Problems

1. Find the convolution result of the following signal using basic convolution formula :
   $X_1(n1) = [1,1,1,1,1]$
   $n1 = [-2,-1,0,1,2]$

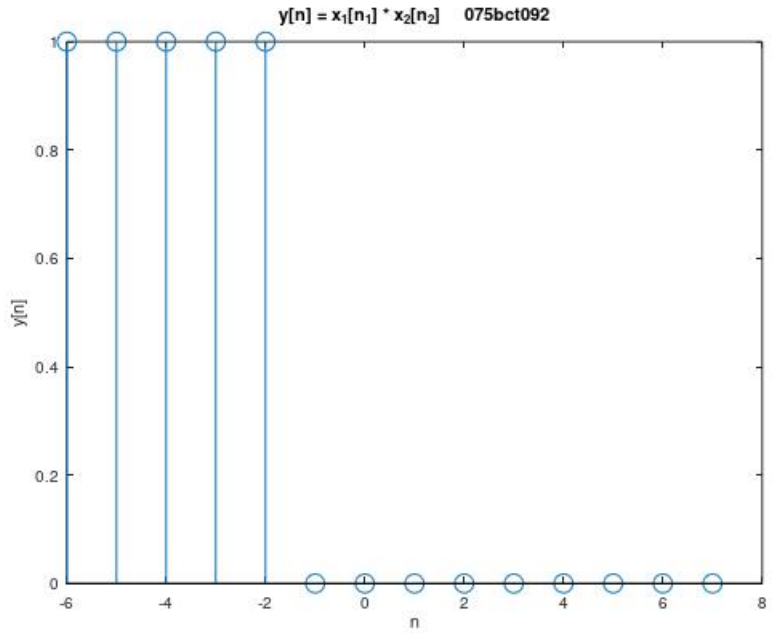
   $X2(n2) = [1,0,0,0,0,0,0,0,0,0]$
   $n2 = [-4,-3,-2,-1,0,1,2,3,4,5]$
   X2 is a periodic signal.
   $Y2 = X1 * X2$

Ans:

```
n1 = [-2,-1,0,1,2];
x1 = [1,1,1,1,1];
n2 = [-4,-3,-2,-1,0,1,2,3,4,5];
x2 = [1,0,0,0,0,0,0,0,0,0];

i= -6:7;
s = zeros(1,length(i));
[y2_fold,n_fold] = sigfold(x1,n1);
temp = 1;
for j = i

[y_shift,n_shift] = sigshift_m(y2_fold,n_fold,j);
[y_multiply,n_multiply] = sigmulti(y_shift,n_shift,x2,n2);
 for k = 1:length(n_multiply)
 s(temp) = s(temp) + y_multiply(k);
end
temp = temp+1;
end

stem(i,s);
title('y[n] = x_1[n_1] * x_2[n_2]     075bct092');
xlabel('n');
ylabel('y[n]');

function [y,n] = sigshift_m(x,m,n0)
n = m + n0;
y = x;
end

function [y,n] = sigfold(x,n)
  y = fliplr(x);
  n = -fliplr(n);
  stem(n,y)
end
```

```
function[y,n] = sigmulti(x1,n1,x2,n2)
n = min(min(n1),min(n2)):max(max(n1),max(n2));
y1=zeros(1,length(n));
y2 = y1;
y1((n>=min(n1))&(n<=max(n1))==1)=x1;
y2((n>=min(n2))&(n<=max(n2))==1)=x2;
y = y1.*y2;
end
```

OUTPUT:



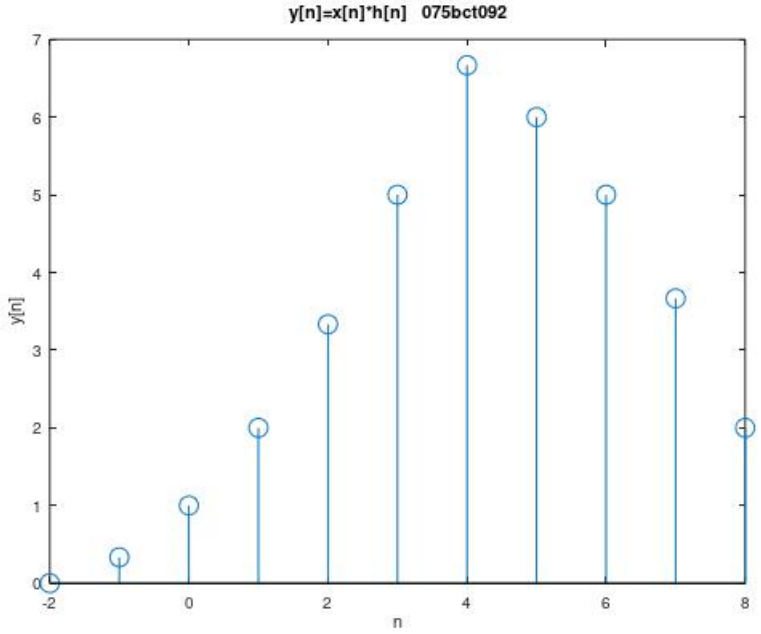
2. Find the convolution using conv function

a. $x[n]=\begin{cases}\frac{1}{3}n & for\ 0\le n\le 6\\ 0 & else\end{cases}$ **and**

$h[n]=\begin{cases}1 & for\ -2\le n\le 2\\ 0 & else\end{cases}$

Ans:
```
n1= [0,1,2,3,4,5,6];
x1=[0,1/3,2/3,1,4/3,5/3,2];
n2=[-2,-1,0,1,2];
x2=[1,1,1,1,1];
y=conv(x1,x2);
n=-2:8;
stem(n,y);
title('y[n]=x[n]*h[n]   075bct092');
xlabel('n');
ylabel('y[n]');
```

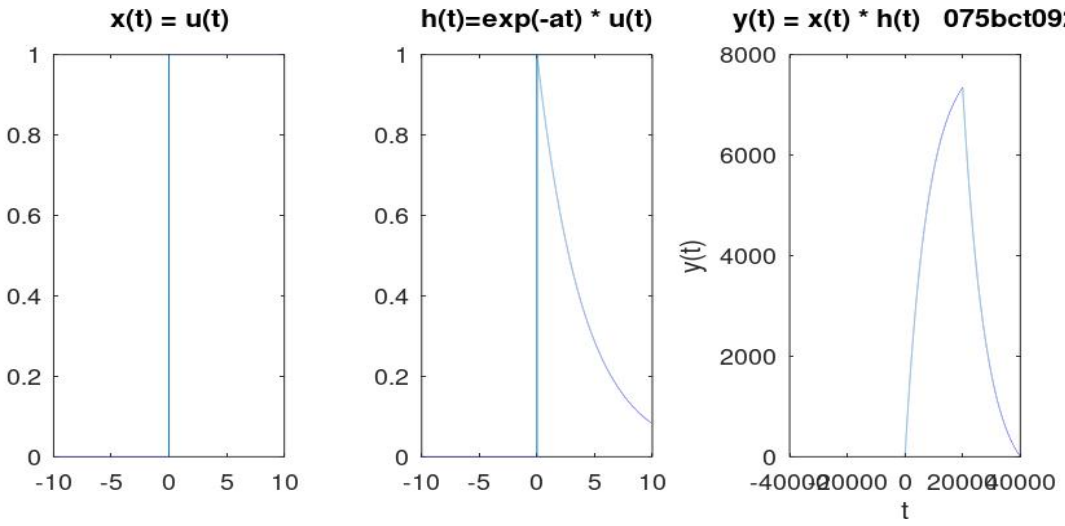
OUTPUT:



b. $x(t) = u(t)$
$h(t) = e^{-at} u(t)$, where $a>0$

Ans:
```
t= -10:0.0005:10;
ut = (t>=0);
xt = double(ut);
a= 0.25;
ht=exp(-a*t).*ut;
subplot(1,3,1);
plot(t,xt);
title('x(t) = u(t)');

subplot(1,3,2);
plot(t,ht);
title('h(t)=exp(-at) * u(t)');

subplot(1,3,3);
r = -(length(t)-1):length(t)-1;
y=conv(xt,ht);
plot(r,y)
title('y(t) = x(t) * h(t)   075bct092');
xlabel('t');
ylabel('y(t)');
```

OUTPUT:



3. Consider two discrete time sequences **x[n]** and **h[n]** given by

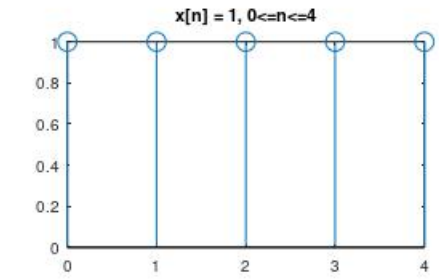
   x[n] = 1 for $0 \le n \le 4$, elsewhere 0
   h[n] = 2^n for $0 \le n \le 6$, elsewhere 0

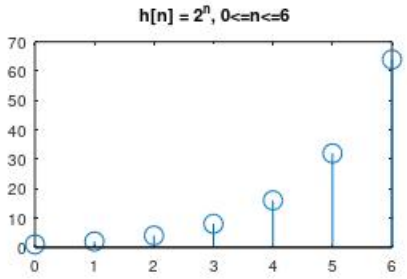
   a. Find the response of the LTI system with impulse response **h[n]** to input **x[n]**.
   b. Plot the signals and comment on the result.

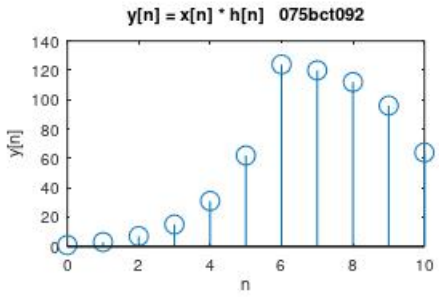
Ans:

```
n1 = [0,1,2,3,4];
x1 = [1,1,1,1,1];
n2 = [0,1,2,3,4,5,6];
h2 = [2^0,2^1,2^2,2^3,2^4,2^5,2^6];
y = conv(x1,h2);
n = 0:10;
subplot(2,2,1);
stem(n1,x1);
title('x[n] = 1, 0<=n<=4');
subplot(2,2,2);
stem(n2,h2);
title('h[n] = 2^n, 0<=n<=6');
subplot(2,2,3);
stem(n,y);
title('y[n] = x[n] * h[n]   075bct092');
xlabel('n');
ylabel('y[n]');
```

OUTPUT:







4. If the impulse response of a LTI system is given by **sinc** function as

$h[n] = 2\tau/T_p \, \text{sinc}(k\, 2\tau/T_p)$

and input signal is a rectangular wave given by

$x(t) = 1$ for $1 \le t \le 100$

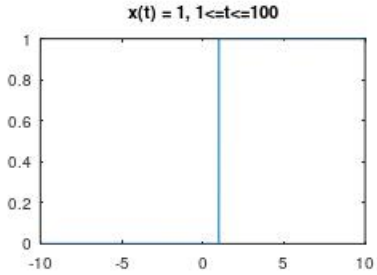
0 elsewhere,

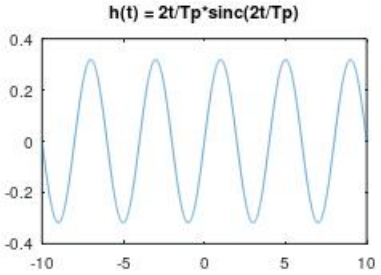
Find output of the system for different values of τ. Comment on the result.

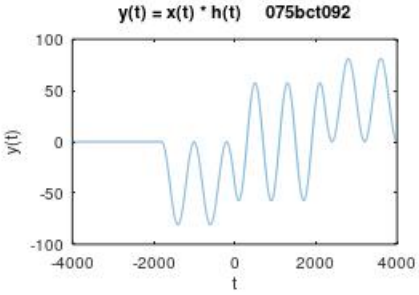
Ans:

```
t = -10:0.005:10;
Tp = 4;
ht = 2*t/Tp.*sinc(2*t/Tp);
xt = double(and(t>=1,t<=100));
subplot(2,2,1);
plot(t,xt);
title('x(t) = 1, 1<=t<=100');
subplot(2,2,2);
plot(t,ht);
title('h(t) = 2t/Tp*sinc(2t/Tp)');
subplot(2,2,3);
r = -(length(t)-1):length(t)-1;
y = conv(xt,ht);
plot(r,y)
title('y(t) = x(t) * h(t)     075bct092');
xlabel('t');
ylabel('y(t)');
```

OUTPUT:


x(t) = 1, 1<=t<=100
1
0.8
0.6
0.4
0.2
0
-10
-5
0
5
10


h(t) = 2t/Tp*sinc(2t/Tp)
0.4
0.2
0
-0.2
-0.4
-10
-5
0
5
10


y(t) = x(t) * h(t) 075bct092
100
50
0
-50
-100
y(t)
-4000
-2000
0
2000
4000
t