National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

Department of Electrical Engineering

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Course/Section: Bee-6B **Semester: 4th Semester**

EE-232 Signals and Systems

Lab #11 Fourier Transform

Name	Reg. no.	Report Marks / 10	Viva Marks / 5	Total/15
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Objectives:

- This Lab experiment has been designed to familiarize students with the concepts of Fourier Transform in MATLAB.

Lab Tasks:

Lab Task 1:

Generate a signal as sum of two sinusoidal of frequency f1=400Hz and f2=800Hz.

Use FFT to find the Fourier transform. Show your results.

MATLAB code:

```
Fs=10000;    %sample frequency
F1=400; %first frequency
F2=800; %second frequency
time=0:1/Fs:1-(1/Fs);    %time index
F1t=cos(2*pi*F1*time);   %1st frequency signal
F2t=cos(2*pi*F2*time);   %2st frequency signal
signal=F1t+F2t; %total signal
L=length(signal);    %length of signal
NFFT = 2^nextpow2(L);    % Next power of 2 from length of signal
Freq=fft(signal,NFFT)/L;     %FFT of signal
f_domain = Fs/2*linspace(0,1,(NFFT/2)+1);    %frequency index

subplot(2,1,1); %for time domain
plot(time,signal);
xlabel('Time(sec)');
ylabel('Amplitude');
axis([0 0.01 -2 2])
title('Time domain')
subplot(2,1,2); %for frequency domain
stem(f_domain,2*abs(Freq(1:(NFFT/2)+1)));
xlabel('Frequency (Hz)');
ylabel('Amplitude');
axis([-0.1 1000 -0.15 2])
title('Frequency domain')
```

MATLAB graph:

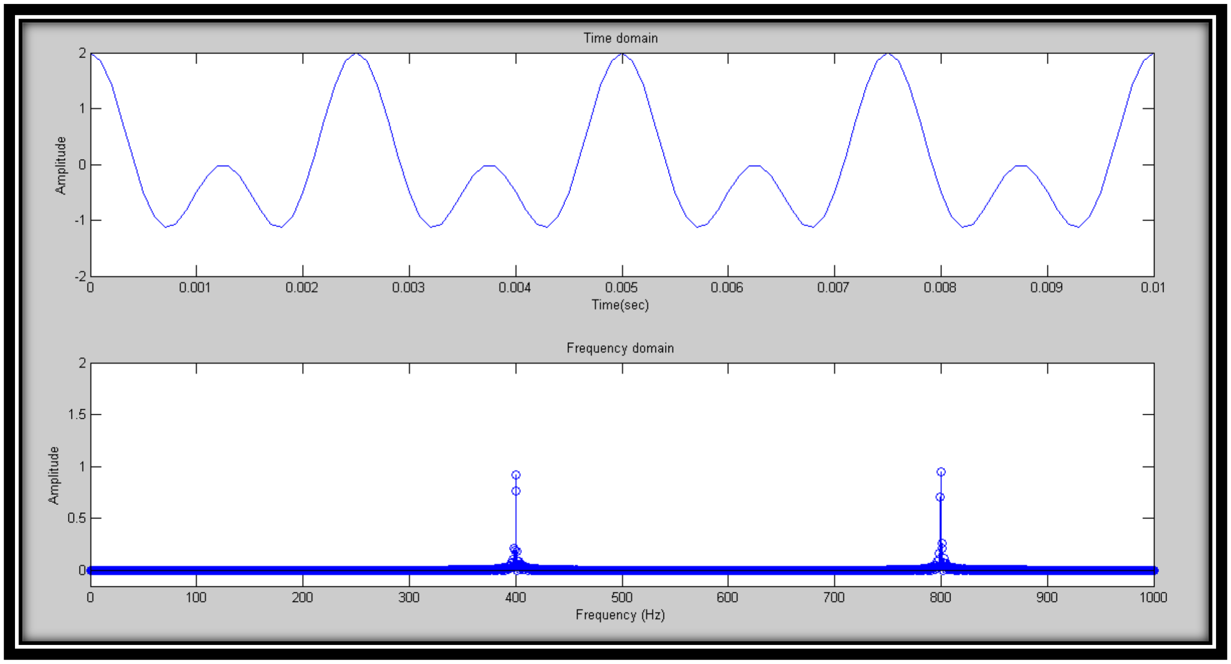


Figure 1 (Task 1)

Lab Task 2:

Calculate Fourier transform of e^{-at} u (t).Plot original signal, magnitude and phase of its Fourier transform.

MATLAB code:

```
Fs=100;    %sample frequency
time=0:1/Fs:5-(1/Fs);    %time index
signal=exp(-1*time); %total signal with a=-1
L=length(signal);    %length of signal
NFFT = 2^nextpow2(L);    % Next power of 2 from length of signal
Freq=fft(signal,NFFT)/L;     %FFT of signal
f_domain = Fs/2*linspace(0,1,(NFFT/2)+1);    %frequency index

subplot(3,1,1); %In time domain
plot(time,signal);
xlabel('Time(sec)');
ylabel('Amplitude');
title('Time domain');

```

```
subplot(3,1,2); %Magnitude spectrum in frequency domain
stem(f_domain,2*abs(Freq(1:(NFFT/2)+1)));
xlabel('Frequency (Hz)');
ylabel('magnitude');
axis([-0.1 Fs/2 -0.15 1])
title('Magnitude spectrum in Frequency domain')

subplot(3,1,3); %phase spectrum in frequency domain
stem(f_domain,angle(Freq(1:(NFFT/2)+1)));
xlabel('Frequency (Hz)');
ylabel('Phase');
axis([-0.1 Fs/2 -2 2])
title('phase spectrum in Frequency domain')
```

MATLAB graph:

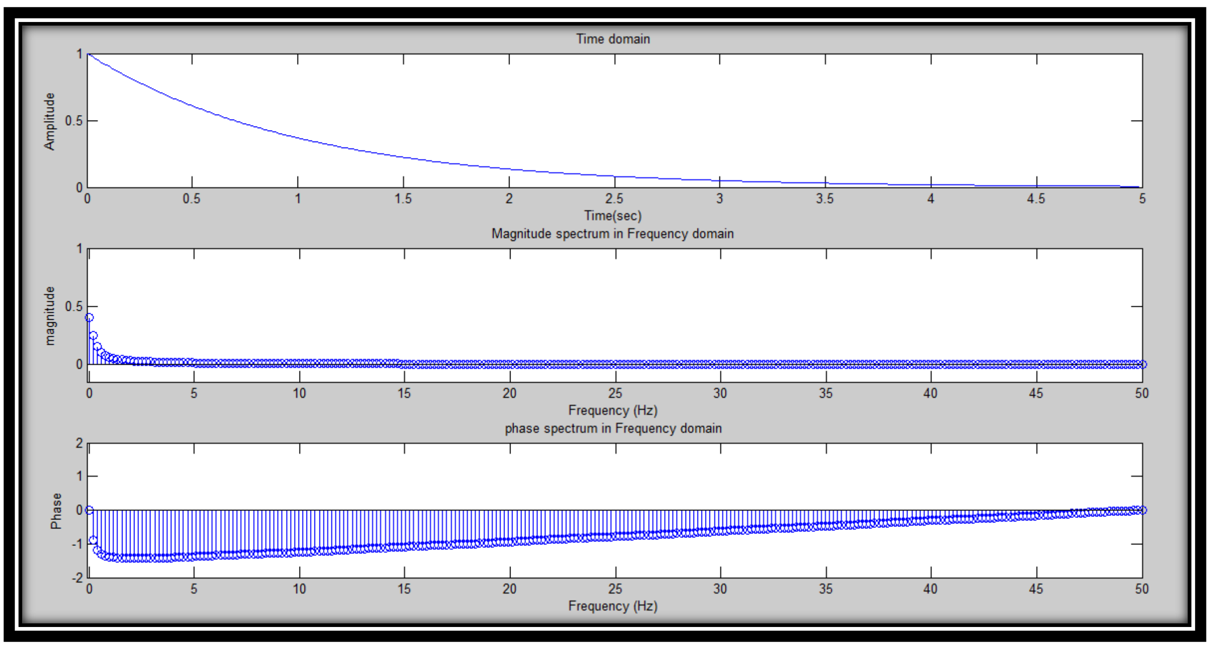


Figure 2 (Task 2)

Lab Task 3:

Convolve the signals x1(t) =e^{at} and $x_2(t)$ = sin (t) for 100 samples. Verify that “convolution in time domain equals multiplication in frequency domain.”

MATLAB code:

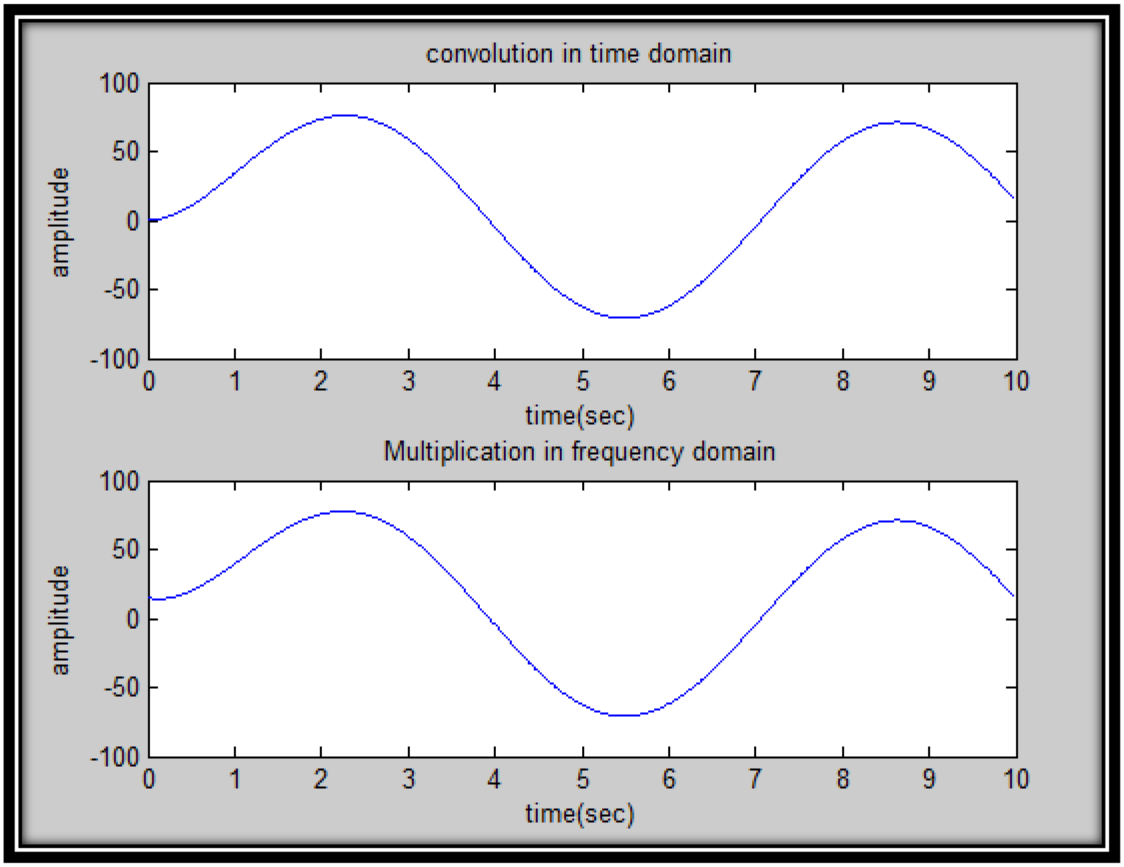
```
Fs=100; %sample frequency
Time=0:1/Fs:10-1/Fs;     %time index
X1=exp(-Time);%a=-1
X2=sin(Time);
one_side=conv(X1,X2); %after convolution

WX1=fft(X1);
WX2=fft(X2);
multi_freq=WX1.*WX2;
second_side=ifft(multi_freq); % after multiplication in frequency domain

subplot(2,1,1); %plot convolution in time domain
plot(Time,one_side(1:length(Time)));
xlabel('time(sec)')
ylabel('amplitude')
title('convolution in time domain')

subplot(2,1,2); %plot multiplication in frequency domain
plot(Time,second_side);
xlabel('time(sec)')
ylabel('amplitude')
title('Multiplication in frequency domain')
```

MATLAB graph:



Conclusion:

In this lab, we learn how FFT works and how much it is useful tool to avoid convolution.