

**Experiment Name: Circular Convolution****Aim:**

To find circular convolution

- a. Using FFT and IFFT.
- b. Using Concentric Circle Method.
- c. Using Matrix Method.

**Theory:**

Circular convolution is a mathematical operation that is like linear convolution but is performed in a periodic or circular manner. This is particularly useful in discrete-time signal processing where signals are often represented as periodic sequences.

**Mathematical Definition:**

Given two periodic sequences  $x[n]$  and  $h[n]$ , their circular convolution is defined as:

$$y[n] = (x[n] \odot h[n]) = \sum_{k=0}^{N-1} x[k]h[(n-k) \bmod N]$$

**Applications:**

- Discrete-Time Filtering: Circular convolution is used for filtering discrete-time signals.
- Digital Signal Processing: It's a fundamental operation in many digital signal processing algorithms.
- Cyclic Convolution: In certain applications, such as cyclic prefix OFDM, circular convolution is used to simplify the implementation of linear convolution.

**Program:****a. Using FFT and IFFT.**

```
clc;
```

```
close all; c
```

```
lear all;
```

```
x1 = [1 2 1 2];
```

```
x2 = [1 2 3 4];
```

```
X1_k = fft(x1);
```

```
X2_k = fft(x2);
```

```
Y1_k = X1_k.*X2_k;  
y1 =ifft(Y1_k);  
disp("Using FFT and IFFT:")  
disp(y1);
```

#### **b. Using Concentric Circle Method.**

```
clc;  
close all;  
clear all;  
  
x = [1 2 1 2];  
h = [1 2 3 4];  
N = max(length(x),length(h));  
y = zeros(1,N);  
for n=1:N  
    h_s = circshift(h,n-1); %shifting h(n) by 1 unit  
  
    y(n) = sum(x.*h_s);  
end  
  
disp("Using Concentric Circle Method:");  
disp(y);
```

#### **c. Using Matrix Method.**

```
clc;  
clear all;  
close all;
```

```
x = [1 2 1 2];  
h = [1 2 3 4];  
N = max(length(x),length(h));  
h_n = zeros(N,N);  
for n=1:N h_s = circshift(h,n-1); %shifting h(n) by 1 unit  
h_n(:,n) = h_s;  
end  
y = h_n *x';  
disp("Using Concentric Circle Method:")  
disp(y');
```

### **Result**

Performed Circular Convolution using a) FFT and IFFT; b) Concentric Circle method; c) Matrix method and verified result.

## **Observation**

### **a) USING FFT AND IFFT**

*Using FFT and IFFT:*

16 14 16 14

### **b) USING Concentric Circle Method**

Using Concentric Circle Method:

16 14 16 14

### **c) USING Matrix Method**

Using Matrix Method.:

16 14 16 14