**EXPERIMENT # 12**

**LINEARITY AND SCALING PROPERTY OF FOURIER TRANSFROM**

**Objective: -**

The main objective of this lab is as follows:

There are many properties of Fourier transform but we discuss only:

Learn about the linearity and scaling property of Fourier Transform.

**Introduction: -**

**Linearity:**

The Fourier Transform is linear. The **Fourier Transform** of a sum of functions, is the sum of the **Fourier Transforms** of the functions. Also, if you multiply a function by a constant, the **Fourier Transform** is multiplied by the same constant.

Mathematical way of representation:

The Fourier transform is linear; that is, if



Example:



**THE SCALING PROPERTY**

The scaling property states that time compression of a signal results in its spectral expansion, and time expansion of the signal results in its spectral compression.

𝒙(𝒂𝒕) ⇔ 𝟏/|𝒂|×𝑿(𝝎/𝒂)

The function (𝑎𝑡)represents the function 𝑥(𝑡)compressed by factor “a”. Similarly, a function (𝜔𝑎) represents the function 𝑋(𝜔) expanded in frequency by same factor a.

Example:

(𝑡)=𝑟𝑒𝑐𝑡(𝑡/4),𝑎=2



**Issues: -**

There are no major issues during the lab.

**Conclusion: -**

The Fourier Transform is linear, that is, it possesses the properties of homogeneity and additivity. If you horizontally ``stretch'' a signal by the factor. in the time domain, you ``squeeze'' its **Fourier transform** by the same factor in the frequency domain. This is an important general **Fourier** duality relationship.

**Applications: -**

**Fourier transform** is useful in the study of frequency response of a filter , solution of PDE, discrete **Fourier transform** and Fast **Fourier transform** in signal analysis. A **Fourier transform** when applied to a partial differential equation reduces the number of independent variables by one.

**Linearity** is the **property** of a mathematical relationship or function that it can be graphically represented as a straight line, closely related to proportionality. Physical examples include the relationship of voltage and current across a resistor (Ohm's law), and the relationship of mass and weight.

**Postlab:**

Post Lab:

Task 01 :

t=-6:0.01:6;

w=-2\*pi:.1:2\*pi;

x1=sin(5.\*t)./(5.\*t);

x2=heaviside(t+2);

x=4\*x1+3\*x2;

X1 =-(pi.\*(heaviside(w - 5) - heaviside(w + 5)))./5;

X2 =pi.\*dirac(w) - (exp(w.\*2i).\*1i)./w;

X =4.\*X1+3.\*X2;

subplot(331)

plot(t,x1,'linewidth',2), grid,title('x\_1 (t)=sinc(5\*t)'),xlabel('t---->')

subplot(332)

plot(t,x2,'linewidth',2), grid,title('x\_2 (t)=u(t+2)'),xlabel('t---->')

subplot(333)

plot(t,x,'linewidth',2),grid,title('x(t)=4\*x\_1 (t)+ 3\*x\_2 (t)'),xlabel('t---->')

subplot(334)

plot(w,(2\*X1+3\*X2),'linewidth',2),grid,title('plot of 2\*X\_1 (w)+ 3\*X\_2 (w)'),xlabel('w---->')

subplot(335)

plot(w,abs(2\*X1+3\*X2),'linewidth',2),grid,title('|2\*X\_1 (w)+ 3\*X\_2 (w)|'),xlabel('w---->')

subplot(336)

plot(w,phase(2\*X1+3\*X2),'linewidth',2),grid,title('\angle(2\*X\_1 (w)+ 3\*X\_2 (w))'),xlabel('w---->')

subplot(337)

plot(w,(X),'linewidth',2),grid,title('Plot of X(w)'),xlabel('w---->')

subplot(338)

plot(w,abs(X),'linewidth',2),grid,title('|X(w)|'),xlabel('w---->')

subplot(339)

plot(w,phase(X),'linewidth',2),grid,title('\angle X(w)'),xlabel('w---->')



Task 02 :

t=-1:0.01:1;

w=-0.33\*pi:0.1:0.33\*pi;

x=sin(pi.\*t);

X =pi.\*(dirac(w+pi)-dirac(w-pi)).\*1i;

subplot(231)

plot(t,x,'linewidth',2), grid,title('x(t)')

subplot(232)

plot(w,abs(X),'linewidth',2), grid,title('|X(w)|')

subplot(233)

plot(w,phase(X),'linewidth',2), grid,title('\angle X(w)')

x1=sin(5\*pi.\*t);

X1=-pi.\*(dirac(w - 5.\*pi) - dirac(w + 5.\*pi)).\*1i;

subplot(234)

plot(t,x1,'linewidth',2),grid,title('x(t)=x\_1(t)')

subplot(235)

plot(w,abs(X1),'linewidth',2),grid,title('|X\_1(w)|')

subplot(236)

plot(w,phase(X1),'linewidth',2),grid,title('\angle X\_1(w)')