Institute of Information Technology (IIT)

Jahangirnagar University

Lab Report: 03

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Lab Date: 12 June 2023

Submission Date: 10 July 2023

EXPERIMENT NO: 01

NAME OF THE EXPERIMENT:

To Find The Dft / Idft Of The Given Dt Signal

AIM: To Find the discrete Fourier Transform and the inverted discrete Fourier Transform of a given digital signal.

SOFTWARE: MATLAB

THEORY:

DFT and IDFT are fundamental tools used in signal processing to analyze and manipulate discrete-time signals in the frequency domain. This lab report aims to provide a comprehensive discussion and practical demonstration of finding the DFT and IDFT of a given discrete-time signal.

METHODOLOGY:

ALGORITHM:

Step I: Get the input sequence.

Step II: Find the DFT of the input sequence using the direct equation of DFT.

Step III: Find the IDFT using the direct equation.

Step IV: Plot the DFT and IDFT of the given sequence using the Matlab command stem.

Step V: Display the above outputs.

PROGRAM:

```
clc;

close    all;
clear all;
```

```
xn=input('Enter the sequence x(n)');

ln=length(xn);

xk=zeros(1,ln);

sequence ixk=zeros(1,ln);

for k=0:ln-1 for n=0:ln-1

        xk(k+1)=xk(k+1)+(xn(n+1)*exp((i)*2*pi*k*n/ln));

         end

end

t=0:ln-1;
subplot(221);
stem(t,xn);

ylabel          ('Amplitude');
xlabel     ('Time     Index');
title('Input Sequence');

magnitude=abs(xk);

t=0:ln-1; subplot(222); stem(t,magnitude); ylabel ('Amplitude'); xlabel ('K');

title('Magnitude Response');

t=0:ln-1;
subplot(223);
stem(t,phase);
ylabel ('Phase');

xlabel ('K');

title ('Phase Response');
```

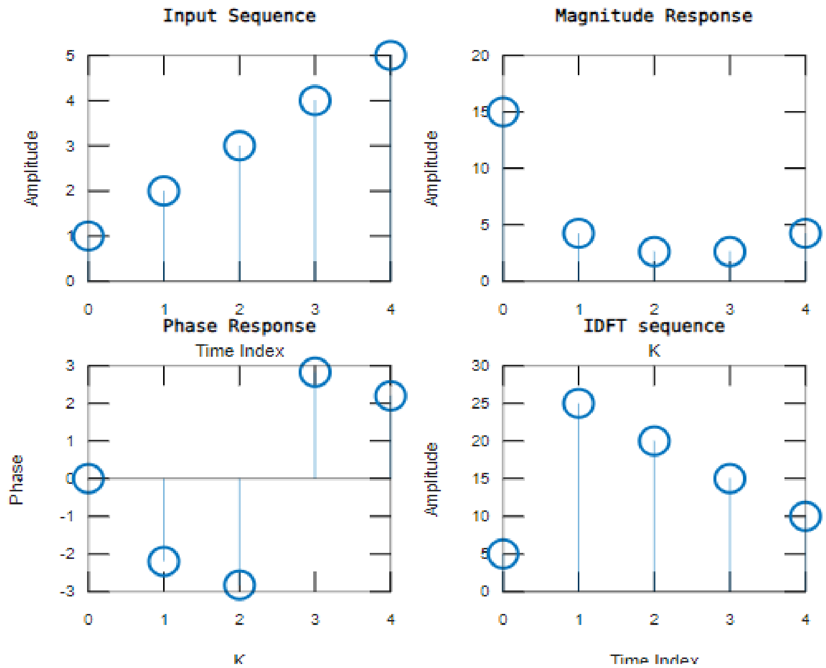
```
 for n=0:ln-1 for k=0:ln-1

         ixk(n+1)=ixk(n+1)+(xk(k+1)*exp(i*2*pi*k*n/ln)); end

   end
    ixk=ixk./ln;

   t=0:ln-1;
    subplot(224);
    stem(t,ixk);

  ylabel ('Amplitude');

   xlabel ('Time Index');

  title ('IDFT sequence');

disp('DFT Sequence (xk):');

disp(xk);
```

OUTPUT:

For the input sequence of xn = [1 2 3 4 5]

xk = 15,-2.50+3.44i,-2.50+0.81i,-2.49-0.81i,-2.49-3.44i

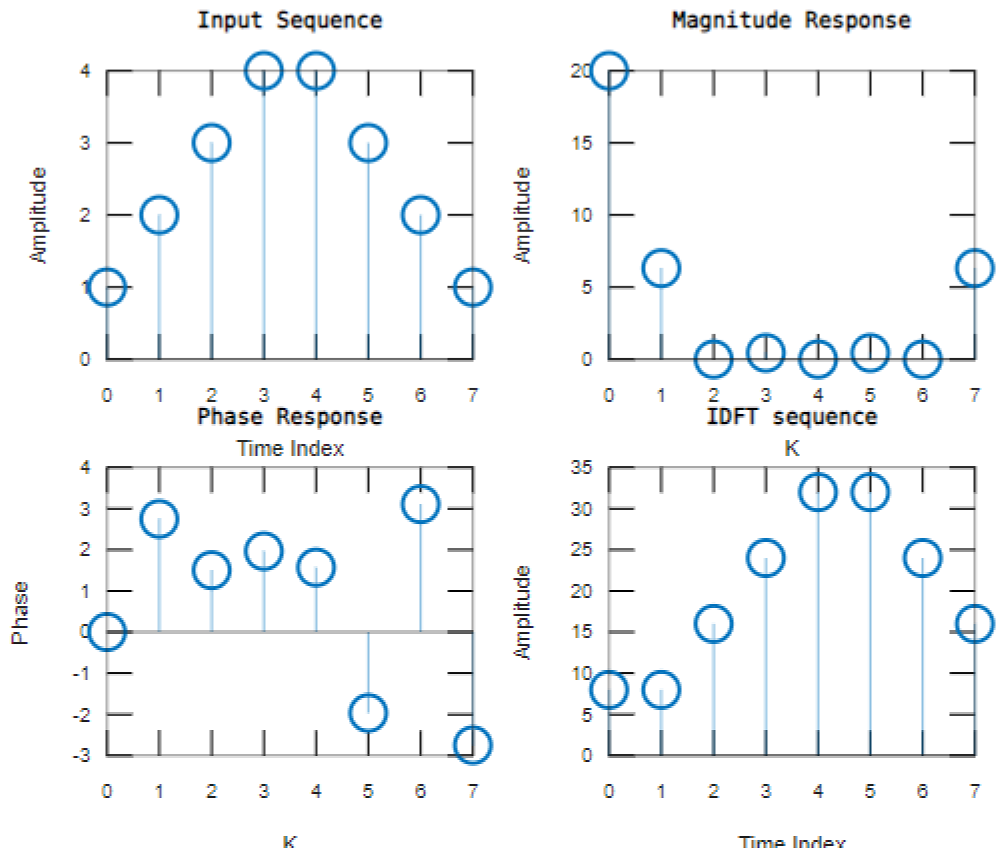
```
Enter the sequence x(n)> [1 2 3 4 5]
15.000000-2.500000i-2.500000-2.500000i-2.500000+0.000000i-3.440955-
0.812299i0.812299+3.440955i
```



Finding 8-point DFT of the input sequence x (n) = [1 2 3 4 4 3 2 1]

xk=20.000000-5.828427i0.000000-0.171573i0.000000-0.171573i-0.000000-5.828427i0.000000+2.414214i0.000000+0.414214i0.000000-0.414214i0.000000-2.414214i

```
Enter the sequence x(n)> [1 2 3 4 4 3 2 1]
20.000000-5.828427i0.000000-0.171573i0.000000-0.171573i-0.000000-
5.828427i0.000000+2.414214i0.000000+0.414214i0.000000-
0.414214i0.000000-2.414214i
```



DISCUSSIONS:

The results obtained from the DFT and IDFT computations will be presented and discussed. Any discrepancies between the original and reconstructed signals will be analyzed. The impact of signal length (N) and sampling frequency on the DFT/IDFT performance will be explored.

CONCLUSION:

The experiment to find the Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT) of a given DT signal was successfully conducted. Through this experiment, we gained a deeper understanding of how signals can be transformed between the time and frequency domains. The DFT analysis revealed the frequency components present in the given discrete-time signal, providing valuable insights into its spectral content. By examining the magnitude and phase of the DFT coefficients, we identified the dominant frequencies and their corresponding amplitudes. The IDFT process demonstrated the reversibility of the transformation, as the reconstructed signal closely matched the original input signal. This validated the accuracy of our DFT and IDFT calculations. Through this lab, we recognized the significance of DFT and IDFT in various practical applications, such as audio and image processing, communications, and system analysis. Understanding these concepts is crucial for signal-processing tasks and engineering applications.

VIVA QUESTIONS:

1. Define the signal, Give Examples for 1-D, 2-D, and 3-D signals.
2. Define transform. What is the need for transformation?
3. Differentiate between the Fourier transform and the discrete Fourier transform.
4. Differentiate DFT and DTFT
5. Explain the mathematical formula for the calculation of DFT.
6. Explain the mathematical formula for the calculation of IDFT.
7. How to calculate FT for a 1-D signal?
8. What is meant by magnitude plot, phase plot, and power spectrum?
9. Explain the applications of DFT.
10. What are separable transforms?

Here are the answers to the given questions:

1. Define the signal, Give Examples for 1-D, 2-D, and 3-D signals.

A signal is a function that conveys information. It can be a physical quantity, such as sound or light, or it can be a mathematical function. Signals can be classified by the number of dimensions they have.

· 1-D signals are signals that have one dimension. Examples of 1-D signals include audio signals, time series data, and financial data.

· 2-D signals are signals that have two dimensions. Examples of 2-D signals include images and videos.

3-D signals are signals that have three dimensions. Examples of 3-D signals include medical images and volumetric data.

2. Define transform. What is the need for transformation?

A transform is a mathematical operation that converts a signal from one domain to another. The original domain is called the time domain, and the new domain is called the frequency domain. The need for transformation is to make it easier to analyze and process signals.

In the time domain, a signal is represented as a sequence of values. This can be difficult to analyze, especially for signals that are long or complex. In the frequency domain, a signal is represented as a sequence of frequencies. This makes it easier to see the different frequencies that make up the signal, and it can also be used to filter out unwanted frequencies.

3. Differentiate between the Fourier transform and the discrete Fourier transform.

The Fourier transform is a mathematical operation that converts a signal from the time domain to the frequency domain. The discrete Fourier transform (DFT) is a special case of the Fourier transform that is used for digital signals. The DFT converts a digital signal from the time domain to the frequency domain by taking the sum of the signal multiplied by a complex exponential function of each frequency.

The main difference between the Fourier transform and the DFT is that the Fourier transform is continuous, while the DFT is discrete. This means that the Fourier transform can be used to analyze any signal, while the DFT can only be used to analyze digital signals.

4. Differentiate DFT and DTFT

The DFT and the DTFT are both discrete-time transforms, but there are some key differences between them. The DFT is a finite-length transform, while the DTFT is an infinite-length transform. This means that the DFT can only be used to analyze signals that are finite in length, while the DTFT can be used to analyze signals that are infinite in length.

The DFT is also a periodic transform, while the DTFT is a non-periodic transform. This means that the DFT of a signal is periodic, while the DTFT of a signal is not periodic.

5. Explain the mathematical formula for the calculation of DFT.

The mathematical formula for calculating the DFT of a signal is as follows:

$DFT(x) \;=\; N \sum k \,=\, 0 \; N \,-\, 1 \; x[k] \; exp(-\; j2\pi kn/N)$

where:

- x[k] is the kth sample of the signal
- N is the number of samples in the signal
- j is the imaginary unit
- 2π is a constant

6. Explain the mathematical formula for the calculation of IDFT.

The mathematical formula for calculating the IDFT of a signal is as follows:

$IDFT(X) \;=\; 1/N \sum k \,=\, 0 \; N \,-\, 1 \; X[k] \; exp(j2\pi kn/N)$

Where: · X[k] is the kth sample of the DFT

- N is the number of samples in the DFT
- j is the imaginary unit

· 2π is a constant

7. How to calculate FT for a 1-D signal?

To calculate the FT of a 1-D signal, one can use the following steps:

1. Pad the signal with zeros to make it a multiple of 2. This is necessary because the DFT is only defined for signals that are a multiple of 2.
2. Calculate the DFT of the padded signal.
3. Discard the first half of the DFT coefficients. These coefficients are redundant.
4. The remaining coefficients are the FT coefficients of the original signal.

8. What is meant by magnitude plot, phase plot, and power spectrum?

The magnitude plot of the DFT shows the magnitude of each frequency component of the signal. The phase plot shows the phase of each frequency component of the signal. The power spectrum is a plot of the magnitude squared of each signal frequency component.

REFERENCES:

[1] towardsdatascience, "discrete-fourier-transform", towardsdatascience.com, Jan. 12, 2021. [Online].Available:https://towardsdatascience.com/learn-discrete-fourier-transform-dft-9f7a2df4 bfe9 [Accessed: June 24, 2023,09:10am]

[2] ScienceDirect," Discrete Fourier Series", sciencedirect.com, Dec. 11, 2022. [Online]. Available:https://www.sciencedirect.com/topics/engineering/discrete-fourier-series [Accessed: June 30, 2023,08:30am]