Introduction with System Simulation

Task 01: Write a program for Generation of Various Signals and Sequences (Periodic and Aperiodic), such as Unit impulse, unit step, square, saw tooth, triangular, sinusoidal, ramp, sinc/sampling etc.

Program

%unit impulse function%

```
clc;
clearall;
closeall;
t=-10:1:10;
x=(t==0);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('unit impulse function');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('unit impulse discreat function');
```

%unit step function%

```
clc;
clearall;
closeall;
N=100;
t=1:100;
x=ones(1,N);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('unit step function');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('unit step discreat function');
```

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%unit ramp function%

```
clc;
clearall;
closeall;
t=0:20;
x=t;
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('unit ramp function');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('unit ramp discreat function');
```

%sinusoidal function%

```
clc;
clearall;
closeall;
t=0:0.01:2;
x=sin(2*pi*t);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('sinusoidal signal');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('sinusoidal sequence');
```

%square function%

```
clc;
clearall;
closeall;
t=0:0.01:2;
x=square(2*pi*t);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('square signal');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('square sequence');
```

%sawtooth function%

```
t=0:0.01:2;
x=sawtooth(2*pi*5*t);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('sawtooth signal');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('sawtooth sequence');
```

%triangular function%

```
t=0:0.01:2;
x=sawtooth(2*pi*5*t,0.5);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('trianguler signal');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('trianguler sequence');
```

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%sinc function%

```
clc;
clearall;
closeall;
t=linspace(-5,5);
x=sinc(t);
subplot(2,1,1);
plot(t,x,'g');
xlabel('time');
ylabel('amplitude');
title('sinc signal');
subplot(2,1,2);
stem(t,x,'r');
xlabel('time');
ylabel('amplitude');
title('sinc sequence');
```
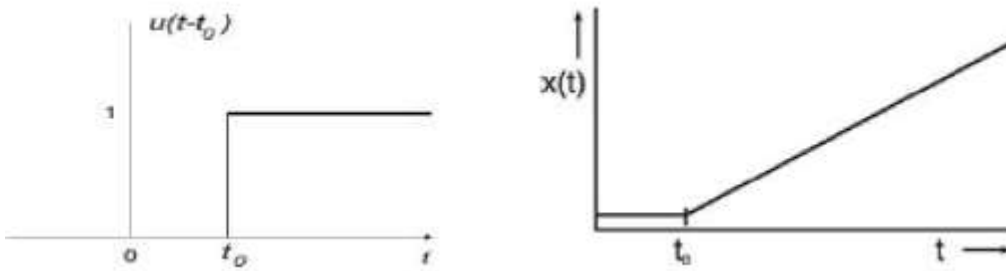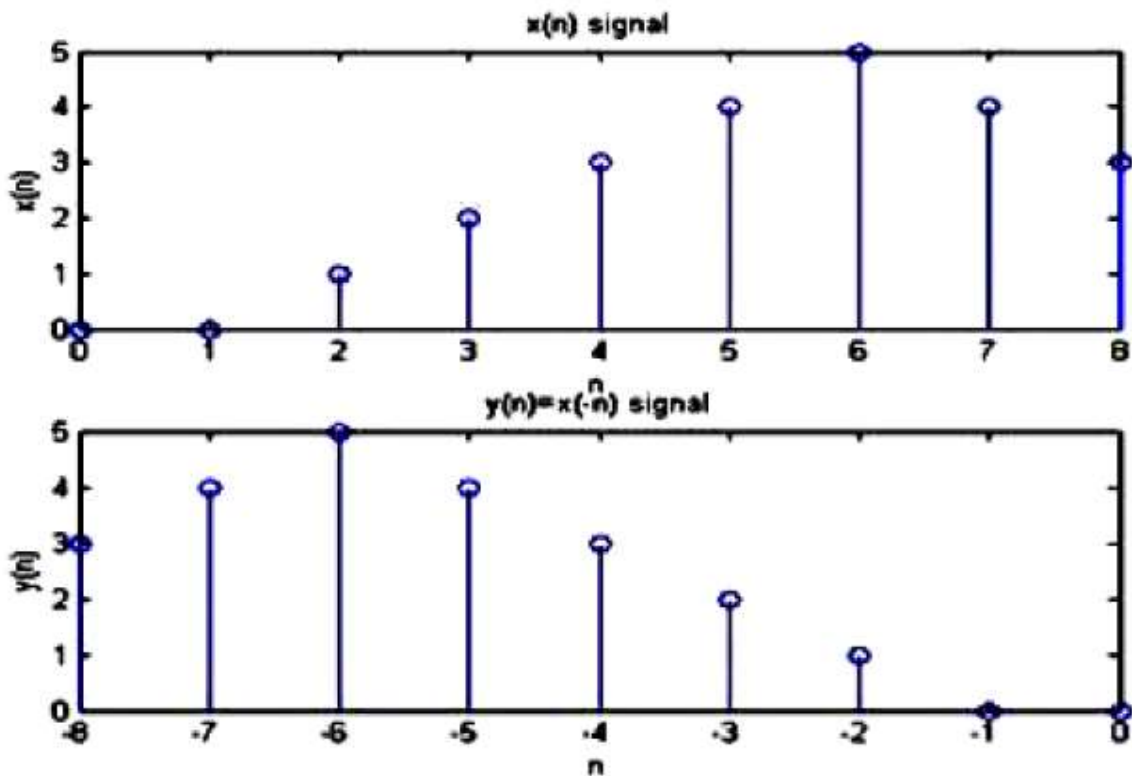
OUTPUT
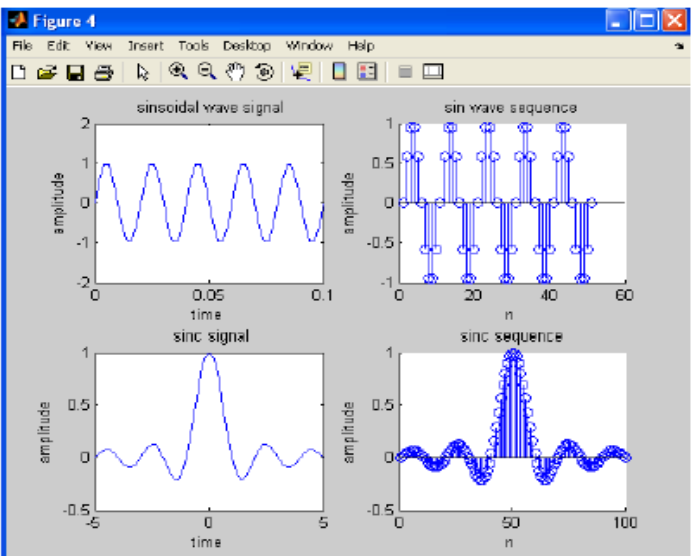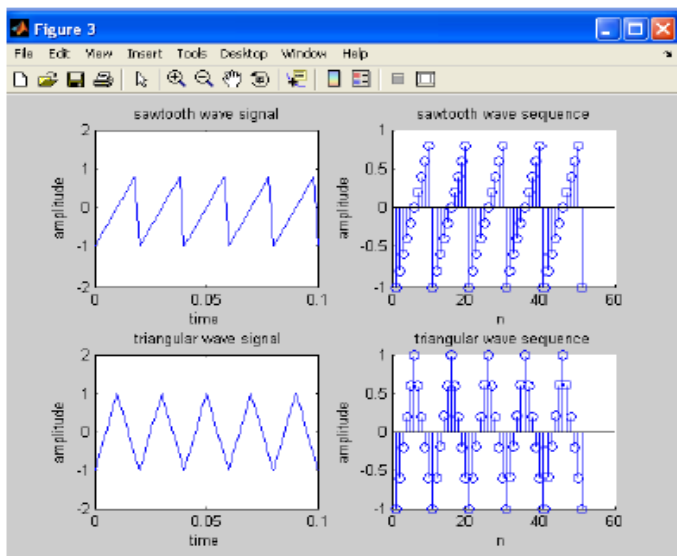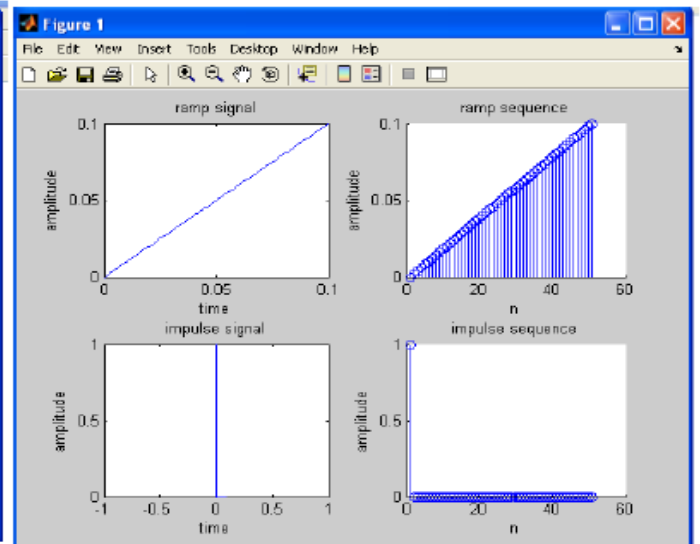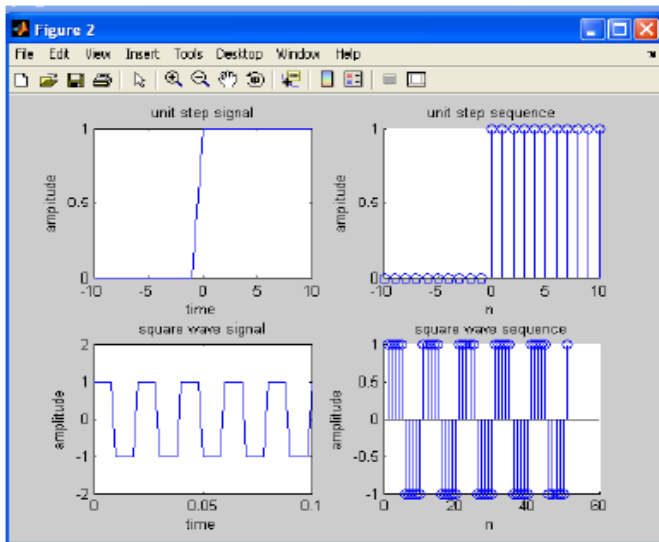
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Exercise (1)

A. Write a MATLAB program to get the output shown below where $t_0 = 2$

B. Write a MATLAB program to get the following output.

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Task 02: Verify the Linearity of a given Discrete System.

Program

```
clc;
clear all;
close all;
% entering two input sequences and impulse sequence
x1 = input (' type the samples of x1 ');
x2 = input (' type the samples of x2 ');
if(length(x1)~=length(x2))
disp('error: Lengths of x1 and x2 are different');
return;
end;
h = input (' type the samples of h ');
% length of output sequence
N = length(x1) + length(h) -1;
disp('length of the output signal will be ');
disp(N);
% entering scaling factors
a1 = input (' The scale factor a1 is ');
a2 = input (' The scale factor a2 is ');
x = a1 * x1 + a2 * x2;
% response of x and x1
yo1 = conv(x,h);
y1 = conv(x1,h);
% scaled response of x1
y1s = a1 * y1;
% response of x2
y2 = conv(x2,h);

% scaled response of x2
y2s = a2 * y2;
yo2 = y1s + y2s;
disp ('Input signal x1 is '); disp(x1);
disp ('Input signal x2 is '); disp(x2);
disp ('Output Sequence yo1 is '); disp(yo1);
disp ('Output Sequence yo2 is '); disp(yo2);
/if ( yo1 == yo2 )
disp(' yo1 = yo2. Hence the LTI system is LINEAR ')
end;
```

Output

Type the samples of x1 [1 5 6 7]
Type the samples of x2 [2 3 4 8]
Type the samples of h [2 6 5 4]
Length of the output signal will be
7
The scale factor a1 is 2
The scale factor a2 is 3
Input signal x1 is
1 5 6 7
Input signal x2 is
2 3 4 8
Output Sequence yo1 is
16 86 202 347 424 286 152
Output Sequence yo2 is
16 86 202 347 424 286 152
yo1 = yo2. Hence the LTI system is LINEAR

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Task 03: Verify the Time Invariance of a given Discrete System.
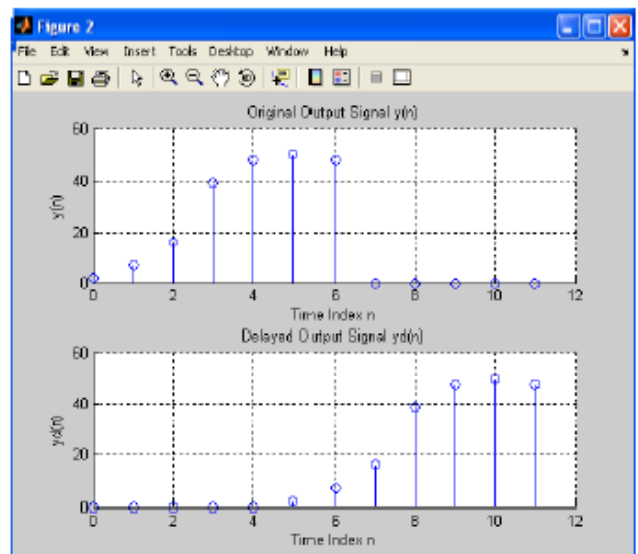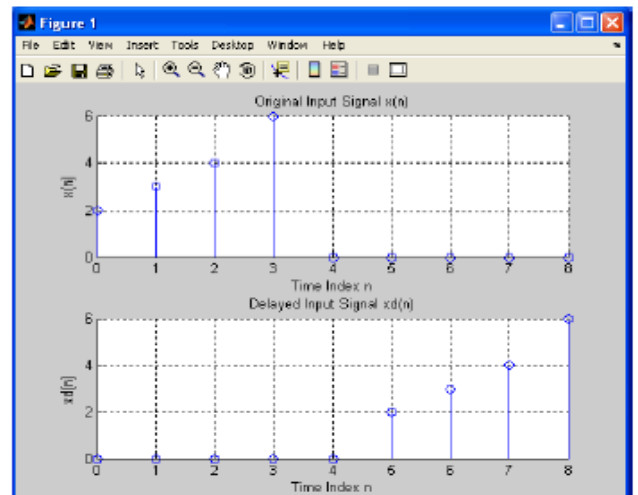
Program

```
clc;
clear all;
close all;
% entering two input sequences
x = input(' Type the samples of signal x(n) ');
h = input(' Type the samples of signal h(n) ');
% original response
y = conv(x,h);
disp(' Enter a POSITIVE number for delay ');
d = input(' Desired delay of the signal is ');
% delayed input
xd = [zeros(1,d), x];
nxd = 0 : length(xd)-1;
%delayed output
yd = conv(xd,h);
nyd = 0:length(yd)-1;
disp(' Original Input Signal x(n) is ');
disp(x);
disp(' Delayed Input Signal xd(n) is ');
disp(xd);
disp(' Original Output Signal y(n) is ');
disp(y);
disp(' Delayed Output Signal yd(n) is ');
disp(yd);
xp = [x , zeros(1,d)];
subplot(2,1,1);
stem(nxd,xp);
grid;
xlabel(' Time Index n ');
ylabel(' x(n) ');
title(' Original Input Signal x(n) ');
subplot(2,1,2);
stem(nxd,xd);
grid;
xlabel(' Time Index n ');
ylabel(' xd(n) ');
title(' Delayed Input Signal xd(n) ');
yp = [y zeros(1,d)];

figure;
subplot(2,1,1);
stem(nyd,yp);
grid;
xlabel(' Time Index n ');
ylabel(' y(n) ');
title(' Original Output Signal y(n) ');
subplot(2,1,2);
stem(nyd,yd);
grid;
xlabel(' Time Index n ');
ylabel(' yd(n) ');
title(' Delayed Output Signal yd(n) ');
```

Output

Type the samples of signal x(n) [2 3 4 6]
Type the samples of signal h(n) [1 2 3 8]
Enter a POSITIVE number for delay
Desired delay of the signal is 5
Original Input Signal x(n) is
2 3 4 6
Delayed Input Signal xd(n) is
0 0 0 0 0 2 3 4 6
Original Output Signal y(n) is
2 7 16 39 48 50 48
Delayed Output Signal yd(n) is
0 0 0 0 0 2 7 16 39 48 50 48

The Time Invariance of a given Discrete System is verified from output figure below.
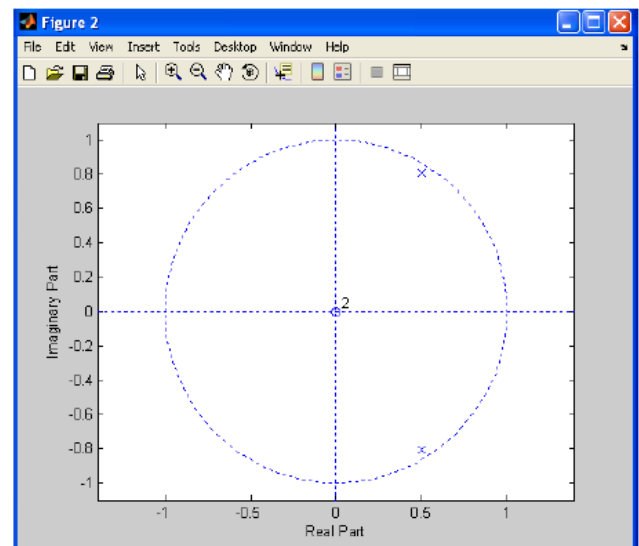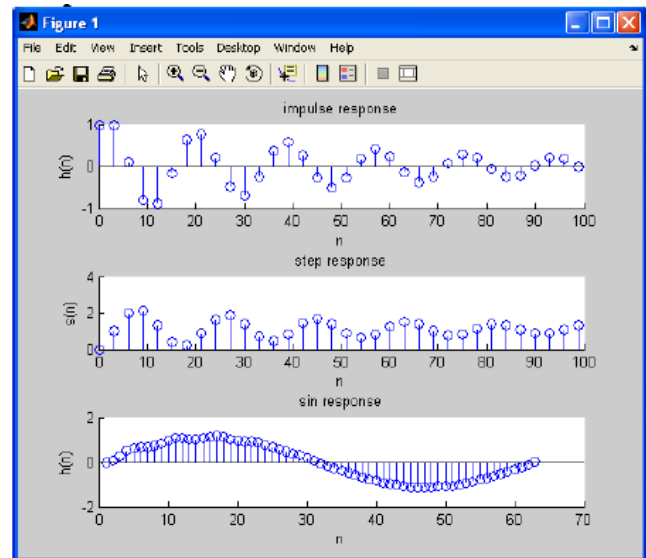
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Task 04: Compute the Unit impulse, unit step and sinusoidal response of the given LTI system and verifying its stability

Program

```
%given difference equation y(n)-y(n-1)+.9y(n-2)=x(n);
b=[1];
a=[1,-1,.9];
n =0:3:100;
%generating impulse signal
x1=(n==0);
%impulse response
h1=filter(b,a,x1);
subplot(3,1,1);
stem(n,h1);
xlabel('n');
ylabel('h(n)');
title('impulse response');
%generating step signal
x2=(n>0);
% step response
s=filter(b,a,x2);
subplot(3,1,2);
stem(n,s);
xlabel('n');
ylabel('s(n)')
title('step response');

%generating sinusoidal signal
t=0:0.1:2*pi;
x3=sin(t);
% sinusoidal response
h2=filter(b,a,x3);
subplot(3,1,3);
stem(h2);
xlabel('n');
ylabel('h(n)');
title('sin response');
% verifing stability
figure;
zplane(b,a);
```

Output

The Unit sample, unit step and sinusoidal response of the given LTI system is computed and its stability verified. Hence all the poles lie inside the unit circle, so system is stable.

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Exercise (2)

C. Write a MATLAB program to perform the convolution between X (n) = [1 2 3 5] and y (n) = [- 1 – 2]

D. Write a MATLAB program to compute the cross correlation between signals and Sequences. x=cos(2*pi*10*t), y=cos(2*pi*15*t) by increasing the amplitude of the signal by 3 times

E. Write a MATLAB program to verify the time invariance property of the following sequence x1= sin(2*pi*1*n); x2= sin(2*pi*2*n), and check whether it satisfies the time invariance property or not.

F. Calculate resonance frequency and plot the response curves for Impedance, reactance and current for series and parallel RLC circuit.

G. Consider the mechanical system depicted in the figure. The input is given by f(t), and the output is given by y(t). Determine the differential equation governing the system and using MATLAB, write a m-file and plot the system response such that forcing function f(t)=1. Let m=10, k=1 and b=0.5. Show that the peak amplitude of the output is about 1.8.
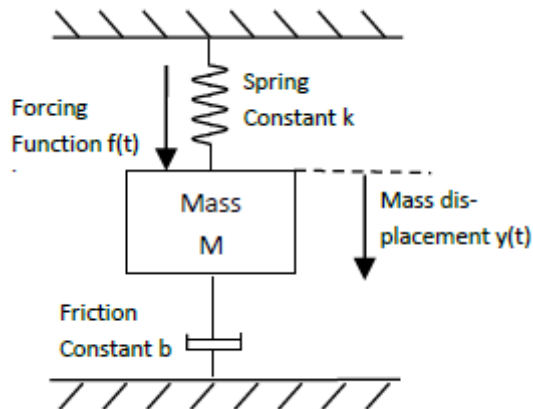
H. A system has a transfer function $\frac{X(s)}{R(s)} = \frac{(15/z)(s+z)}{s^2+3s+15}$. Plot the response of the system when R(s) is a unit impulse and unit step for the parameter z=3, 6 and 12.