University of Bahrain
College of Information Technology
Department of Computer Engineering

Experiment 2

Convolution

Prepared By

Name : Ali Redha Ali

ID: 20195330

Sec: 01

Course Number: ITCE340/272

Objective:

1. Introducing the implementation of different signals in MATLAB

2. Introducing the linear convolution

Introduction:

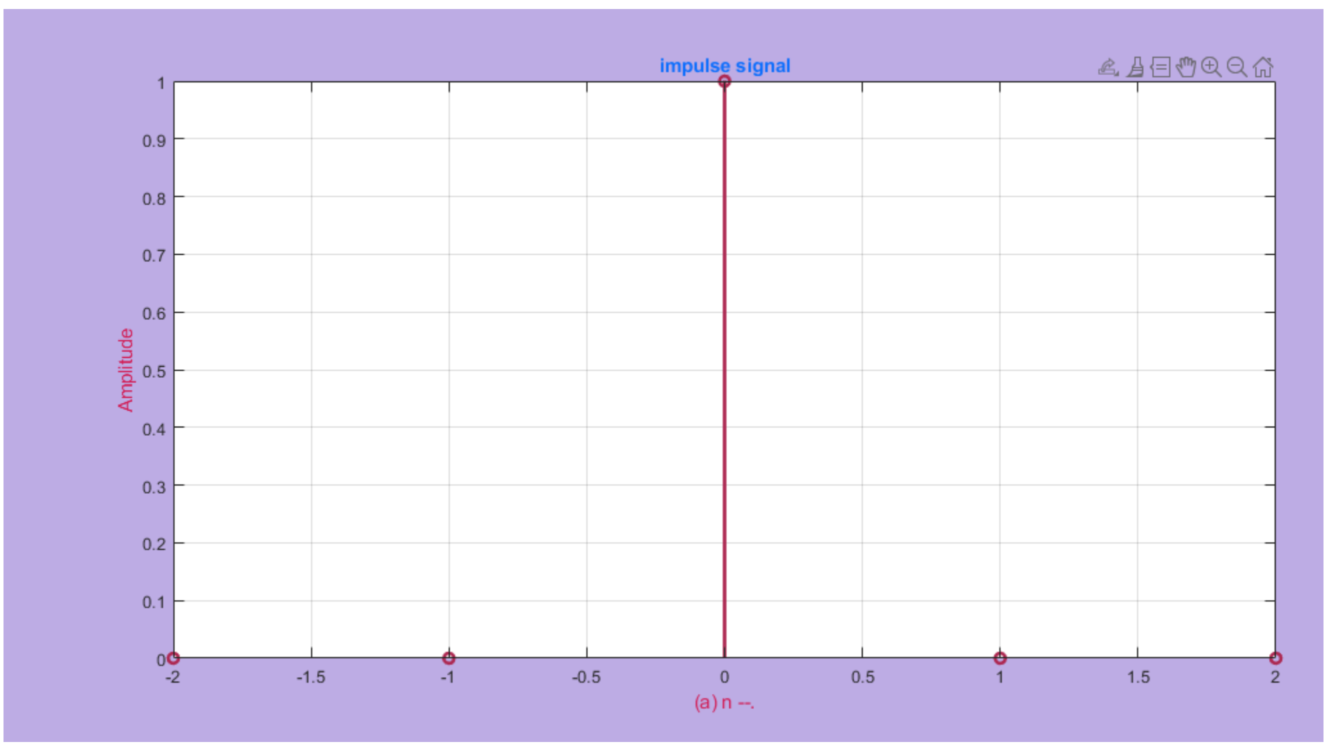
In this will lab we will learn how to do convolution in MATLAB

Procedure

a- Code and execute the following programs for the generation of unit impulse, unit step, ramp, exponential, sinusoidal and cosine sequences.

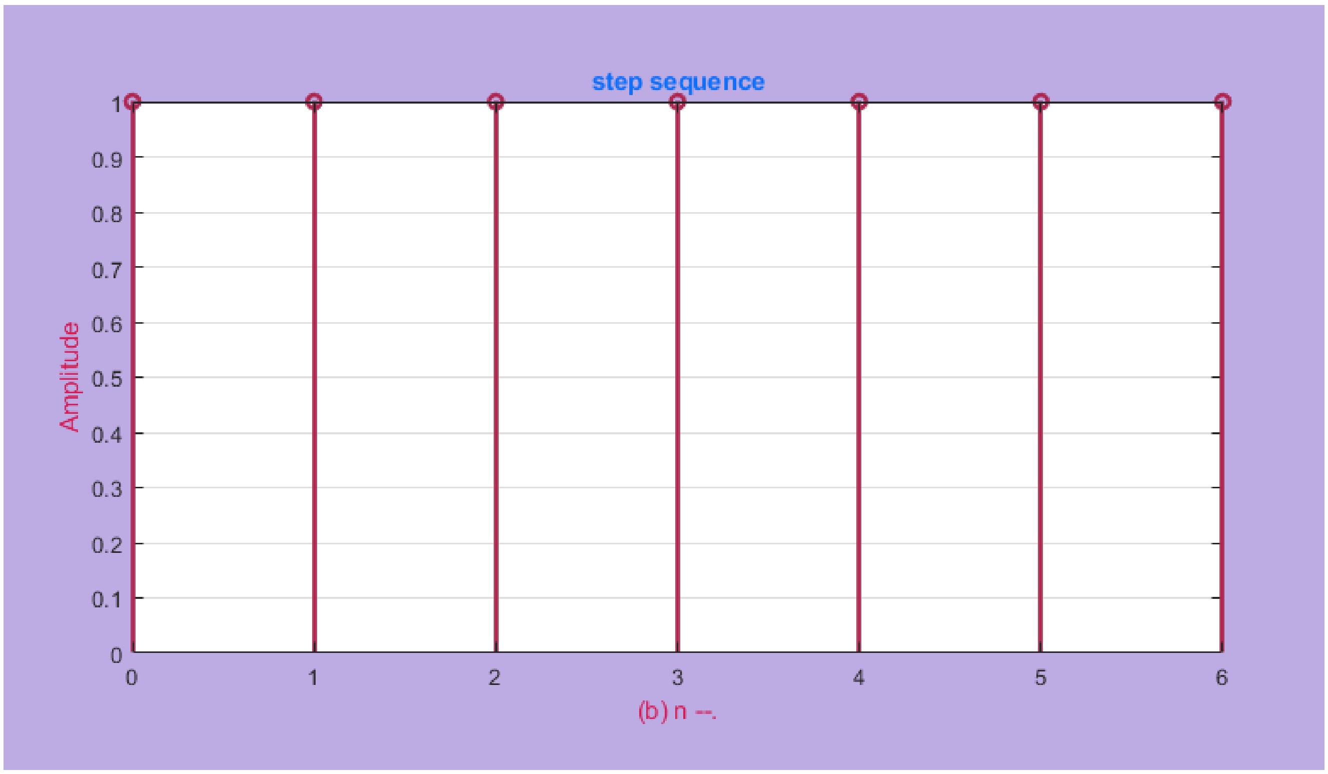
```
%%Program for the generation of unit impulse signal


f14=figure(1)
set(f14,'color','#BDACE4');
t= -2:1:2;
y=[zeros(1,2),ones(1,1),zeros(1,2)];
subplot(2,2,1);
stem(t,y ,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude','color','#D21D55');
xlabel('(a) n --.','color','#D21D55');
```



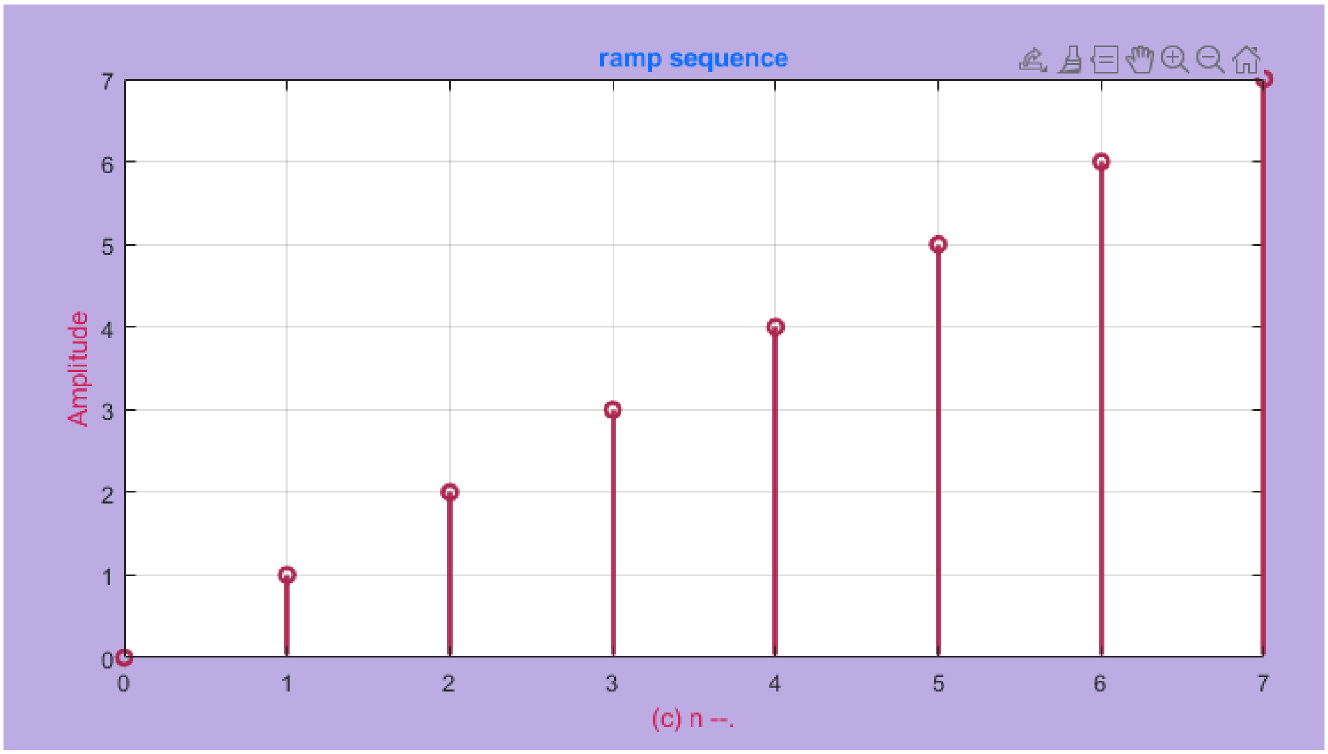
Program for the generation of unit step sequence [u(n)-u(n-N]

```
n=input('enter the N value');
t1=0:1:n-1;
y1=ones(1,n);
subplot(2,2,2);
stem(t1,y1,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude','color','#D21D55');
xlabel('(b) n --.','color','#D21D55');
```

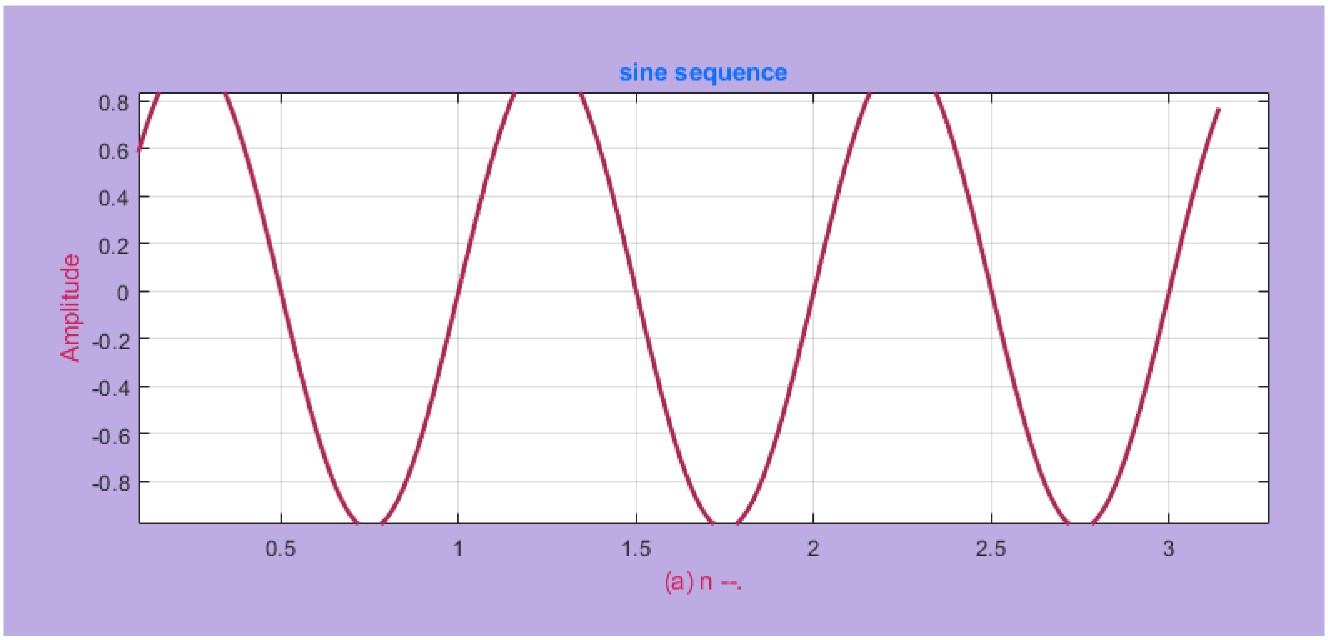


Program for the generation of ramp sequence

```
n1=input('enter the length of ramp sequence');
t2=0:n1;
subplot(2,2,3);
stem(t2,t2,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude','color','#D21D55');
xlabel('(c) n --.','color','#D21D55');
```

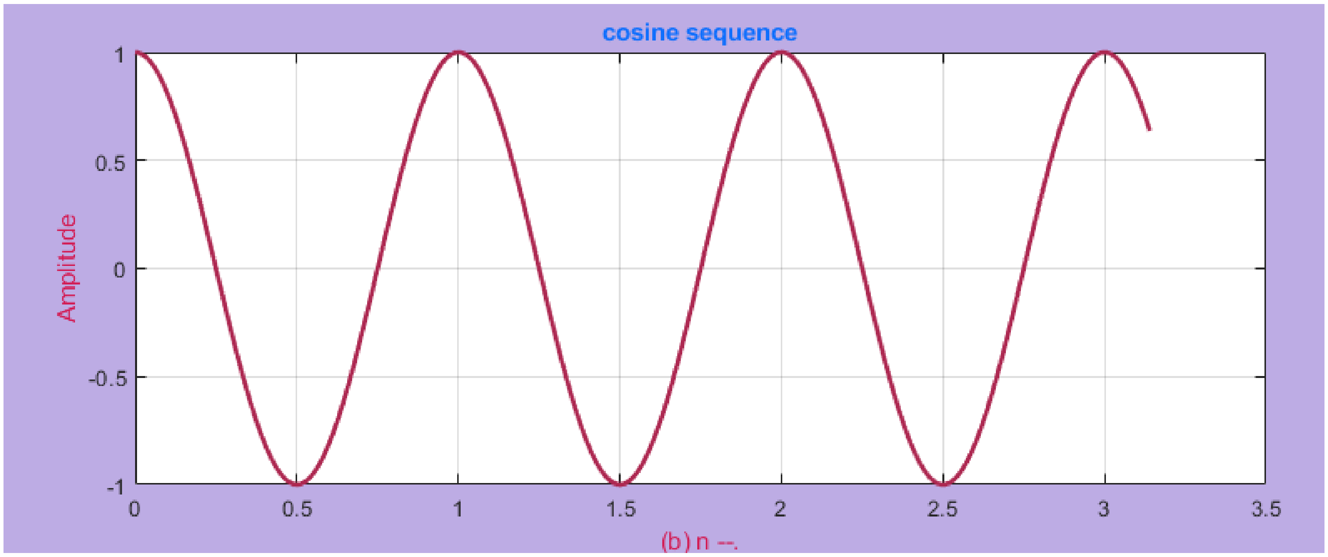


```
% % Program for the generation of sine sequence
f13=figure(2);
set(f13,'color','#BDACE4');
t=0:.01:pi;
y=sin(2*pi*t);
figure(2);
subplot(2,1,1);
plot(t,y,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude','color','#D21D55');
xlabel('(a) n --.','color','#D21D55');
title ('sine sequence','color','#0d6efd');grid on;
```



```
% % Program for the generation of cosine sequence

t=0:.01:pi;
y=cos(2*pi*t);
subplot(2,1,2);
plot(t,y,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude','color','#D21D55');
xlabel('(b) n --.','color','#D21D55');
title ('cosine sequence','color','#0d6efd');grid on;
```



b- Linear Convolution

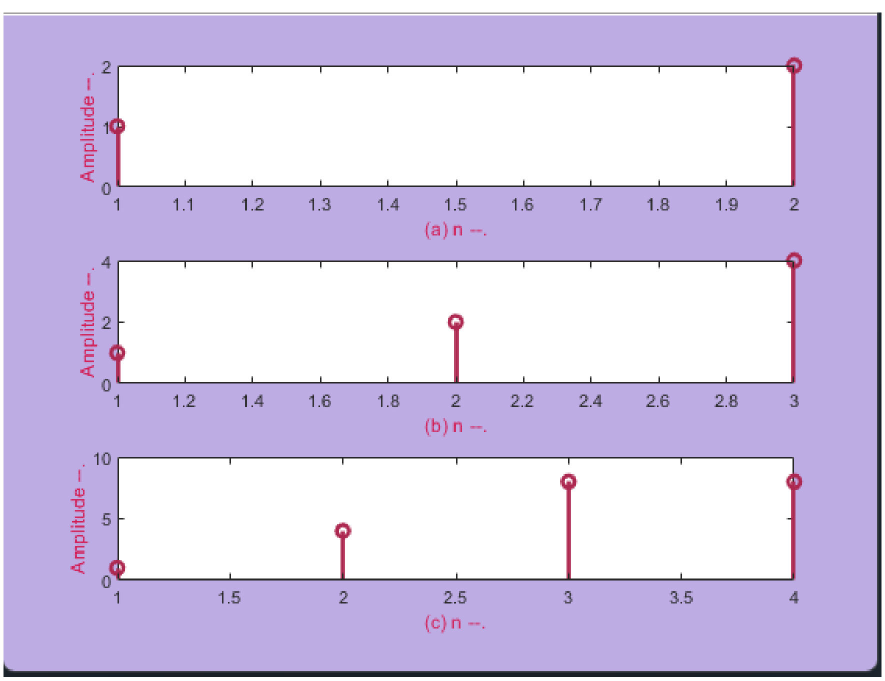
Algorithm

1. Get two signals $x(m)$and $h(p)$in matrix form
2. The convolved signal is denoted as $y(n)$
3. $y(n)$is given by the formula

$$y(n) = \sum_{k=-\infty}^{\infty} [x(k)\, h(n-k)] \text{ where } n=0 \text{ to } m + p - 1$$

4. Stop

```
%% Program for linear convolution of the sequence x=[1, 2] and h=[1, 2, 4]
f17=figure("Name",'Signals');
set(f17,'color','#BDACE4');
x=input('enter the 1st sequence');
h=input('enter the 2nd sequence');
y=conv(x,h);
subplot(3,1,1);
stem(x,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude --.','color','#D21D55');
xlabel('(a) n --.','color','#D21D55');
subplot(3,1,2);
stem(h,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude --.','color','#D21D55');
xlabel('(b) n --.','color','#D21D55');
subplot(3,1,3);
stem(y,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude --.','color','#D21D55');
xlabel('(c) n --.','color','#D21D55');
disp('The resultant signal is');
y
```

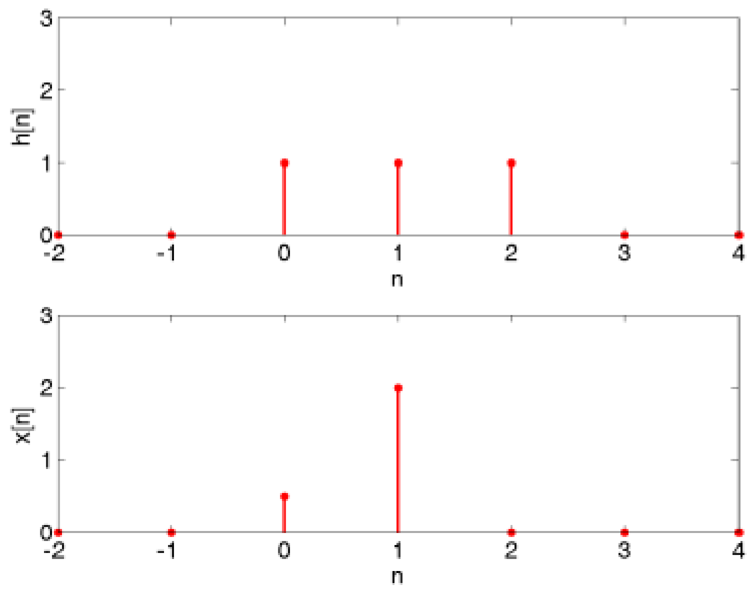


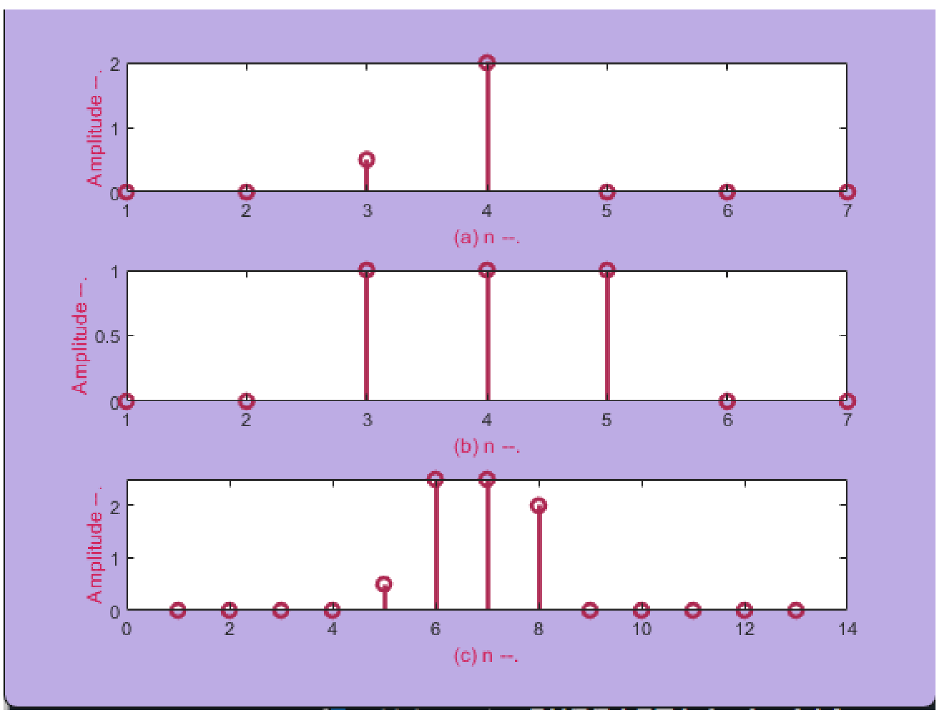
Report

1- Write a programs to implement the following:

```
%%  Program for linear convolution of the sequence x=[1, 2] and h=[1, 2, 4]
f17=figure("Name",'Signals');
set(f17,'color','#BDACE4');
x=input('enter the 1st sequence');
h=input('enter the 2nd sequence');
y=conv(x,h);
subplot(3,1,1);
stem(x,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude --.','color','#D21D55');
xlabel('(a) n --.','color','#D21D55');
subplot(3,1,2);
stem(h,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude --.','color','#D21D55');
xlabel('(b) n --.','color','#D21D55');
subplot(3,1,3);
stem(y,'color' ,'#AD2851' ,'lineWidth',2);
ylabel('Amplitude --.','color','#D21D55');
xlabel('(c) n --.','color','#D21D55');
disp('The resultant signal is');
y
```

a- Consider the following signals





```
y =

  Columns 1 through 5

         0         0         0         0    0.5000

  Columns 6 through 10

    2.5000    2.5000    2.0000         0         0

  Columns 11 through 13

         0         0         0
```

b- Consider a LTI system that has a step response h[n] = u[n] to the unit impulse input signal

n

What is the response when an input signal of the form x[n] = a u[n]

where 0<a<1, is applied?

For n□0:

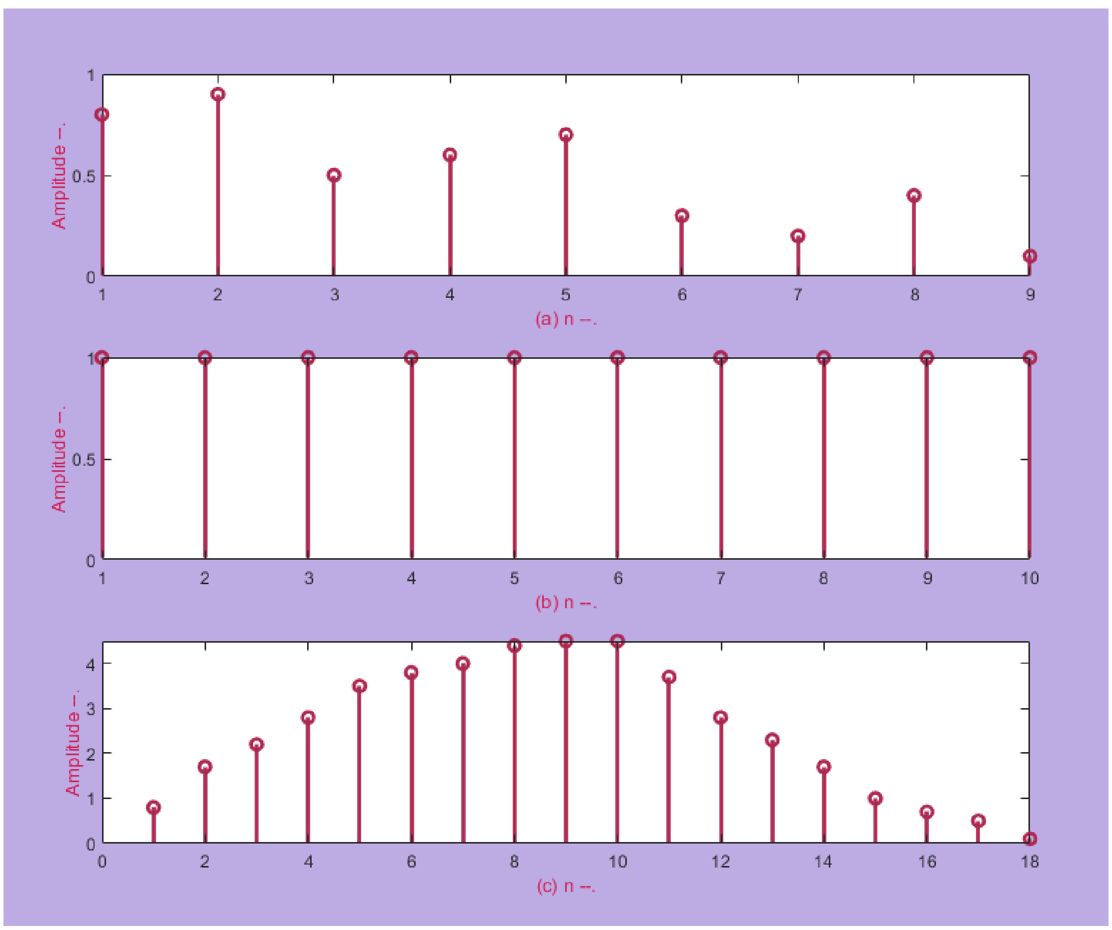
Therefore,

$$y[n] = \sum_{k=0}^{n} \alpha^{k}$$

$$= \frac{1-\alpha^{n+1}}{1-\alpha}$$

$$y[n] = \left(\frac{1-\alpha^{n+1}}{1-\alpha} \right) u[n]$$

4



c-

Let $x(t)$ be the input to a LTI system with unit impulse response $h(t)$:

$$x(t) = e^{-at}u(t) \qquad a > 0$$
$$h(t) = u(t)$$

For $t>0$:

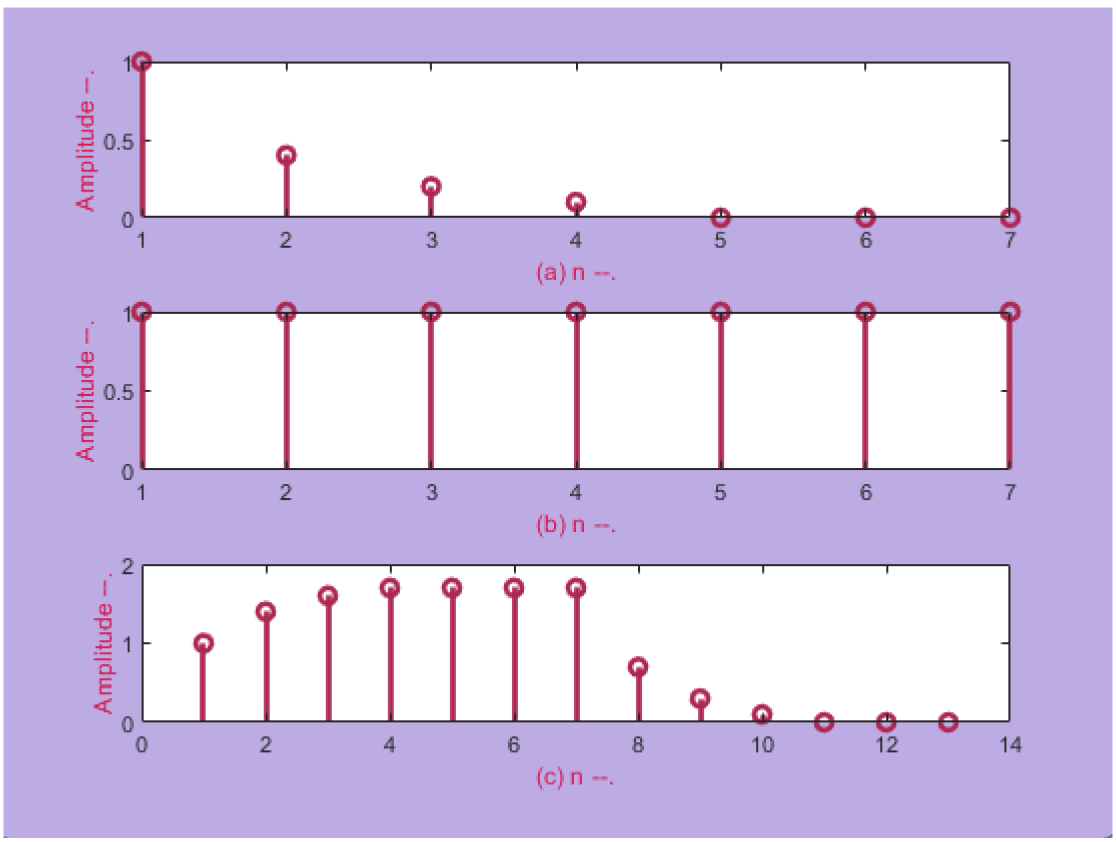
$$x(\tau)h(t-\tau) = \begin{cases} e^{-a\tau} & 0 < \tau < t \\ 0 & \text{otherwise} \end{cases}$$

We can compute $y(t)$ for $t>0$:

$$y(t) = \int_0^t e^{-a\tau} d\tau = -\tfrac{1}{a} e^{-a\tau}\Big|_0^t$$
$$= \tfrac{1}{a}\left(1 - e^{-at}\right)$$

So for all t:

$$y(t) = \tfrac{1}{a}\left(1 - e^{-at}\right)u(t)$$



Conclusion:

In this lab I learned a lot of things which are

- How to implement signal function in MATLAB
- How to use stem function in MATLAB
- How to use convolution in MATLAB
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