Experiment 3. Discrete fourier transform

Name	Prathamesh Mane
UID no. & Branch	**2022200078 (B1)**
Experiment No.	3

AIM:	The aim of this experiment is to study magnitude spectrum of the DT signal.
OBJECTIVE:	1. Develop a function to perform DFT of N point signal 2. Calculate DFT of a DT signal and Plot Spectrum of Signal. 3. Calculate the effect of zero padding on magnitude spectrum
INPUT SPECIFICATION:	1. Length of first Signal N 2. DT Signal values
PROBLEM DEFINITION:	(1) Take any four-point sequence x[n]. Find DFT X[k]. Plot Magnitude Spectrum. (2) Append the input signal by four zeros. Find DFT and plot Magnitude Spectrum Give your conclusion. (3) Expand the input signal by inserting alternate zero. Find DFT and plot Magnitude Spectrum Give your conclusion. (4) Expand the input signal by inserting alternate two zeros. Find DFT and plot Magnitude Spectrum Give your conclusion.

Theoretical solution using formula

- Case 1 : **finding DFT of four point signal**

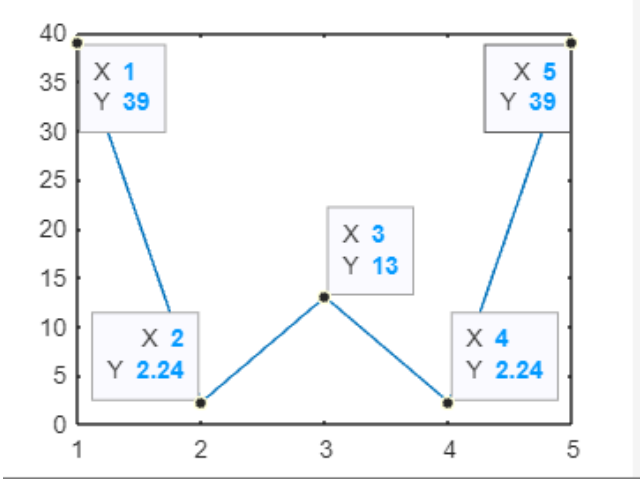
Code result :

```
Enter the length of the signal (N): 4
Enter the real part of the signal x[n]: 6 12 7 14

X[k] computed by DFT:
 39.00 + j  0.00
 -1.00 + j  2.00
-13.00 + j  0.00
 -1.00 + j -2.00

Magnitude of X[k]:
 39.00
  2.24
 13.00
  2.24

x[n] computed by IDFT:
  6.00 + j  0.00
 12.00 + j  0.00
  7.00 + j -0.00
 14.00 + j  0.00
```

Result analysis :

A=[6, 12 , 7 ,14]
X[k] = [39, -1 + 2j, -13, -1 - 2j]
Magnitude : [39 , 2.24 , 13 , 2.24]

Magnitude spectrum :



- Case 2 : **add four zeros at the end of signal and find the DFT**

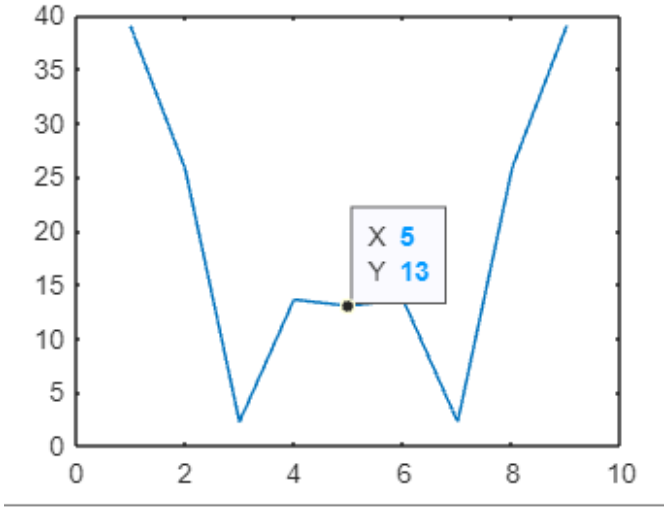
Code result :

```
Enter the length of the signal (N): 8
Enter the real part of the signal x[n]: 6 12 7 14 0 0 0 0

X[k] computed by DFT:
 39.00 + j  0.00
  4.59 + j-25.38
 -1.00 + j  2.00
  7.41 + j-11.38
-13.00 + j  0.00
  7.41 + j 11.38
 -1.00 + j -2.00
  4.59 + j 25.38

Magnitude of X[k]:
 39.00
 25.80
  2.24
 13.59
 13.00
 13.59
  2.24
 25.80

x[n] computed by IDFT:
  6.00 + j -0.00
 12.00 + j -0.00
  7.00 + j  0.00
 14.00 + j  0.00
 -0.00 + j  0.00
  0.00 + j -0.00
  0.00 + j  0.00
  0.00 + j  0.00
```

Result analysis :

A=[6, 12 , 7 ,14 , 0, 0, 0, 0]
Using the result of case one and using the property of DFT
X[k] = [39, 4.59-25.38j ,-1 + 2j ,7.41-11.38j ,-13, 7.41-11.38j ,-1 - 2j , 4.59-25.38j]
Magnitude = [39 , 25.80 ,2.24 ,13.59 , 13 ,13.59 , 2.24 ,25.80]

Magnitude spectrum :



- Case 3 : **add one zero between every element and find the DFT**

Code result :

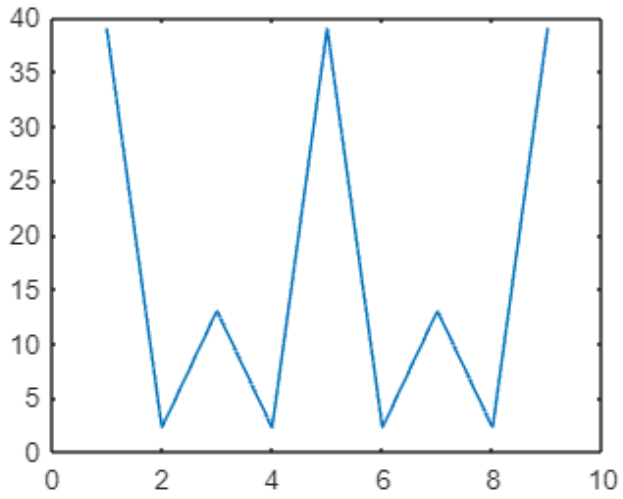
```
Enter the length of the signal (N): 8
Enter the real part of the signal x[n]: 6 0 12 0 7 0 14 0

X[k] computed by DFT:
 39.00 + j  0.00
 -1.00 + j  2.00
-13.00 + j  0.00
 -1.00 + j -2.00
 39.00 + j -0.00
 -1.00 + j  2.00
-13.00 + j  0.00
 -1.00 + j -2.00

Magnitude of X[k]:
 39.00
  2.24
 13.00
  2.24
 39.00
  2.24
 13.00
  2.24
```

```
x[n] computed by IDFT:
  6.00 + j -0.00
  0.00 + j -0.00
 12.00 + j -0.00
 -0.00 + j -0.00
  7.00 + j  0.00
 -0.00 + j  0.00
 14.00 + j  0.00
 -0.00 + j  0.00
```

Result analysis :

A=[6,0, 12 ,0, 7 ,0 ,14, 0]
Using the result of case one and using the property of DFT
X[k] = [39, -1 + 2j, -13, -1 - 2j , 39, -1 + 2j, -13, -1 - 2j]
Magnitude = [39 , 2.24 , 13 , 2.24, 39 , 2.24 , 13 , 2.24]

Magnitude spectrum :



- Case 4 : **add two zeros between every element and find the DFT**

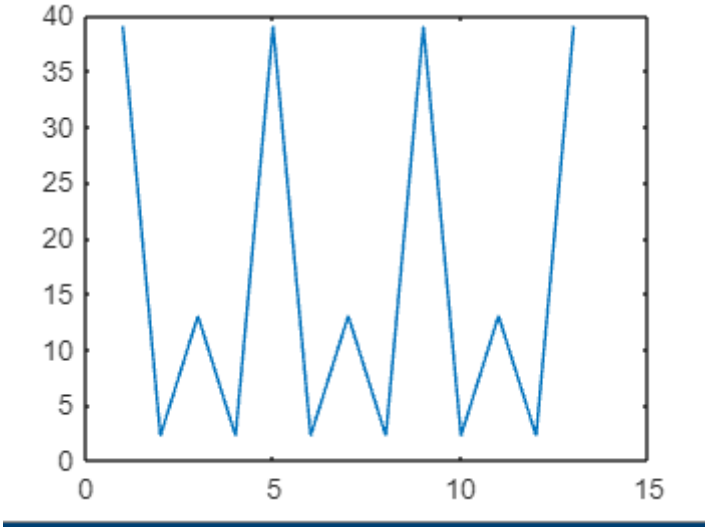
Code result :

```
Enter the length of the signal (N): 12
Enter the real part of the signal x[n]: 6 0 0 12 0 0 7 0 0 14 0 0

X[k] computed by DFT:
 39.00 + j  0.00
 -1.00 + j  2.00
-13.00 + j  0.00
 -1.00 + j -2.00
 39.00 + j -0.00
 -1.00 + j  2.00
-13.00 + j  0.00
 -1.00 + j -2.00
 39.00 + j -0.00
 -1.00 + j  2.00
-13.00 + j  0.00
 -1.00 + j -2.00

Magnitude of X[k]:
 39.00
  2.24
 13.00
  2.24
 39.00
  2.24
 13.00
  2.24
 39.00
  2.24
 13.00
  2.24

x[n] computed by IDFT:
  6.00 + j -0.00
 -0.00 + j  0.00
  0.00 + j -0.00
 12.00 + j -0.00
 -0.00 + j  0.00
  0.00 + j  0.00
  7.00 + j  0.00
  0.00 + j  0.00
 -0.00 + j -0.00
 14.00 + j  0.00
  0.00 + j  0.00
  0.00 + j  0.00
```

Result analysis :

A=[6,0,0, 12 ,0,0, 7 ,0 ,0,14, 0,0]
Using the result of case one and using the property of DFT
X[k] = [39, -1 + 2j, -13, -1 - 2j, 39, -1 + 2j, -13, -1 - 2j, 39, -1 + 2j, -13, -1 - 2j]
Magnitude = [39 , 2.24 , 13 , 2.24, 39 , 2.24 , 13 , 2.24, 39 , 2.24 , 13 , 2.24]

Magnitude spectrum :



CONCLUSION:

- In first case we calculated the DFT using the formula
- In second case we padded zero at the last of the signal and then the result obtained was compared with the result of first case and it was found that the terms at even position remains the same.
- In third case we padded zero between every element of the signal and then the result obtained was compared with the result of first case and it was found that the original result is repeated once
- When we padded two zeros in between it was found that the result is repeated twice. This means if the input signal is padded by ‘m’ number of zeros in between then the resultant sequence is also repeated ‘m’ times.
- When the signal is expanded in time domain, spectrum is compressed in frequency domain. That means, Expansion in the time domain by a factor corresponds to the compression of the signal in the Frequency domain by the same factor
- DFT converts sequence from Time Domain to Frequency Domain
- DFT Converts N samples from time domain to N coefficients in frequency domain
- Frequency domain coefficients are separated by W(omega) = 2 pi / N