Experiment No: 3 Date: 08/08/2024

Linear Convolution

Aim

To find the Linear Convolution of

i. x[n] = [1 2 1 1] h[n] = [1 1 1 1]
ii. x[n] = [1 2 1 2] h[n] = [3 2 1 2]

Theory

Linear Convolution is a mathematical operation used to combine two signals and then produce third signals, applications in filters, Image Processing, Audio Processing, Signal Processing etc.

Given two signals x(t) and h(t), then mathematically,

$$y(t) = x(t)^{*}h(t)\int_{-\infty}^{+\infty} x(\tau)h(t-\tau)d\tau$$

Program

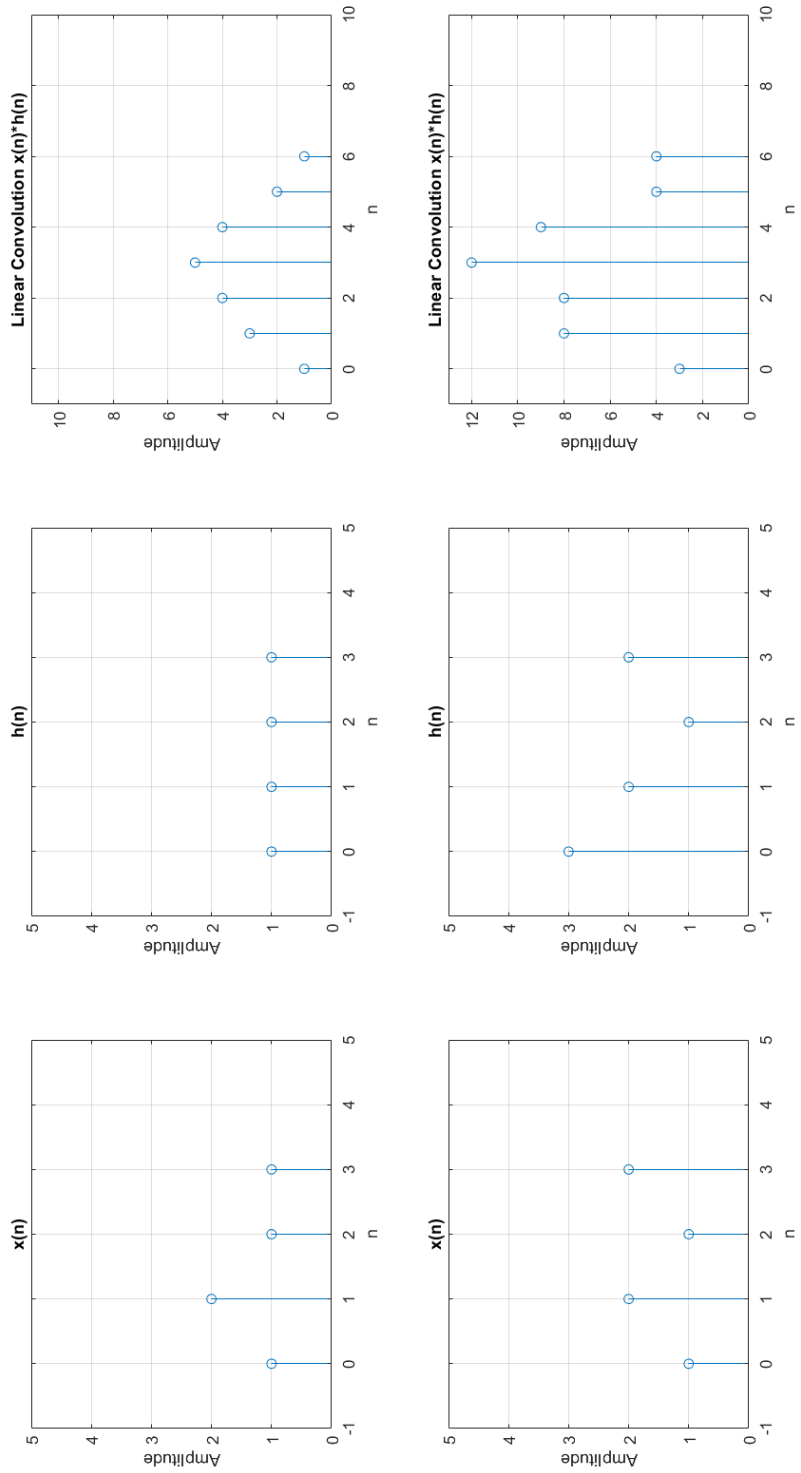
→Using Built-in Function

```
%Q1
% Linear Convolution of :- Q1: x(n)=[1 2 1 1]  , h(n)=[1 1 1 1]

clc;
clear;
close;
t = 0:1:6;
t1 = 0:1:3;
t2 = 0:1:3;
xn1 = [1 2 1 1];
hn1 = [1 1 1 1];
yn1 = conv(xn1, hn1);
disp('Linear Convolution of :- Q1: x(n)=[1 2 1 1]  ,h(n)=[1 1 1 1]')
disp(yn1);

subplot(2,3,1);
stem(t1,xn1);
axis([-1 5 0 5]);
xlabel('n');
ylabel('Amplitude');
title('x(n)');
grid on;

subplot(2,3,2);
stem(t2,hn1);
xlabel('n');
```

```
ylabel('Amplitude');
grid on;
axis([-1 5 0 5]);
title('h(n)');

subplot(2,3,3);
stem(t,yn1);
xlabel('n');
ylabel('Amplitude');
grid on;
axis([-1 10 0 11]);
title('Linear Convolution x(n)*h(n)');

%Q2
% Linear Convolution of x(n)=[1 2 1 2]  , h(n)=[3 2 1 2]
t = 0:1:6;
t1 = 0:1:3;
t2 = 0:1:3;
xn1 = [1 2 1 2];
hn1 = [3 2 1 2];
yn1 = conv(xn1, hn1);
disp('Linear Convolution of x(n)=[1 2 1 2]  , h(n)=[3 2 1 2]')
disp(yn1);
subplot(2,3,4);
stem(t1,xn1);
axis([-1 5 0 5]);
xlabel('n');
ylabel('Amplitude');
title('x(n)');
grid on;

subplot(2,3,5);
stem(t2,hn1);
xlabel('n');
ylabel('Amplitude');
grid on;
axis([-1 5 0 5]);
title('h(n)');

subplot(2,3,6);
stem(t,yn1);
xlabel('n');
ylabel('Amplitude');
grid on;
axis([-1 10 0 13]);
title('Linear Convolution x(n)*h(n)');
```

Observation

```
Linear Convolution of :- Q1: x(n)=[1 2 1 1]  , h(n)=[1 1 1 1]
     1     3     4     5     4     2     1
Linear Convolution of x(n)=[1 2 1 2]  , h(n)=[3 2 1 2]
     3     8     8    12     9     4     4
```



→Without using Built-in Function

```
clc;
clear;
close all;

%Q1
%linear convolution of x(n)=[1 2 1 1]  , h(n)=[1 1 1 1]

x = [1, 2, 1, 1];
h = [1, 1, 1, 1];
len_x = length(x);
len_h = length(h);
len_y = len_x + len_h - 1;
y = zeros(1, len_y);
for i = 1:len_x
    for j = 1:len_h
        y(i+j-1) = y(i+j-1) + x(i) * h(j);
    end
end
disp('Linear Convolution of x(n)=[1 2 1 1]  , h(n)=[1 1 1 1]');
disp(y);
n = 0:len_y-1;
subplot(1,2,1)
stem(n, y, 'filled');
title('Linear Convolution x(n)=[1 2 1 1]  , h(n)=[1 1 1 1]');
xlabel('n');
ylabel('y(n)');
grid on;

%Q2
% Linear Convolution of x(n)=[1 2 1 2]  , h(n)=[3 2 1 2]

xn1 = [1 2 1 2];
hn1 = [3 2 1 2];
l1 = length(xn1);
l2 = length(hn1);
p = l1 + l2 - 1;
Xn1 = zeros(1,p);
for i = 1:p
    sum=0;
    for j=1:l1
        if (i-j+1>0) && (i-j+1 <= l2)
            sum = sum+xn1(j)*hn1(i-j+1);
        end
    end
    y(i) = sum;
end
```

```
p_range = 0:p-1;
disp('Linear Convolution of x(n)=[1 2 1 2]  , h(n)=[3 2 1 2]')
disp(y)
subplot(1,2,2)
stem(p_range,y);
axis([-2 2 0 12]);
xlabel('n');
ylabel('Amplitude');
title('Linear Convolution of x(n)=[1 2 1 2]  , h(n)=[3 2 1 2]');
grid on;
```

Result

Performed Linear Convolution with and without using built in function.

Observation

Linear Convolution of :- Q1: x(n)=[1 2 1 1] , h(n)=[1 1 1 1]

1 3 4 5 4 2 1

Linear Convolution of x(n)=[1 2 1 2] , h(n)=[3 2 1 2]

3 8 8 12 9 4 4