

2. LINEAR CONVOLUTION AND CIRCULAR CONVOLUTION

(a) LINEAR CONVOLUTION

AIM:

To perform linear convolution of two sequences without using in-built function.

APPARATUS:

PC with MATLAB

THEORY:

Convolution is a formal mathematical operation, just as multiplication, addition, and integration. Addition takes two *numbers* and produces a third *number*, while convolution takes two *signals* and produces a third *signal*. Convolution is used in the mathematics of many fields, such as probability and statistics. In linear systems, convolution is used to describe the relationship between three signals of interest: the input signal, the impulse response, and the output signal.

$$y(n) = \sum_{k=0}^{N-1} x_1(k)x_2(n-k) \quad 0 < n < N-1$$

In Linear convolution if $x_1(n)$ has L samples and $x_2(n)$ has M samples then the linear convoluted output $y(n)$ has a total of L+M-1 number of samples.

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:

```
% To verify Linear convolutions.

close all;
clear all;
clc;
clearvars
x=input('Enter x:      ')
```

DIGITAL SIGNAL PROCESSING LAB

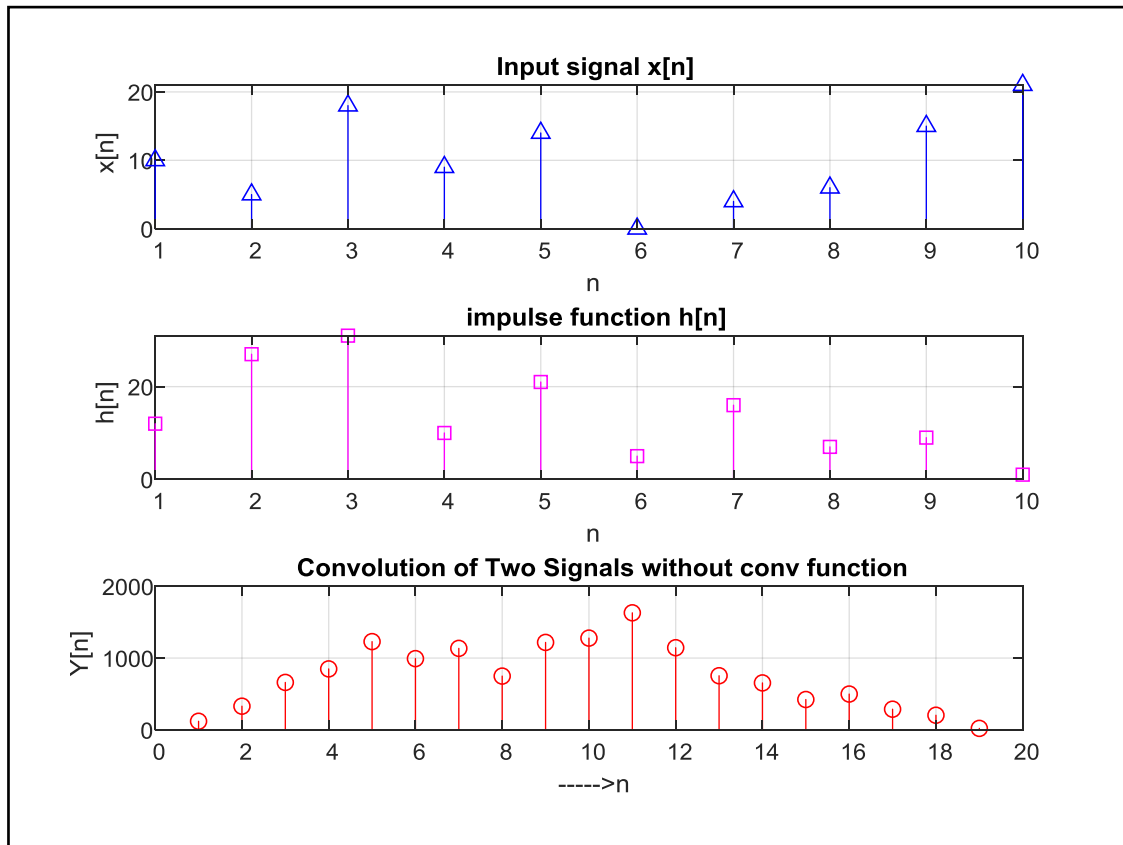
```
% x=sin(2*pi*0.1.*(1:1:11));
h=input('Enter h:  ')
% h=[1 2 3 4 5 3 1 -1];
% convolution
m=length(x);
n=length(h);
X=[x,zeros(1,n)];
H=[h,zeros(1,m)];
for i=1:n+m-1
    Y(i)=0;
    for j=1:m
        if(i-j+1>0)
            Y(i)=Y(i)+X(j)*H(i-j+1);
        else
            end
    end
end
end
% plot results
figure;
subplot(3,1,1); stem(x, '-b^'); xlabel('n');
ylabel('x[n]'); grid on;
title('Input signal x[n]');
subplot(3,1,2); stem(h, '-ms');
xlabel('n'); ylabel('h[n]'); grid on;
title('impulse function h[n]');
subplot(3,1,3); stem(Y, '-ro');
ylabel('Y[n]'); xlabel('----->n'); grid on;
title('Convolution of Two Signals without conv function');
```

INPUT:

Enter x: [10 5 18 9 14 0 4 6 15 21]

Enter h: [12 27 31 10 21 5 16 7 9 1]

OUTPUT:



RESULT:

Without using in-built function for convolution, linear convolution for two input sequences is performed.

(b).CIRCULAR CONVOLUTION**AIM:**

To perform circular convolution of two sequences without using in-built function for circularconvolution.

APPARATUS:

PC with MATLAB

THEORY:

Given two sequences $x_1(n)$ and $x_2(n)$, then the circular convolution of these 2 sequences is given by $x_3(n) = x_1(n) \circledast x_2(n)$ which is given by the following equation,

$$x_3(n) = \sum_{m=0}^{N-1} x_1(m) x_2((n-m))_N$$

It can be found by 2 methods:

1. Concentric circle method
2. Matrix Multiplication method

If $x_1(n)$ has L number of samples and $x_2(n)$ has M number of samples and $L > M$, then circular convolution between the 2 sequences can be performed by taking $N = \max(L, M)$ by adding L-M number of zero samples to the sequence $x_2(n)$ so that both the sequences are periodic with N.

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:

```
% To verify Circular convolutions.

clc;
close all; clear all;
x=input('Enter x(n):\n');
h=input('Enter h(n):\n');
m=length(x);%length of sequence x(n)
n=length(h);%length of sequence h(n)
N=max(m,n);%length of output sequence y(n)
%For equating both sequence length
x=[x,zeros(1,N-m)];
```

```

h=[h,zeros(1,N-n)];
for n=1:N
    Y(n)=0;
    for i=1:N
        j=n-i+1;
        if(j<=0)
            j=N+j;
        end
        Y(n)=[Y(n)+x(i)*h(j)];
    end
end
n=0:N-1;%Range of all Sequences
figure('Name','Anil Kumar Soni');
subplot(311)
disp('First Sequence x(n) is:')
disp(x)
stem(n,x)
xlabel('n')
ylabel('x(n)')
title('First Sequence')
grid on;
subplot(312)
disp('Second Sequence h(n) is:')
disp(h)
stem(n,h)
xlabel('n')
ylabel('h(n)')
title('Second Sequence')
grid on;
subplot(313)
disp('Convolutd Sequence Y(n) is:')
disp(Y)
stem(n,Y)
xlabel('n')
ylabel('Y(n)')
title('Circular Convolutd Sequence')
grid on;

```

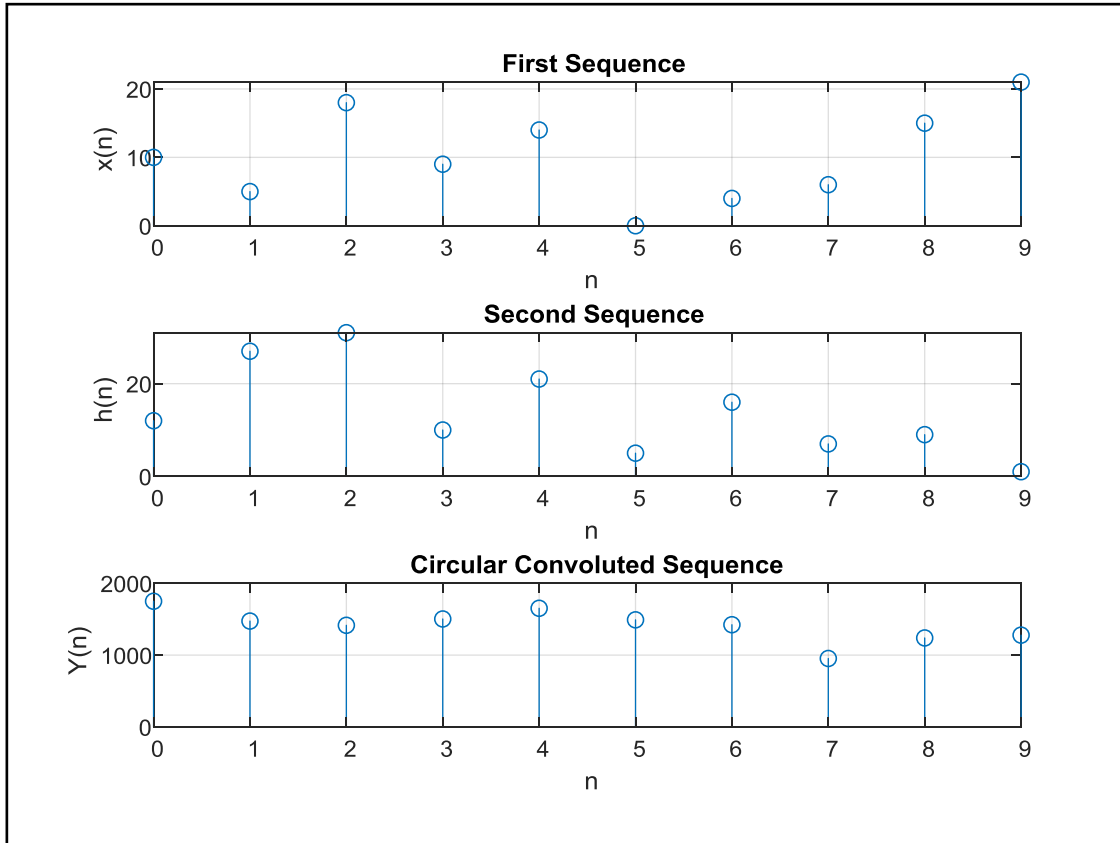
INPUT:

Enter x: [10 5 18 9 14 0 4 6 15 21]

Enter h: [12 27 31 10 21 5 16 7 9 1]

OUTPUT:

Circular convolution of two sequences is.



RESULT:

Without using built-in function for convolution, circular convolution of two input sequences is performed.