MAWLANA BHASHANI SCIENCE AND TECHNOLOGY UNIVERSITY

SANTOSH, TANGAIL-1902

DEPARTMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY

Lab Report

Lab Report No : 05

Lab Report on : Study of Fourier Transform, Inverse Fourier Transform, and DTFT using MATLAB.

Course Title : Digital Signal Processing Lab

Course Code : ICT-3206

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Introduction:

Fourier analysis is a fundamental tool in Digital Signal Processing that represents signals in the frequency domain. Fourier Transform (FT) is used for continuous-time signals, while Discrete-Time Fourier Transform (DTFT) is used to analyze discrete-time systems. This experiment demonstrates Fourier Transform, Inverse Fourier Transform, and DTFT of given signals using MATLAB.

Objective:

- To find the Fourier Transform and Inverse Fourier Transform of a given signal.
- To obtain the Fourier Transform of a time-domain signal and analyze its spectrum.
- To evaluate and plot the DTFT of a discrete-time transfer function.

Theory:

The **Fourier Transform** of a signal $x(t)$is defined as

$$X(\omega) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t} dt$$

The **Inverse Fourier Transform** recovers the original signal from its frequency representation. The **DTFT** represents discrete-time signals in the frequency domain and is widely used for frequency response analysis.

MATLAB Code:

Program 1: Fourier Transform and Inverse Fourier Transform

```
% Fourier transform and Inverse Fourier transform of a given sequence

clc; clear all; close all;

syms x;
f = exp(-x^2);
disp('The input equation is')
disp(f)

a = fourier(f);
disp('The fourier transform of the input equation is')
disp(a)

b = ifourier(a);
disp('The Inverse fourier transform is')
disp(b)
```

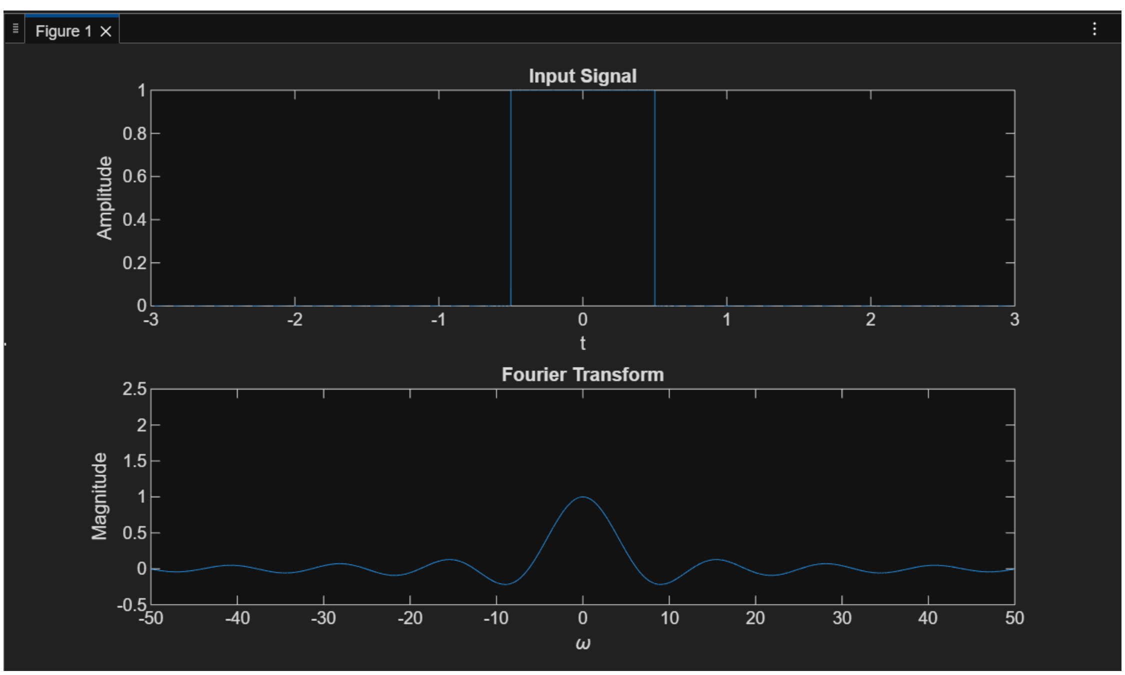
Output:

```
The input equation is
exp(-x^2)

The fourier transform of the input equation is
pi^(1/2)*exp(-w^2/4)

The Inverse fourier transform is
exp(-x^2)
```

Program 2: Fourier Transform of a Time-Domain Signal

```
clc; close all; clear all;

syms t w
a = heaviside(t + 0.5) - heaviside(t - 0.5);

subplot(2,1,1)
fplot(a, [-3 3])
title('Input Signal')
xlabel('t'); ylabel('Amplitude')

b = simplify(fourier(a, t, w))

subplot(2,1,2)
fplot(b, [-50 50])
title('Fourier Transform')
xlabel('\omega'); ylabel('Magnitude')
axis([-50 50 -0.5 2.5])
```

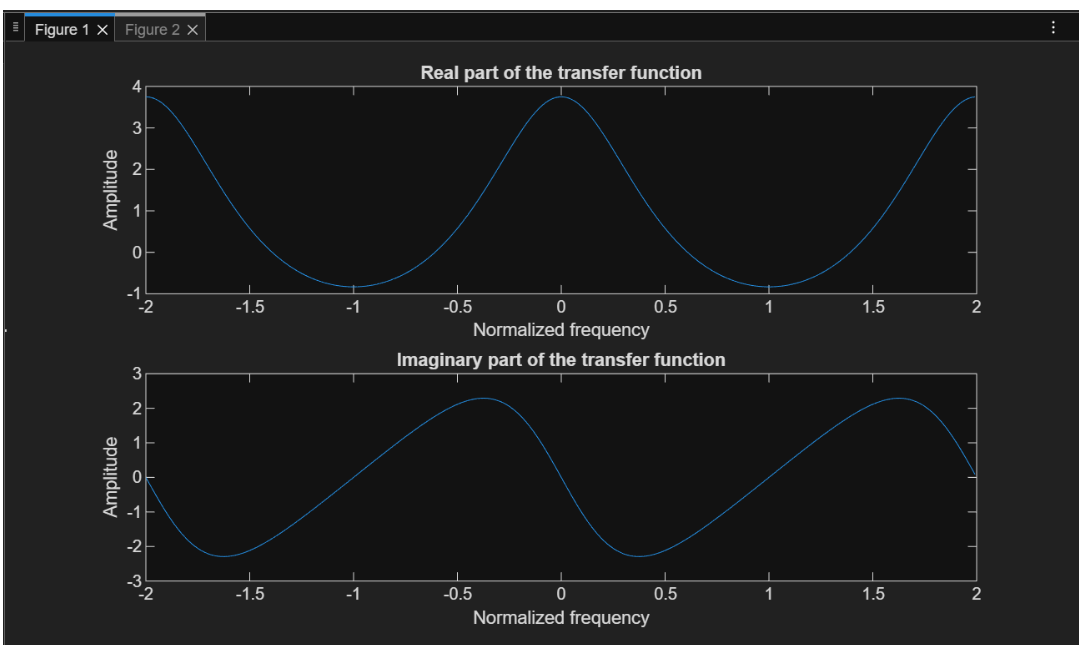
Output:

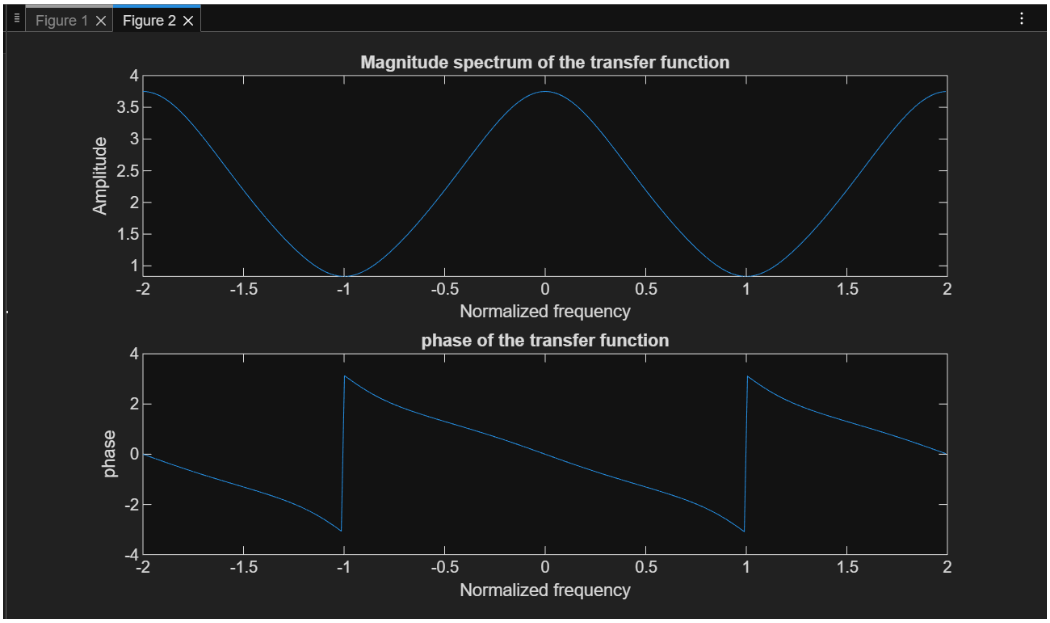


Program 3: DTFT of a Discrete-Time Transfer Function

```
% Evaluation and plotting of DTFT of the transfer function of the form
%  a=e^(-jw)
% h(e)=[1+2*a^(-1)]/[1-0.2*a^(-1)]

clc; clear all; close all;
w = -2*pi:8*pi/511:2*pi;
num = [1 2];
den = [1 -0.2];
h = freqz(num, den, w);
subplot(2,1,1); plot(w/pi, real(h));
xlabel('Normalized frequency')
ylabel('Amplitude')
title('Real part of the transfer function')
subplot(2,1,2); plot(w/pi, imag(h));
xlabel('Normalized frequency')
ylabel('Amplitude')
title('Imaginary part of the transfer function')
figure;
subplot(2,1,1); plot(w/pi, abs(h));
xlabel('Normalized frequency')
ylabel('Amplitude')
title('Magnitude spectrum of the transfer function')
subplot(2,1,2); plot(w/pi, angle(h));
xlabel('Normalized frequency')
ylabel('phase')
title('phase of the transfer function')
```

Output:





Result:

- Fourier Transform and Inverse Fourier Transform of the given signal were obtained successfully.
- Frequency-domain representation of the rectangular pulse was observed.
- DTFT magnitude and phase responses of the given transfer function were plotted correctly.

Conclusion:

This experiment successfully demonstrated Fourier Transform, Inverse Fourier Transform, and DTFT analysis using MATLAB. These tools are essential for understanding the frequency characteristics of signals and systems.