**EXPERIMENT # 13**

**SHIFTING PROPERTIES OF FOURIER TRANSFORM**

**Introduction**

If x(t)⟷X(ω)

Then Time shifting property states that

x(t−t0)⟷e−jωt0X(ω)

Frequency Shifting Property

If x(t)⟷X(ω)

Then frequency shifting property states that

ejω0t.x(t)⟷X(ω−ω0)

**OBJECTIVE**

Understanding of shifting properties of Fourier Transform

**Procedure**

**Part 1**

syms t w;

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

X=fourier(x)

xx\_shift=heaviside(t)-heaviside(t-4);

XX\_shift=fourier(xx\_shift)

t=[-6:0.01:6];

to=2;

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

w=[-2\*pi:0.01:2\*pi];

X=(cos(2\*w)\*1i+sin(2\*w))./w-(cos(2\*w)\*1i-sin(2\*w))./w;

X\_shift=X.\*exp(-j\*w\*to);

xx\_shift=heaviside(t)-heaviside(t-4);

XX\_shift =(cos(4\*w)\*1i+sin(4\*w))./w-1i./w;

subplot(3,3,1);

plot(t,x);

axis([-5 5 0 1])

title('x(t)=rect(t/4)')

subplot(3,3,2);

plot(w,abs(X));

axis([-5 5 0 4])

title('|x(w)|')

subplot(3,3,3);

plot(w,angle(X));

axis([-5 5 0 4])

title('Phase')

subplot(3,3,4);

plot(t+to,x);

axis([-5 5 0 1])

title('x(t-2)')

subplot(3,3,5);

plot(w,abs(X\_shift));

axis([-5 5 0 4])

title('|Xshift(w)|')

subplot(3,3,6);

plot(w,angle(X\_shift));

axis([-5 5 0 4])

title('Phase')

subplot(3,3,7);

plot(t,xx\_shift);

axis([-5 5 0 1])

title('F^-^1(Xshift)')

subplot(3,3,8);

plot(w,abs(XX\_shift));

axis([-5 5 0 4])

title('|X(w)e^-^2^j^w|')

subplot(3,3,9);

plot(w,angle(XX\_shift));

axis([-5 5 0 4])

title('Phase'



**part 2**

syms t;

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

x\_shift=heaviside(t+2)-heaviside(t-2)\*exp(j\*2\*t);

X=fourier(x)

X\_shift=fourier(x\_shift)

t=[-10:0.01:10];

to=2;

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

x\_shift=heaviside(t+2)-heaviside(t-2).\*(j\*2\*t);

w=[-3\*pi:0.01:3\*pi];

X=(2\*sin(2\*w-4))./(w-2);

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

X\_shift=(2\*sin(2\*(w-2)))./(w-2);

subplot(3,3,1);

plot(t,x);

axis([-5 5 0 1])

title('x(t)=rect(t/4)')

subplot(3,3,2);

plot(w,abs(Xo));

axis([-10 10 0 4])

title('|x(w)|')

subplot(3,3,3);

plot(w,angle(Xo));

axis([-10 10 0 4])

title('Phase')

subplot(3,3,4);

plot(t,x\_shift);

axis([-5 5 -2 1])

title('xshift(t)')

subplot(3,3,5);

plot(w,abs(X\_shift));

axis([-10 10 0 4])

title('|Xshift(w)|')

subplot(3,3,6);

plot(w,angle(X\_shift));

axis([-10 10 0 4])

title('Phase')

subplot(3,3,7);

plot(t,x\_shift);

axis([-5 5 -1 1])

title('F^-^1(Xshift)')

subplot(3,3,8);

plot(w,abs(X\_shift));

axis([-10 10 0 4])

title('|X(w)e^-^2^j^w|')

subplot(3,3,9);

plot(w,angle(X\_shift));

axis([-10 10 0 4])

title('Phase')



**Issues**

I faced no issues while performing the lab.

**Conclusion**

We can prove shifting property of Fourier transform in MATLAB .

**Applications**

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

POST LAB:

t=[pi : 0.1 : 3\*pi];

syms t;

w=[-20: 0.01 : 20];

x=triangularPulse(pi,3\*pi,t).\*(cos(10.\*t));

X=fourier(x);

X=-((cos(2.pi.\*w)./2 - (sin(2.\*pi.\*w).\*1i)./2).(4.w.^2 + 400).(cos(pi.w) - 1))./(pi.(w.^2 - 100).^2);

t=[pi : 0.1 : 3\*pi];

X\_using\_property=(pi./2).(exp(-j\*2\*pi\*w)).(((2.(sin((w-10).\*pi./2))./(w-10).\*pi).^2)+((2.(sin((w+10).\*pi./2))./(w+10).\*pi).^2));

t1=[pi : 0.1 : 3\*pi];

x=triangularPulse(pi,3\*pi,t1).\*(cos(10.\*t1));

subplot(411),plot(t,x);

title('x'),xlabel('t -> pi\leqt\leq3\*pi'),ylabel('y axis');

subplot(412),plot(w,X);

title('Fourier function'),xlabel('w -> -20\leqt\leq20'),ylabel('y axis');

subplot(413),plot(w,X\_using\_property);

title('From properties'),xlabel('w -> -20\leqt\leq20'),ylabel('y axis');

subplot(414),plot(w,angle(X\_using\_property));

title('From properties'),xlabel('w -> -20\leqt\leq20'),ylabel('y axis');

QUESTION NO 2:-

w=[-7:0.01 :7];

X=triangularPulse(-6,-2,w)+triangularPulse(2,6,w);

subplot(211),plot(w,X);

title('X(w)'),xlabel('w -> -7\leqt\leq7'),ylabel('y axis');

t=[-7 0.01 : 7];

x\_using\_property=(2./pi).(cos(4.\*t)).((sin(t)./(t)).^2);

subplot(212),plot(t,x\_using\_property);

title('x(t)'),xlabel('w -> -7\leqt\leq7'),ylabel('y axis');