Department of Electrical Engineering

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Course/Section: **BEE-6B**   **Semester:**   **4th Semester**

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EE-232 Signals and Systems

Lab Report #5 Introduction to Properties of Systems

Matlab code:

```
clc;
clear all;
R=[-10:1:10];%Index vector
X1=zeros(1,length(R)),X1(11)=100;%impluse signal
X2=2*X1;%second scaled impluse signal
LHS=sin((pi/2)*(X1+X2));
RHS=sin((pi/2)*X1)+sin((pi/2)*X2);%superposition theorem
stem(R,LHS,'ro')
hold on
stem(R,RHS,'go')
legend('sin((pi/2)*(X1+X2))','sin((pi/2)*X1)+sin((pi/2)*X2)');
hold off
```

We check superposition, but it not holds for this function. Therefore, function is non-linear.

Matlab graph:
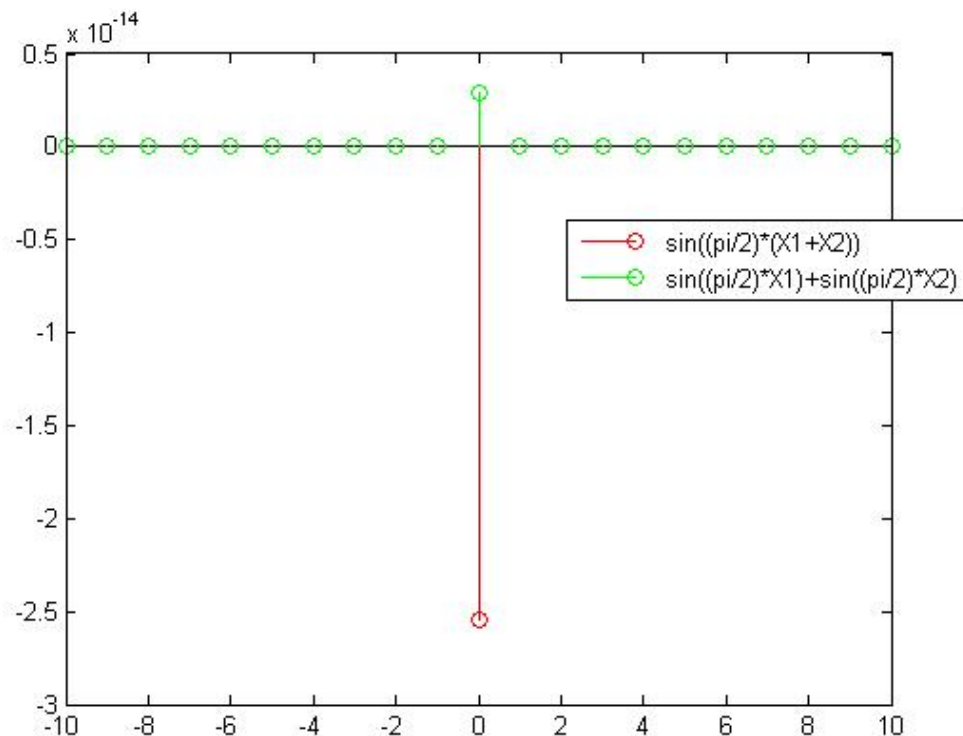
b)

Matlab code:

```
clc
clear all
R=[-5:0.1:9];%index for input
R1=[-5:0.1:8];%index for output
x=heaviside(R);%input unit signal
y=x(1:length(R1))+x(11:length(R));%output signal
length(y)
plot(R,x,'r')
hold on
plot(R1,y,'g')
axis([-5 9 -1 3])
legend('Input','Output')
hold off
```

Considering input and output, function is non causal because output gives response before input impulse given to system.

Matlab graph:
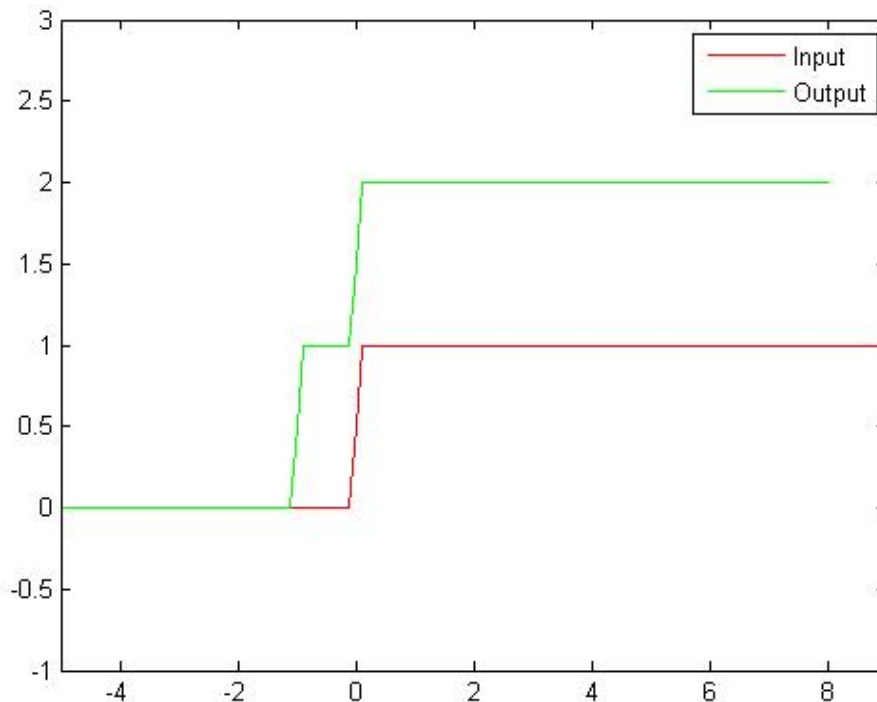
c)

Matlab code:

```
clc;
clear all;
R=[-10:0.1:10];%index for input signal
R1=[-10:0.1:11];%index for output
Yr=[-5:0.1:5];%index for shifted input signal
Yr1=[-5:0.1:5.5];%index for output of shifted input signal

X=exp(R);%input signal
Xs=[zeros(1,10),exp(R)];%input shifted signal
Y=X(1:2:length(X));%output signal
Y1=Xs(1:2:length(Xs));%output of shifted input signal

subplot(121)
plot(R,X,'r')
hold on
plot(Yr,Y,'g')
axis([-11.5 11.5 -0.5 exp(10.1)])
legend('Input','Outtput')
hold off

subplot(122)

plot(R,X,'r')
hold on
plot(Yr,Y,'g')

plot(R1,Xs,'b')

plot(Yr1,Y1,'y')
axis([-11.5 11.5 -0.5 exp(10.1)])
legend('Input','Outtput','shifted Input','output of shifted input')
hold off
```
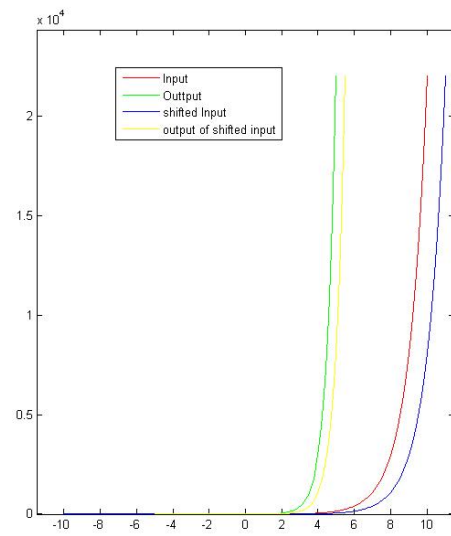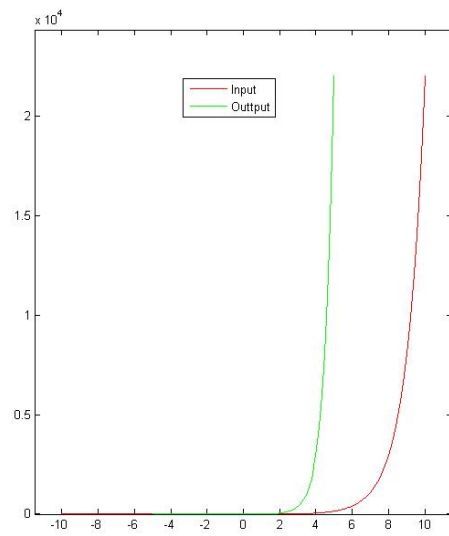
System is time variant because shifted input not shift output with same scale.

Matlab graph:

Pre-Lab:

Commutative property:

Matlab code:

```
clc
clear all
x = [2 3 6 4 8 9 2];%first vector
y = [2 1 0 3 4 8 3];%second vector
disp('x*y is:');
A1=conv(x,y)%convolution
disp('y*x is:');
A2=conv(x,y)%convolution
disp('Commutative property holds');
```

Matlab graph:

```
x*y is:

A1 =

     4     8    15    20    37    72    79    99   109   118   104    43     6

y*x is:

A2 =

     4     8    15    20    37    72    79    99   109   118   104    43     6

Commutative property holds
```

Associative property:

Matlab code:

```
clc
clear all
x = [2 3 6 9 2];%first vector
y = [2 1 4 3];%second vector
z = [6 5 9 8 2];%Third vector
disp('x*(y*z) is:');
A1=conv(x,conv(y,z))%convolution
disp('(x*y)*z is:');
A2=conv(conv(x,y),z)%convolution
disp('Associative property holds');
```

Matlab graph:

```
x*(y*z) is:

A1 =

  Columns 1 through 7

        24          68         214         471         765        1144        1286

  Columns 8 through 12

       1167         885         446         118          12

(x*y)*z is:

A2 =

  Columns 1 through 7

        24          68         214         471         765        1144        1286

  Columns 8 through 12

       1167         885         446         118          12

Associative property holds
```

d)

<u>Matlab code</u>:

```
clc
clear all
x = [1 2 3 4 5];%first vector
y = [1 1 1 1 1];%second vector
disp('x*y is:');
A1=conv(x,y)%convolution
disp('y*x is:');
A2=conv(x,y)%convolution
```

Convolution holds commutative property.

<u>Matlab graph</u>:

```
x*y is:

A1 =

    1    3    6   10   15   14   12    9    5

y*x is:

A2 =

    1    3    6   10   15   14   12    9    5
```

Matlab code:

```matlab
pic=imread('aaaaa.jpg');
H1=[0.25 0.5 0.25];%coloum filter
H2=[0.25;0.5;0.25];%row filter
H3=convn(H1,H2);%convn for multi-dimension
y1=convn(pic,H3);%R:H:S
H4=convn(pic,H1);
y2=convn(H4,H2);%L:H:S
subplot(221)
imshow(pic)
title('orignal')
subplot(222)
imshow(y1)
title('R:H:S')
subplot(223)
imshow(y2)
title('L:H:S')
```

As L:H:S and R:H:S are equal, so associative property verified in convolution.

Matlab graph: