



SUBMITTED BY:

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DIGITAL SIGNAL PROCESSING

LAB REPORT

EXPERIMENT

OBJECTIVE: Write MATLAB code to calculate DFT and IDFT of given sequence.

Software Used: MATLAB

Theory:

DFT:

The discrete Fourier transform (DFT) is the primary transform used for numerical computation in digital signal processing. It is very widely used for spectrum analysis, fast convolution, and many other applications. The DFT transforms N discrete-time samples to the same number of discrete frequency samples, and is defined as

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-j \frac{2\pi nk}{N}}$$

The DFT is widely used in part because it can be computed very efficiently using fast Fourier transform (FFT) algorithms.

IDFT:

The inverse DFT (IDFT) transforms N discrete-frequency samples to the same number of discrete-time samples. The IDFT has a form very similar to the DFT,

$$x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) e^{j \frac{2\pi nk}{N}}$$

and can thus also be computed efficiently using FFTs.

MATLAB Code & Output:

The sequence taken is [5 3 -1 4]

Code:

```
x = [5 3 -1 4];
N= length (x);

X = zeros(4,1)

IX = zeros(4,1)

for k = 0:N-1
    for n = 0:N-1
        X(k+1) = X(k+1) + x(n+1)*exp(-j*pi/2*n*k)
    end
end

for k = 0:N-1
    for n = 0:N-1
        IX(k+1) = IX(k+1) + (1/N)*X(n+1)*exp(j*pi/2*n*k)
    end
end

t = 0:N-1
subplot (411)
    stem(t,x);

xlabel ('Time');

ylabel ('Amplitude');

title('Time domain - Input sequence')

subplot (412)

stem (t,x)

xlabel('Frequency');

ylabel('IX (k) | ');

title('DFT - Magnitude response')

subplot (413)
stem(t,angle(X))

xlabel('Frequency');

ylabel('Phase');

title('DFT - Phase response')
```

```

subplot (414)

stem (t, IX)

xlabel ('Frequency');

ylabel(' |IX (k) | ');

title ('IDFT- Magnitude response')

X %%to check |X(k) |
IX
angle(X) %%to check phase

```

Output:

X =

```

0
0
0
0

```

IX =

```

0
0
0
0

```

X =

```

5
0
0
0

```

X =

```

8
0
0
0

```

X =

7
0
0
0

X =

11
0
0
0

X =

11
5
0
0

X =

11.0000 + 0.0000i
5.0000 - 3.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 - 3.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
5.0000 + 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
2.0000 - 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
1.0000 - 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
-3.0000 - 0.0000i
0.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
-3.0000 - 0.0000i
5.0000 + 0.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
-3.0000 - 0.0000i
5.0000 + 3.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
-3.0000 - 0.0000i
6.0000 + 3.0000i

X =

11.0000 + 0.0000i
6.0000 + 1.0000i
-3.0000 - 0.0000i
6.0000 - 1.0000i

IX =

2.7500
0
0
0

IX =

4.2500 + 0.2500i
0.0000 + 0.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

3.5000 + 0.2500i
0.0000 + 0.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
2.7500 + 0.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
2.5000 + 1.5000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.2500 + 1.5000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
0.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
2.7500 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
1.2500 - 0.2500i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
0.5000 - 0.2500i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
-1.0000 + 0.0000i
0.0000 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
-1.0000 + 0.0000i
2.7500 + 0.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
-1.0000 + 0.0000i
3.0000 - 1.5000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
-1.0000 + 0.0000i
3.7500 - 1.5000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
-1.0000 + 0.0000i
4.0000 + 0.0000i

t =

Column 1

0

Column 2

1

Column 3

2

Column 4

3

Warning:
Using
only
the
real
component
of
complex
data.

X =

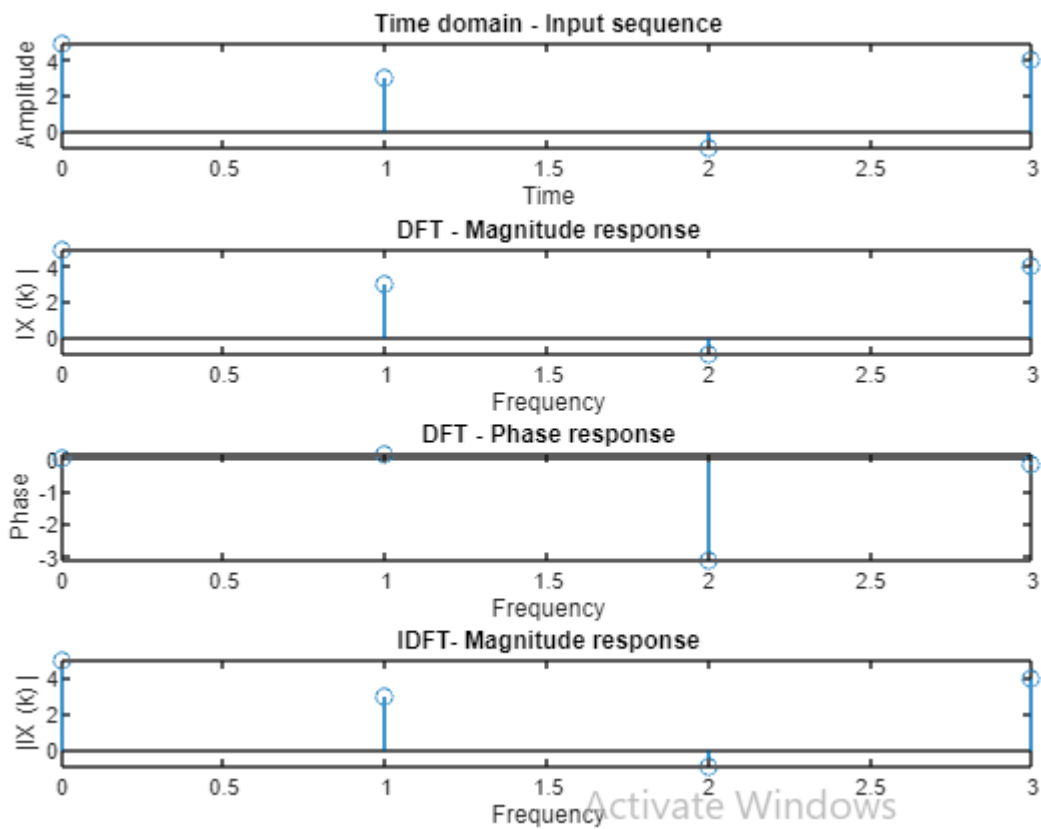
11.0000 + 0.0000i
6.0000 + 1.0000i
-3.0000 - 0.0000i
6.0000 - 1.0000i

IX =

5.0000 - 0.0000i
3.0000 + 0.0000i
-1.0000 + 0.0000i
4.0000 + 0.0000i

ans =

0
0.1651
-3.1416
-0.1651



Result: DFT and IDFT were calculated successfully.