Experiment No: 03

Experiment Name: Write code to calculate autocorrelation and cross-correlation in MATLAB.

Theory: The correlation of two functions or signals or waveforms is defined as the measure of similarity between those signals. There are two types of correlations – Autocorrelation and Cross-correlation.

A signal's coherence or similarity to its time-delayed counterpart is measured by the autocorrelation function. As a result, the autocorrelation is the correlation between two signals. Autocorrelation is defined differently for energy (or aperiodic) signals and power (periodic) signals, just like cross-correlation is. The autocorrelation of an energy or aperiodic signal $x(t)$ is defined as −

$$R11(\tau) = R(\tau) = \int_{-\infty}^{\infty} x(t)x*(t-\tau)dt$$

Where, the variable τ is called the delay parameter and here, the signal $x(t)$ is time shifted by τ units in the positive direction.

Cross- correlation, in which the signal in-hand is correlated with another signal so as to know how much resemblance exists between them. Mathematical expression for the cross-correlation of discrete time signals $x(n)$ and $y(n)$ is given by

$$Rxy[m] = \sum_{n=-\infty}^{\infty} x[n]y\star[n-m]$$

If the energy signals $x(n)$ and $y(n)$ have some similarity. Then, the cross-correlation $Rxy(m)$ between them will have some finite value over the range m. The variable m is called the delay parameter or searching parameter or scanning parameter.

Code:

1. **Autocorrelation-**

```
clc
clear all
xn = input('Enter a Sequence');
hn = fliplr(xn);

L = length(xn);
M = length(hn);
X = [xn, zeros(1,L)];
H = [hn, zeros(1,M)];

for n = 1 : L+M-1
    y(n)=0;
    for i = 1 : L
        if(n-i+1>0)
        y(n) = y(n)+X(i)*H(n-i+1)

        end
    end
end
```

```
A=xcorr(xn,xn)

subplot(4,1,1)
stem (xn)
title('Input Sequence,x(n)')

subplot(4,1,2)
stem (hn)
title('Fliped Input Sequence,h(n)')

subplot(4,1,3)
stem (y)
title('Autocorrelation,y(n)')

subplot(4,1,4)
stem (A)
title('Autocorrelation Using xcorr
Function')
```

Output-

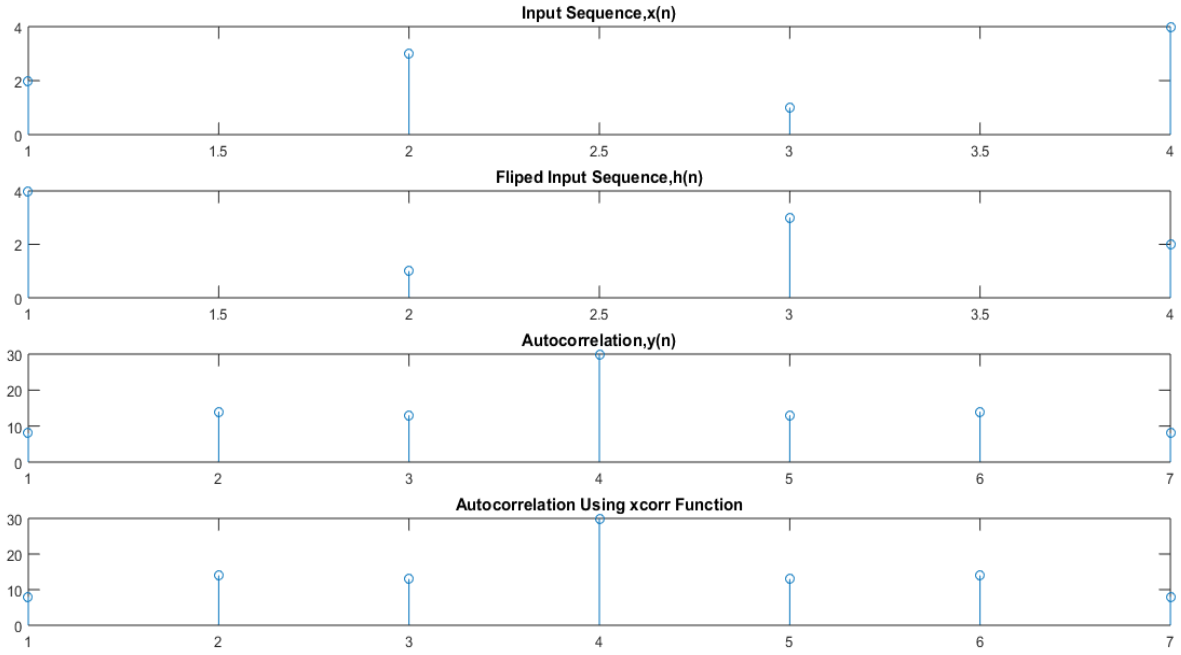
Enter a Sequence[2 3 1 4]

y =

8 14 13 30 13 14 8

A =

8 14 13 30 13 14 8



2. Cross-correlation-

```
clc
clear all

xn = input('Enter a Sequence');
bn = input('Enter another Sequence');
hn = fliplr(bn);

L = length(xn);
M = length(hn);
X = [xn, zeros(1,L)];
H = [hn, zeros(1,M)];

for n = 1 : L+M-1
    y(n)=0;
      for i = 1 : L
        if(n-i+1>0)
          y(n) = y(n)+X(i)*H(n-i+1)

         end
      end
end
```

```
A=xcorr(xn,bn)

subplot(4,1,1)
stem (xn)
title('Input Sequence,xn')

subplot(4,1,2)
stem (bn)
title('Input Sequence,bn')

subplot(4,1,3)
stem (y)
title('Crosscorrelation,y(n)')

subplot(4,1,4)
stem (A)
title('Crosscorrelation Using xcorr
Function')
```

Output-

Enter a Sequence[2 3 1 4]

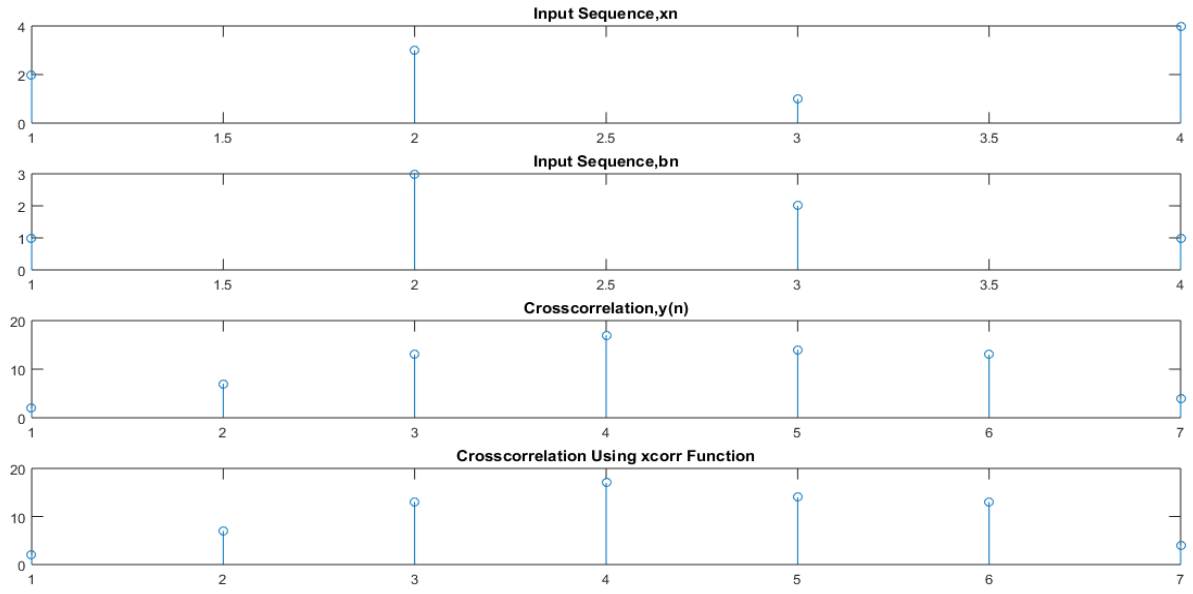
Enter another Sequence[1 3 2 1]

y =

2 7 13 17 14 13 4

A =

2 7 13 17 14 13 4



Discussion: Autocorrelation and Cross-correlation code was implemented in this experiment. For autocorrelation, a input sequence was taken from the user. This sequence wae flipped by using fliplr() function. Then using for loop and if condition the autocorrelation was calculated. For Cross-correlation, two input sequence was taken from the user. One of this tow sequence was flipped. Then calculated the cross-correlation. Also calculated the autocorrelation and cross-correlation was calculated using **xcorr()** function. Using subplot() and stem() function the sequences was ploted.

Conclusion : The code was executed successfully and no errors were found. Form this experiment, we had learned about autocorrelation and cross-correlation and how to plot the signal using MATALB.