Rajshahi University of Engineering & Technology

Department : Electrical & Computer Engineering

Course No: ECE 4124

Course Name: Digital Signal Processing Sessional

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Experiment Name: Study of DFT of a signal & obtain its magnitude and phase.

Theory:

The DFT is one of the most powerful tools in digital signal processing which enables us to find the spectrum of a finite-duration signal.There are many circumstances in which we need to determine the frequency content of a time-domain signal. For example, we may have to analyze the spectrum of the output of an LC oscillator to see how much noise is present in the produced sine wave. This can be achieved by the discrete Fourier transform (DFT). The DFT is usually considered as one of the two most powerful tools in digital signal processing (the other one being digital filtering), and though we arrived at this topic introducing the problem of spectrum estimation, the DFT has several other applications in DSP.The DFT of a sequence x[n] of length N is defined as follows:

$$X[k]=\sum_{n=0}^{N-1} x(n)e^{-j2\pi nk/N} \quad ; \text{for } 0\leq k\leq N-1$$

where X[k] represents the complex amplitude of the k-th frequency component, and j is the imaginary unit.

Its magnitude and phase by taking the absolute value and angle of each frequency component, respectively.The magnitude of the k-th frequency component is given by in matlab:

$$\text{mag\_X} = \text{sqrt}(\text{real}(X[k])^2 + \text{imag}(X[k])^2)$$

and the phase is given by:

$$phi\_X = atan2(imag(X[k]), real(X[k]))$$

Code:

DFT Matlab Code:

```
clc;

clear all;
x=input('Input sequence:');

N=length(x);
X=zeros(1,N);
for k=0:N-1
    for n=0:N-1
        X(k+1)=X(k+1)+x(n+1)*exp(-1i*pi*2*k*n/N);

    end
end
X
%compute magnitude and phase
mag_X=zeros(1,N);
phi_X=zeros(1,N);
for k=1:N
    mag_X(k)=sqrt(real(X(k))^2+imag(X(k))^2);
    phi_X(k)=atan2(imag(X(k)),real(X(k)));
end
%plot results

subplot(2,1,1);
stem(mag_X);
xlabel('Frequency');
ylabel('Magnitude');
title('Magnitude spectrum');
subplot(2,1,2);
stem(phi_X);
xlabel('Frequency(Hz)');
ylabel('phase(rad)');
title('Phase Spectrum');
```

Output :

```
Input sequence:[1 2 3 4]

X =

  10.0000 + 0.0000i  -2.0000 + 2.0000i  -2.0000 - 0.0000i  -2.0000 - 2.0000i

>>
```

The following is DFT plot, that is the magnitude response and phase response:

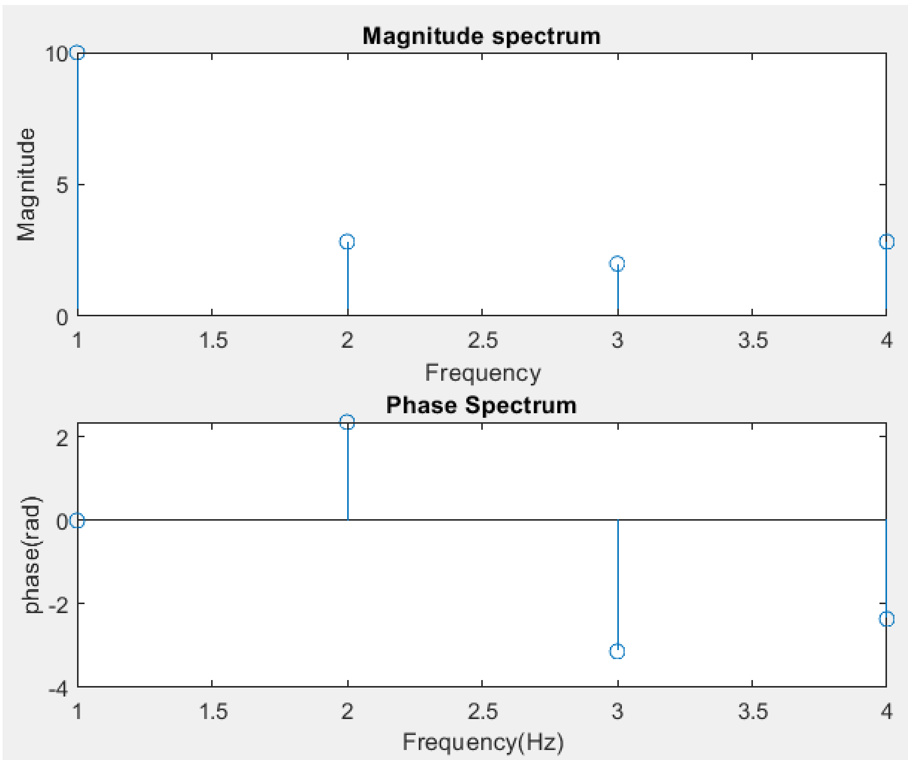

Fig: Magnitude & Phase response plotting

Conclusion:

Firstly,the DFT of a signal has been obtained without built in function.Then the magnitude and phase response has been plotted. The discrete Fourier transform (DFT) converted a finite sequence of equally-spaced samples of a function into a same-length sequence of equally-spaced samples of the discrete-time Fourier transform (DTFT), which is a complex-valued function of frequency.

Reference:

1. https://www.allaboutcircuits.com/technical-articles/an-introduction-to-the-discrete-fourier-transform/#:~:text=Summary-
2. https://www.ee-diary.com/2023/05/dft-in-matlab-without-built-in-function.html