DIGITAL SIGNAL PROCESSING LAB

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Experiment Number	03
Date of Experiment	13/01/2021
Date of Submission	20/01/2021
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Section	ETC - 06

Aim of The Experiment :-

To find the DTFT of an arbitrary sequence and prove the convolution property

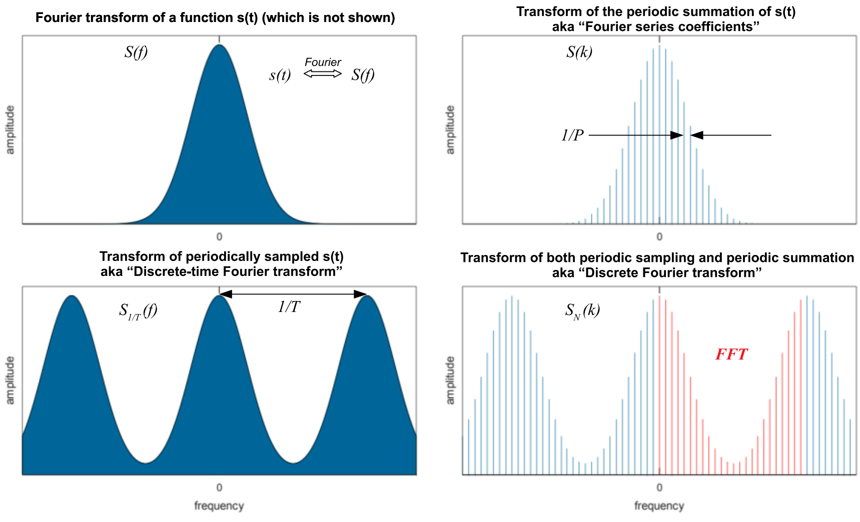
Software Required :-

- MATLAB R2018a

Theory :-

In mathematics, the discrete-time Fourier transform (DTFT) is a form of Fourier analysis that is applicable to a sequence of values.

The DTFT is often used to analyze samples of a continuous function. The term discrete-time refers to the fact that the transform operates on discrete data, often samples whose interval has units of time. From uniformly spaced samples it produces a function of frequency that is a periodic summation of the continuous Fourier transform of the original continuous function. Under certain theoretical conditions, described by the sampling theorem, the original continuous function can be recovered perfectly from the DTFT and thus from the original discrete samples. The DTFT itself is a continuous function of frequency, but discrete samples of it can be readily calculated via the discrete Fourier transform (DFT) (see Sampling the DTFT), which is by far the most common method of modern Fourier analysis.



Code :-

<<<File: expt3_1.m Comment: Main driver file for expt 3>>>

```
% Main driver program
% Written by Debagnik Kar 1804373

clear all
close all
clc

w = -2*pi:0.01:2*pi
n = 0:1:100
x = 0.5.^n

X = dtft(x, n, w)

subplot 221
plot(w/(pi),abs(X),'g')
ylabel('Magnitude')
xlabel('Frequency')
title('Magnitude plot')
subplot 223
plot(w/pi,angle(X),'r')
ylabel('Phase')
xlabel('Frequency')
title('Phase plot')
subplot 222
plot(w/pi,real(X),'g')
title('Real Plot')
xlabel('Frequency')
ylabel('Real part of f(x)')
subplot 224
plot(w/pi,imag(X),'r')
title('Imaginary Plot')
xlabel('Frequency')
ylabel('Imaginary part of f(x)')
```

<<<File: dtft.m Comment: Functional Dependencies for the previous programme>>>

```
% Function for performing DTFT
% Written by Debagnik Kar 1804373

function [X] = dtft(x,n,w)

    temp = n'*w;
    temp = -1i*temp;
    e = exp(temp);
    X = x*e;
end
```

<<<File: expt3_2.m Comment: For analyzing DTFT properties>>>

```
% Program for analysing DTFT Functions
% Writing by Debagnik Kar 1804373

clc
clear all
close all

n = 1
w = linspace(-pi,pi,500)
x1 = [1,3,5,7,9,11,13,15,17]
x2 = [1,-2,3,-2,1]

y = conv(x1,x2)
h1 = freqz(x1,n,w)
h2 = freqz(x2,n,w)
h12 = h1.*h2
h3 = freqz(y',n,w)

subplot 321
stem(x1,'k')
title('Input Sequence one')

subplot 322
stem(x2,'k')
title('Input Sequence two')

subplot 323
plot(w/pi,abs(h12),'g')
title('Magnitude Plot of f(x) without using Convolution')

subplot 324
plot(w/pi,abs(h3),'r')
title('Magnitude Plot of f(x) with using Convolution')

subplot 325
plot(w/pi,angle(h12),'g')
title('Phase Plot of f(x) without using Convolution')

subplot 326
plot(w/pi,angle(h3),'r')
title('Phase Plot of f(x) without using Convolution')
```

Graph/Output :-

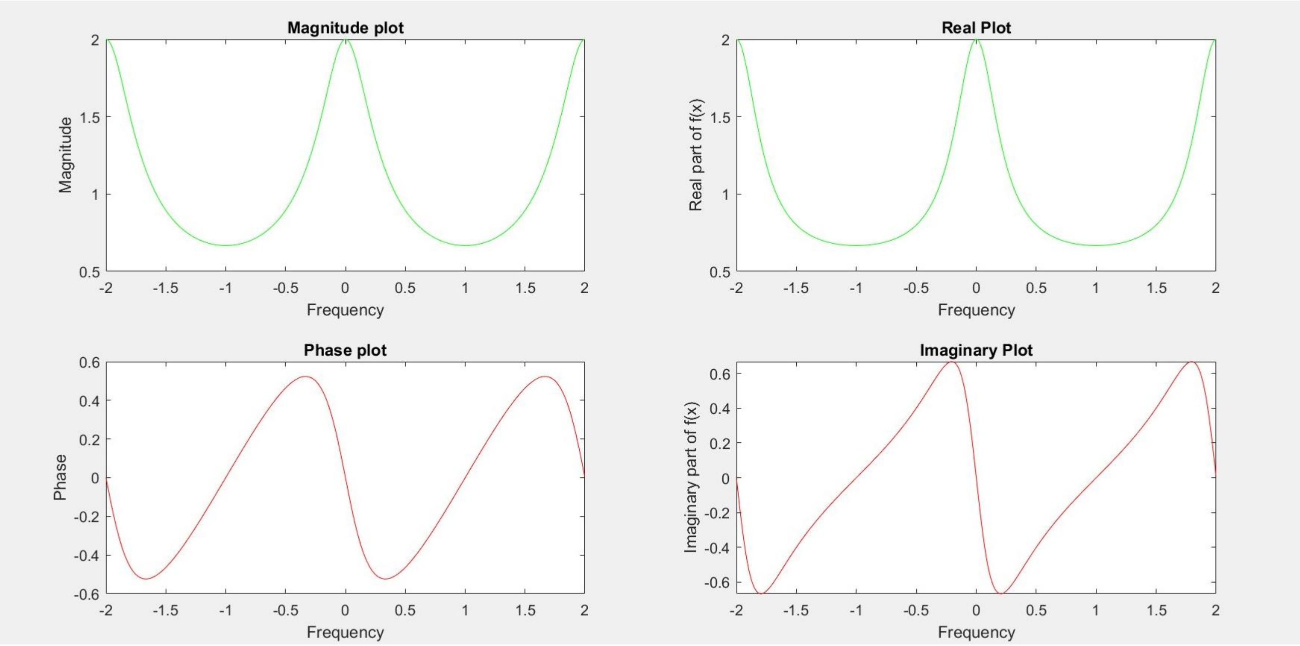


Fig 3.2: DTFT of the given arbitrary sequence

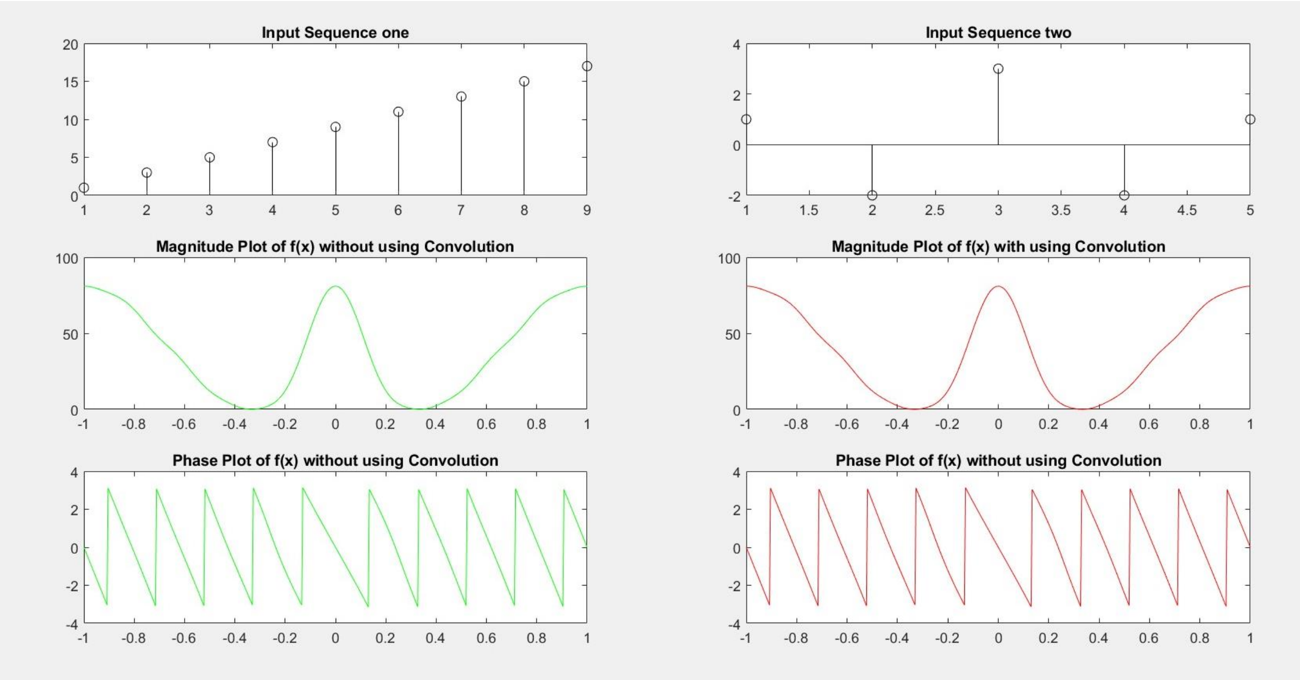


Fig 3.3: Analysis of DTFT properties

Discussion/Inference of the experiment :-

In the figure 3.2 we plotted the graph of a given arbitrary number.

From the figure 3.3 we observed that the DTFT magnitude and phase spectra obtained by performing pointwise multiplication of the two DTFT's of the original sequences are identical to those obtained by performing time domain convolution of the two original sequences; this verifies the convolution property of the DTFT.

Conclusion :-

In this experiment a function for computing DTFT of an arbitrary function is written in MATLAB and we successfully verified the convoluting property of DTFT programmatically. We will like to conclude by stating that the aim of the experiment is fulfilled.