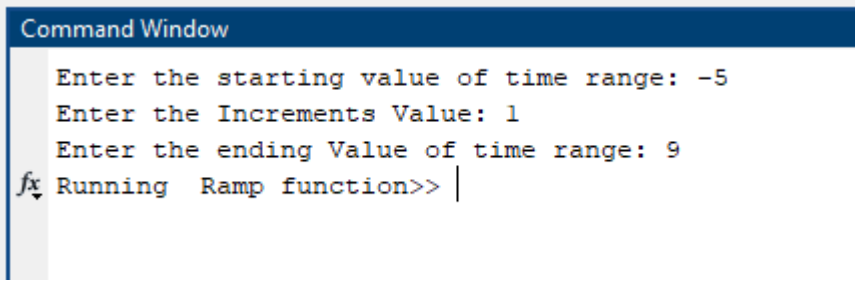

## *vi) Ramp Function*

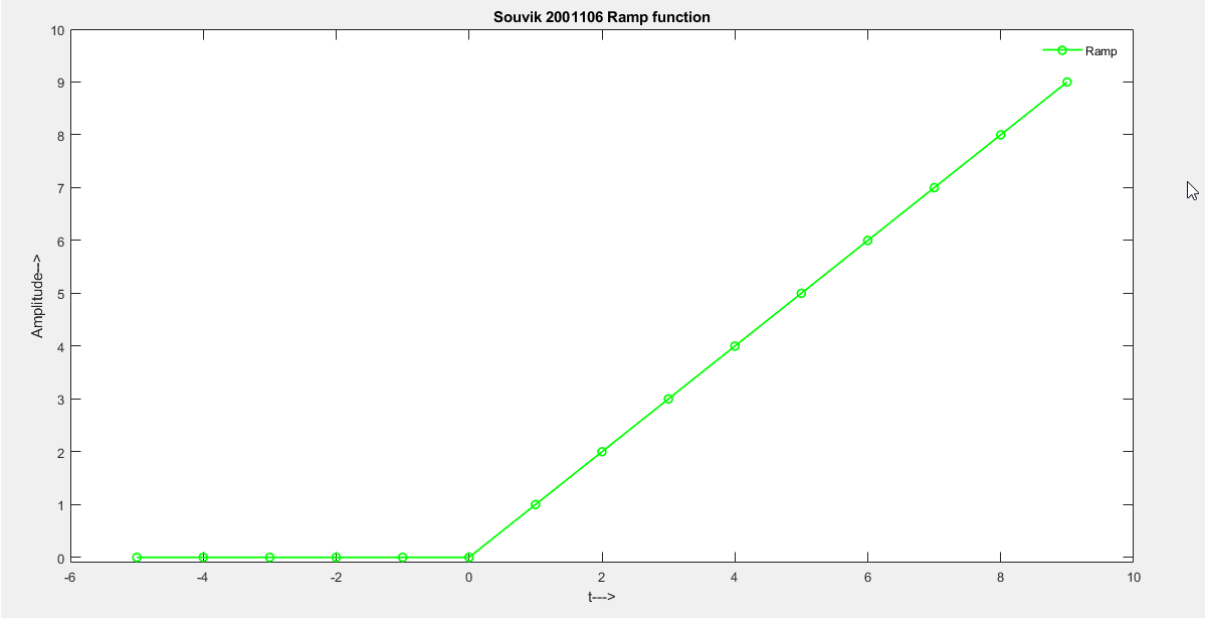
```
clc;
clear all;
close all;
prompt1 = "Enter the starting value of time
range: ";
prompt2 = "Enter the Increments Value: ";
prompt3 = "Enter the ending Value of time
range: ";
s = input(prompt1);
i = input(prompt2);
e = input(prompt3);
t = s:i:e;

%calling Ramp signal plot function

rampSignalPlot(t)
```

***% Ramp Plot Function Code.***

```
function [] = rampSignalPlot(t)
figure;
hold on
x =t.*(t>=0);
plot(t,x,"g-o","LineWidth",1.3);
xlim([t(1)-1 t(end)+1]);
ylim([min(x)-0.1 max(x)+1]);
xlabel("t--->");
ylabel("Amplitude-->");
title("Souvik 2001106 Ramp function")
legend("Ramp");
box on;
legend("boxoff");
hold off;
fprintf("Running  Ramp function")
end
```

**OUTPUT:**






3. Verify Sampling theorem through MATLAB coding.

**Sampling Theorem:** Sampling theorem states that "continues form of a time-variant signal can be represented in the discrete form of a signal with help of samples and the sampled (discrete) signal can be recovered to original form when the sampling signal frequency Fs having the greater frequency value than or equal to the input signal frequency Fm.

$$Fs \geq 2Fm$$

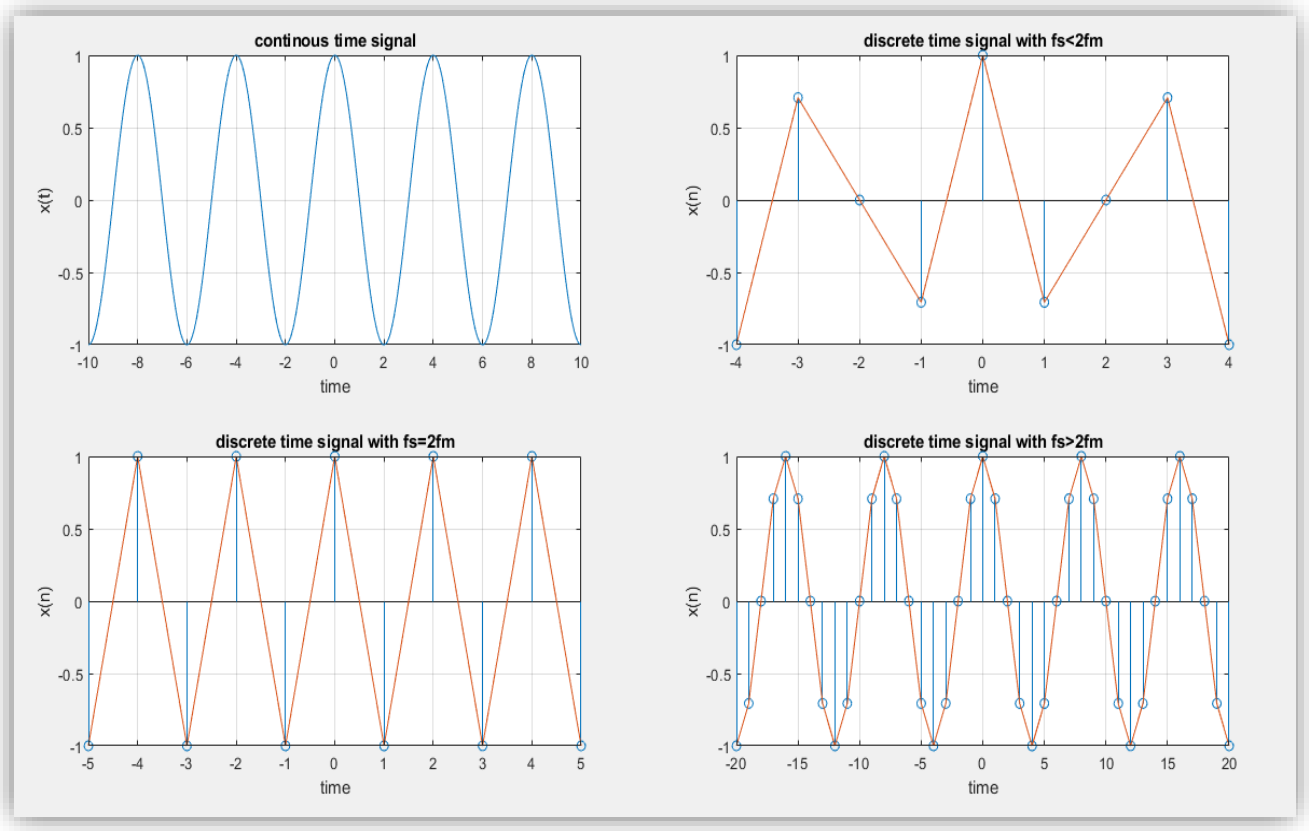
**CODE:**

```
t=-10:.01:10;
T=4;
fm=1/T;
x=cos(2*pi*fm*t);
subplot(2,2,1);
plot(t,x);
xlabel('time');
ylabel('x(t)')
title('continous time signal')
grid;
n1=-4:1:4
fs1=1.6*fm;
fs2=2*fm;
```

```
fs3=8*fm;
x1=cos(2*pi*fm/fs1*n1);
subplot(2,2,2);
stem(n1,x1);
xlabel('time');
ylabel('x(n)')
title('discrete time signal with fs<2fm')
hold on
subplot(2,2,2);
plot(n1,x1)
grid;
n2=-5:1:5;
x2=cos(2*pi*fm/fs2*n2);
subplot(2,2,3);
stem(n2,x2);
xlabel('time');ylabel('x(n)')
title('discrete time signal with
fs=2fm')
hold on
subplot(2,2,3);
plot(n2,x2)
grid;
n3=-20:1:20;
x3=cos(2*pi*fm/fs3*n3);
subplot(2,2,4);
stem(n3,x3);
xlabel('time');ylabel('x(n)')
title('discrete time signal with fs>2fm')
hold on
subplot(2,2,4);
plot(n3,x3)
grid;
```

**OUTPUT:**

4. Perform Interpolation and Decimation of any wave and verify any deformation in wave after performing both actions by same factor




by using MATLAB.

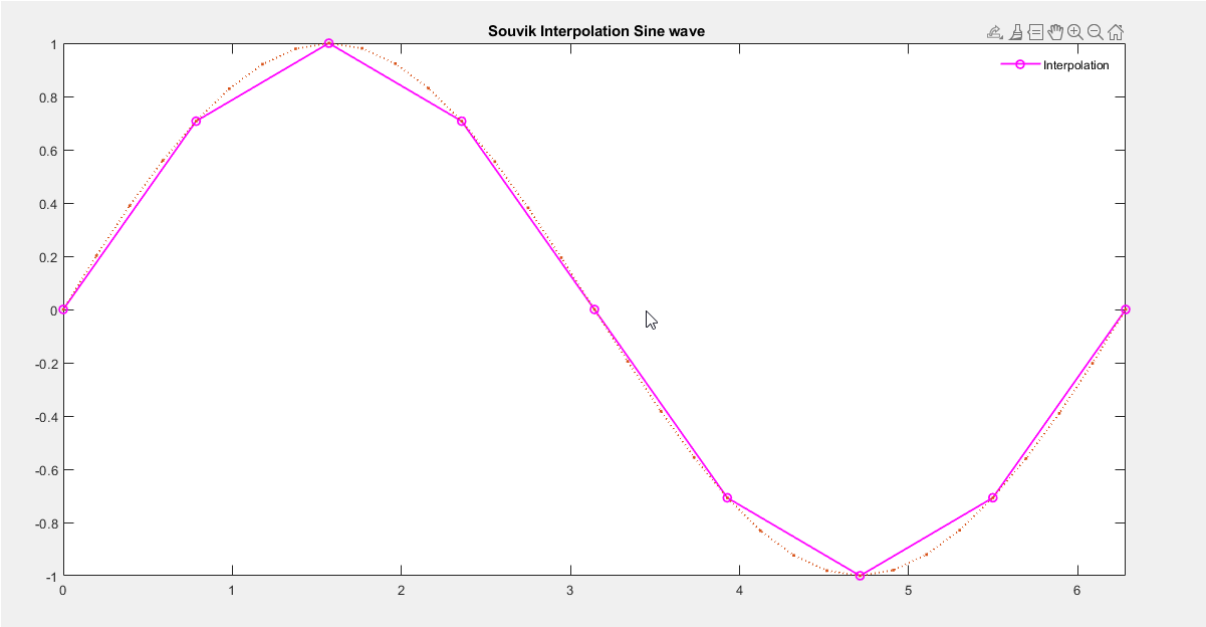
## *Interpolation of Sine Wave: -*

## *CODE:-*

```
x = 0:pi/4:2*pi;
v = sin(x);
xq = 0:pi/16:2*pi;
%figure
%vq1 = interp1(x,v,xq);
%plot(x,v,'o',xq,vq1,':.');
%xlim([0 2*pi]);
```

```
%title('(Default) Linear
Interpolation');
figure
vq2 = interp1(x,v,xq,'spline');
plot(x,v,'o',xq,vq2,':.');
xlim([0 2*pi]);
title(' Souvik Interpolation Sine
wave');
```

**OUTPUT:**



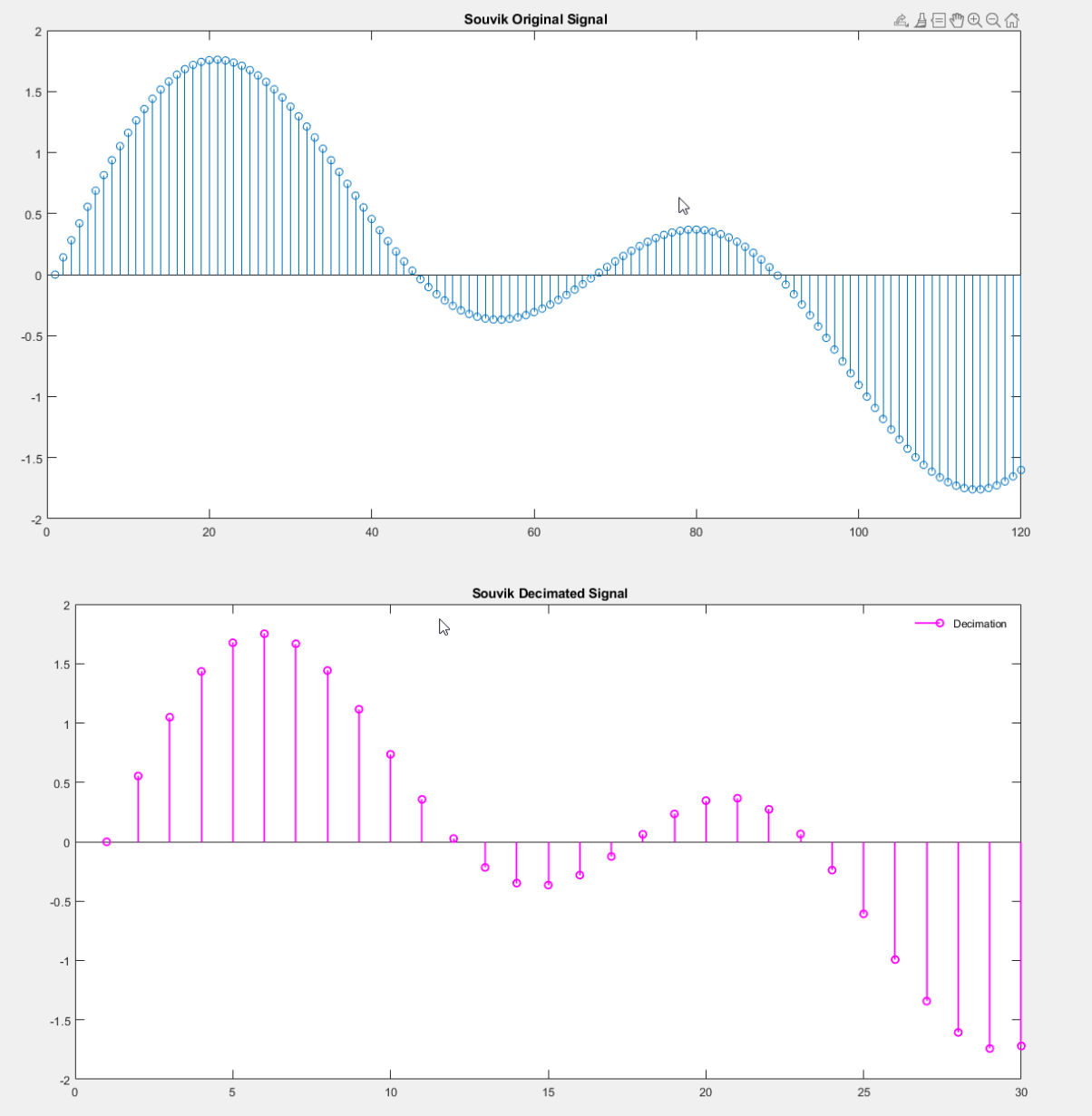

## *Decimation of Sine Wave: -*

**CODE:**

```
t = 0:.00025:1; % Time vector
x = sin(2*pi*30*t) +
sin(2*pi*60*t);
y = decimate(x,4);
```

```
stem(x(1:120)), axis([0 120 -2 2])
% Original signal
title(' Souvik Original Signal')
figure
stem(y(1:30)) % Decimated signal
title(' Souvik Decimated Signal')
```

***OUTPUT:-***

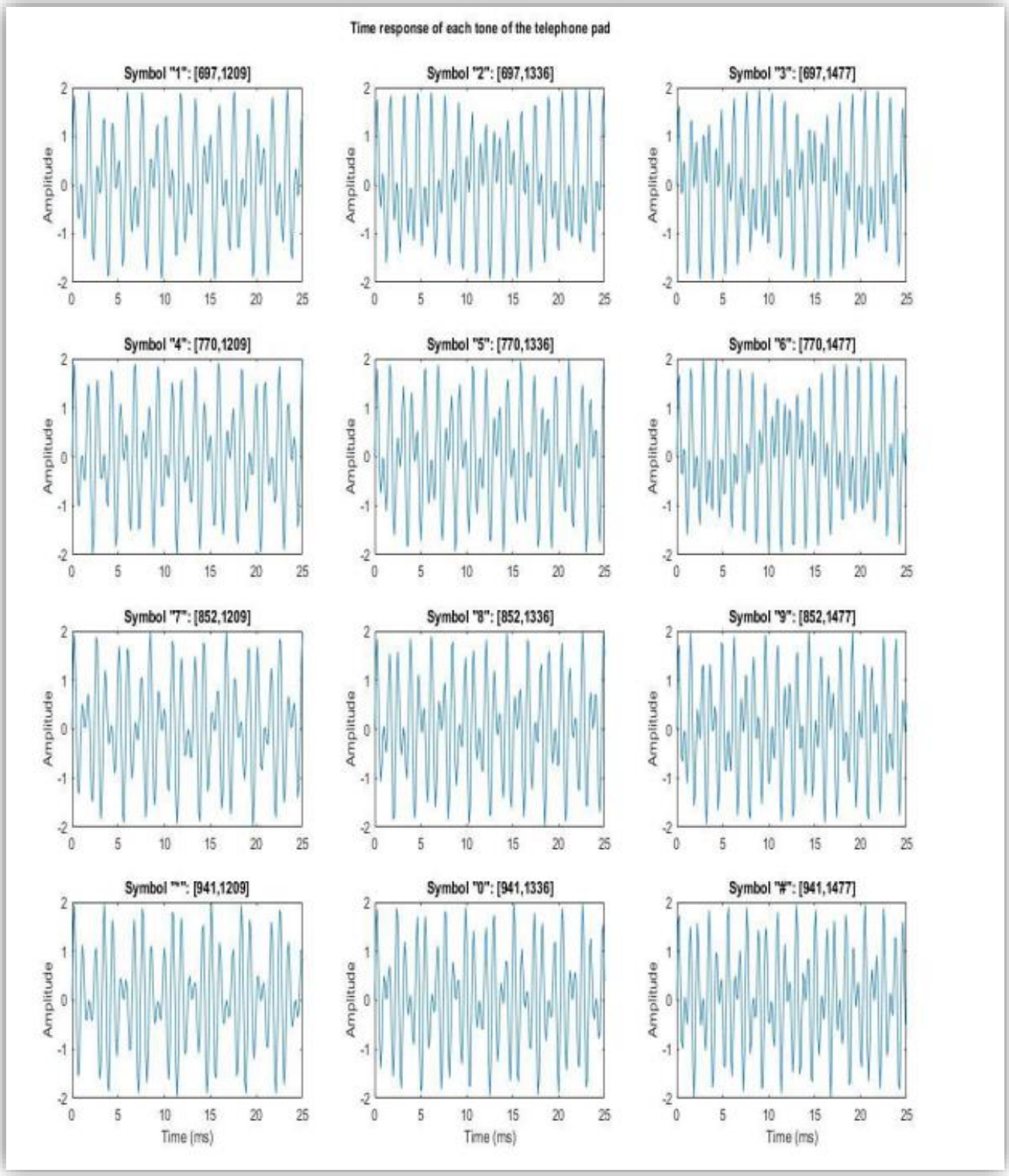



5. Write MATLAB code to plot graph for Dual Tone Multi Frequency for: 1, 2,3,4,5,6,7,8,9,0, *, #.

**CODE:**

```
Symbol={'1','2','3','4','5','6','7','8','9','*','0','
#'};
lfg = [697 770 852 941]; % Low frequency group
hfg = [1209 1336 1477]; % High frequency group
f = [];
for c=1:4,
 for r=1:3,
 f = [ f [lfg(c);hfg(r)] ];
 end
end
Fs = 8000; % Sampling frequency 8 kHz
N = 800; % Tones of 100 ms
t = (0:N-1)/Fs; % 800 samples at Fs
pit = 2*pi*t;
tones = zeros(N,size(f,2));
for toneChoice=1:12,
 % Generate tone
 tones(:,toneChoice) =
sum(sin(f(:,toneChoice)*pit))';
 % Plot tone

subplot(4,3,toneChoice),plot(t*1e3,tones(:,toneChoice
));
 title(['Symbol "', symbol{toneChoice},'":
[',num2str(f(1,toneChoice)),',',num2str(f(2,toneChoic
e)),']'])
 set(gca, 'Xlim', [0 25]);
 ylabel('Amplitude');
 if toneChoice>9, xlabel('Time (ms)'); end
end
set(gcf, 'Color', [1 1 1], 'Position', [1 1 1280
1024])
annotation(gcf,'textbox', 'Position',[0.38 0.96 0.45
0.026],...
 'EdgeColor',[1 1 1],...
 'String', '\bf Time response of each tone of the
telephone pad', ...
 'FitBoxToText','on');
```

## OUTPUT:


Time response of each tone of the telephone pad
Symbol "1": [697,1209]
Symbol "2": [697,1336]
Symbol "3": [697,1477]
Symbol "4": [770,1209]
Symbol "5": [770,1336]
Symbol "6": [770,1477]
Symbol "7": [852,1209]
Symbol "8": [852,1336]
Symbol "9": [852,1477]
Symbol "*": [941,1209]
Symbol "0": [941,1336]
Symbol "#": [941,1477]
Amplitude
Time (ms)

6. (a)Write matlab codes to find convolution, auto and cross correlation of given sequence and analyse

output

A= [ 1 2 5 7]

B= [3 1 2 4]

CODE:

**For Convolution-**

```
    % linear convolution
close all
x=input('Enter x: ');
h=input('Enter h: ');
m=length(x);
n=length(h);
X=[x,zeros(1,n)];
H=[h,zeros(1,m)];
for i=1:n+m-1
Y(i)=0;
for j=1:i
    Y(i)=Y(i)+X(j)*H(i-j+1);
end
Y
end
stem(Y);
ylabel('Y[n]');
xlabel('----->n');
title('Convolution of Two Signals - aryan shukla
2001026')
```

## For Auto Correlation-

```
 clc;
close all;
x=input('Enter the sequence 1: ');
y=input('Enter the sequence 2: ');
y=xcorr(x,y);
figure;
subplot(2,1,1);
stem(x);
title('the resultant is ');
ylabel('Amplitude->');
xlabel('n---->');
title('Input sequence - aryan shukla 2001026');
subplot(2,1,2);
stem(fliplr(y));
ylabel('amplitude');
xlabel('n------>');
title('Output sequence - aryan shukla 2001026');

fliplr(y);
```

## For cross-correlation-

```
 x=input('Enter the sequence 1: ');
h=input('Enter the sequence 2: ');
y=xcorr(x,h);
figure;
subplot(3,1,1);
stem(x);
xlabel('n->');
ylabel('Amplitude->');
title('Input sequence 1 aryan shukla 2001026');
subplot(3,1,2);
stem(fliplr(y));
stem(h);
xlabel('n->');
ylabel('Amplitude->');
title('Input sequence 2 aryan shukla 2001026');
subplot(3,1,3);
stem(fliplr(y));
xlabel('n->');
ylabel('Amplitude->');
title('Output sequence - aryan shukla 2001026');
disp('The resultant is');
fliplr(y);
```

(b) Write matlab codes to find either convolution or auto correlation or cross correlation without

using inbuilt codes

CODE:

```
  clc;
close;
disp('enter the length of the first sequence m=');
m=input('');
disp('enter the first sequence x[m]=');
for i=1:m
x(i)=input('');
end
disp('enter the length of the second sequence n=');
n=input('');
disp('enter the second sequence h[n]=');
for j=1:n
h(j)=input('');
end
y=conv(x,h);
figure;
subplot(3,1,1);
stem(x);
ylabel ('amplitude---->');
xlabel('n---->');
title('x(n) Vs n');
subplot(3,1,2);
stem(h);
ylabel('amplitude---->');
xlabel('n---->');
title('h(n) Vs n');
subplot(3,1,3);
stem(y);
ylabel('amplitude---->');
xlabel('n---->');
title('y(n) Vs n    aryan shukla 2001026');
disp('linear convolution of x[m] and h[n] is y');
```

7. Write a MATLAB code to design IIR Butterworth lowpass, highpass, bandpass and bandstop filter

and verify its characteristics for given cutoff frequency:

lowpass- 1200 Hz

highpass-1200 Hz

bandpass- 1200 hz to 1800Hz

bandstop- 1200 hz to 1800Hz

CODE:

```
 rp=input('enter passband ripple value');
rs=input('enter stopband ripple value');
fp=input('enter passband freq value');
fs=input('enter stopband freq value');
fsp=input('enter sampling freq value');
w1=2*fp/fsp;
w2=2*fs/fsp;
[n,wn]=buttord(w1,w2,rp,rs);
[b,a]=butter(n,wn,'low');
[h,w]=freqz(b,a,512,fsp);
mag=20*log(abs(h));
subplot(4,1,1);
plot(w,mag);
title('gain vs frequency of low pass filter  aryan shukla 2001026');
%high pass
[b,a]=butter(n,wn,'high');
[h,w]=freqz(b,a,512,fsp);
mag=20*log(abs(h));
subplot(4,1,2);
plot(w,mag);
title('gain vs frequency of high-pass filter  aryan shukla 2001026');
%band pass
[n]=buttord(w1,w2,rp,rs);
wn=[w1,w2];
[b,a]=butter(n,wn,'bandpass');
[h,w]=freqz(b,a,512,fsp);
mag=20*log(abs(h));
subplot(4,1,3);
plot(w,mag);
title('gain vs frequency of band-pass filter  aryan shukla 2001026');
%band stop
[n]=buttord(w1,w2,rp,rs);
[b,a]=butter(n,wn,'stop');
[h,w]=freqz(b,a,512,fsp);
mag=20*log(abs(h));
subplot(4,1,4);
plot(w,mag);
title('gain vs frequency of band-stop filter  aryan shukla 2001026');
```

**8. Write a MATLAB code to design FIR lowpass, highpass, bandpass and bandstop filter and verify**

**its characteristics for given cutoff frequency:**

**lowpass- 1500 Hz**

**highpass-1500 Hz**

**bandpass- 1000 hz to 2800Hz**

**bandstop- 1000 hz to 2800Hz**

**CODE:**

```
   fp=input('enter the passing freq:');
fstop=input('enter the stopping freq:');
fsp=input('enter the sampling freq value:');
n=input('enter the order of the filter:');
w1=2*fp/fsp;
w2=2*fstop/fsp;
%low pass filter
A=fir1(n,w1,'Low');
%freqz(A,1,512,fsp);
[h,w]=freqz(A,1,512,fsp);
mag=20*log10(abs(h));
subplot(4,1,1);
plot(w,mag);
title('Gain vs Frequency of Low-pass Filter - aryan shukla 2001026');
%high pass filter
A=fir1(n,w2,'high');
%freqz(A,1,512,fsp);
[h,w]=freqz(A,1,512,fsp);
mag=20*log10(abs(h));
subplot(4,1,2);
plot(w,mag);
title('Gain vs Frequency of High-pass Filter - aryan shukla 2001026');
%band pass filter
wn=[w1,w2];
A=fir1(n,wn,'bandpass');
%freqz(A,1,512,fsp);
[h,w]=freqz(A,1,512,fsp);
mag=20*log10(abs(h));
subplot(4,1,3);
plot(w,mag);
title('Gain vs Frequency of Band-pass Filter - aryan shukla 2001026');
%band stop filter
A=fir1(n,wn,'stop');
%freqz(A,1,512,fsp);
[h,w]=freqz(A,1,512,fsp);
mag=20*log10(abs(h));
subplot(4,1,4);
plot(w,mag);
title('Gain vs Frequency of Band-stop Filter - aryan shukla 2001026');
```