**EXPERIMENT # 14**

**DUALITY AND DIFFERENTIATION PROPERTY OF FOURIER TRANSFORM**

**Introduction**

If 𝒙(𝒕) ⇔ 𝑿(𝝎)

𝑿(𝒕) ⇔ 𝟐𝝅 𝒙(−𝝎)

𝒓𝒆𝒄𝒕(𝒕𝝉) ⇔ 𝝉 𝒔𝒊𝒏𝒄(𝝎𝝉𝟐)

This is the duality property.

**OBJECTIVE**

Understanding of duality and differentiation property of Fourier Transform

**Procedure**

**Part 1**

syms t;

x1=heaviside(t+2)-heaviside(t-2);

f=fourier(x1);

x2=(2\*sin(2\*t))./t;

f1=fourier(x2);

t=[-10:0.01:10];

w=[-10:0.01:10];

x1=heaviside(t+2)-heaviside(t-2);

f=(2\*sin(2\*w))./w;

x2=(2\*sin(2\*t))./t;

f2=-2\*pi\*(heaviside(w-2)-heaviside(w+2));

subplot(2,2,1)

plot(t,x1);

title('x\_1(t)=rect(t/4)');

subplot(2,2,2)

plot(w,f);

title('X\_1(w)');

subplot(2,2,3)

plot(t,x2);

title('x2(t)=2/t\*sin(2\*t)');

subplot(2,2,4)

plot(w,f2);

title(' X2(w)') ;



**part 2**

syms t

x1=exp(-2\*t).\*heaviside(t);

f=fourier(x1);

x2=1./(2+t\*1i);

f1=fourier(x2);

t=[-10:0.01:10];

w=[-10:0.01:10];

x1=exp(-2\*t).\*heaviside(t);

f =1./(2+w\*1i);

x2=1./(2+t\*1i);

f1 =-pi\*exp(2\*w).\*(sign(w)-1);

subplot(2,2,1)

plot(t,x1);

title('x(t)');

subplot(2,2,2)

plot(w,f);

title('X(w)');

subplot(2,2,3)

plot(t,x2);

title('x-2(t)=1/(2j\*t)');

subplot(2,2,4)

plot(w,f1);

title('X\_2(w)');



**part 3**

syms t;

x1=2\*triangularPulse(-4,0,4,t)

f=fourier(x1)

drv=diff(x1)

drv =rectangularPulse(-4, 0, t)/2 - rectangularPulse(0, 4, t)/2

fdrv=fourier(drv)

t=[-10:0.01:10];

w=[-10:0.01:10];

f=2./w.^2+exp(-w.\*2i).\*(pi.\*dirac(1,w)+1i./w.^2).\*1i+exp(w.\*2i).\*(pi.\*dirac(1, w)+1i./w.^2)\*1i-pi\*dirac(1,w)\*2i;

x1=(t - 2).\*(heaviside(t - 2) - heaviside(t)) + (t + 2).\*(heaviside(t + 2) - heaviside(t));

fdrv=(exp(-w.\*2i).\*(exp(w.\*2i).\*1i - 1i).^2.\*1i)./w;

drv=heaviside(t - 2) + heaviside(t + 2) - 2.\*heaviside(t);

fdrv=(exp(-w.\*2i).\*(exp(w.\*2i).\*1i - 1i).^2.\*1i)./w;

fjw =(-(exp(-w.\*2i).\*(exp(w.\*2i) - 1).^2)./(w.^2)).\*(1j.\*w);

subplot(331)

plot(t,x1);

title('Tringle x(t)');

subplot(332)

plot(w,abs(f));

title('|X(w)| vs w') ;

subplot(333)

plot(w,angle(f));

title('<X(w) vs w') ;

subplot(334)

plot(t,drv);

title('xd(t)= dx(t)/dt') ;

subplot(335)

plot(w,abs(fdrv));

title('|Xd(w)| vs w ');

subplot(336)

plot(w,angle(fdrv));

title('<Xd(w) vs w ');

subplot(337)

plot(t,drv);

title('xi(t)=Finv[jwX(w)]');

subplot(338)

plot(w,abs(fjw));

title('|jwX(w)| vs w');

subplot(339)

plot(w,angle(fjw));

title(' <jwX(w) vs w ');



**Issues**

I faced no issues while performing the lab.

**Conclusion**

We can duality and differentiation property of Fourier Transform in MATLAB .

**Applications**

Duality properties of the Fourier transform enable us to easily calculate transforms of functions and also in applications such as electronic communication .

**Postlab**

syms t;

x1=exp(-5\*t).\*heaviside(t-5);

f=fourier(x1);

t=-10:0.1:10;

w=[-10:0.1:10];

x1=exp(-5.\*t).\*heaviside(t-5);

f=exp(- w\*5i - 25)./(5 + w\*1i);

subplot(2,2,1),plot(t,x1),grid on,title(' x1(t) ');

subplot(2,2,2),plot(w,f),grid on,title(' X1(w) ');

syms t w;

x2=exp(- w\*5i - 25)./(5 + w\*1i);

f2=ifourier(x2,w,t);

t=-10:0.1:10;

w=-10:0.1:10;

x2=exp(- w\*5i - 25)./(5 + w\*1i);

f2 =2\*pi\*exp(-5.\*(w)).\*heaviside((w)-5);

subplot(2,2,3),plot(t,x2),grid on,title(' x2(t) ');

subplot(2,2,4),plot(w,f2),grid on,title(' X2(w) ') ;

