```matlab
%   Joseph R. Palicke
%   ECE 44800
%   LAB 3
%   Pt 1
clc
close all
clear all

% linearity

% define components that make x(t) w/ tau = 1s and dt = 1ms

precede = zeros(1,500);
trail = zeros(1,500);
sig = ones(1,1000);

% Create t, x(t), g(t)

t = linspace(0,.999,1000);
xt = [precede sig trail];
gt = exp(-1.*10.*t);

% define N, K, df, f

N = length(xt);
dt = .001;
df = 1/(N.*dt);
K = 0:(N/2-1);
f = 2*K.*df;

% Create yl(t)

yl = 2.*gt-sig;
z=fft([precede yl trail]).*dt;

figure(1);
stem(f(1:50),abs(z(1:50)));
xlabel('f');
ylabel('fft(2*g(t)-x(t)');
title('linearity property pt 1');
figure(2);
stem(f(1:50),angle(z(1:50)));
xlabel('f');
ylabel('phase of fft(2*g(t)-x(t)');
title('linearity property pt 2');

% find G(w) and X(w)

gsubt = [precede gt trail];
Gw = fft(gsubt).*dt;
Xw = fft(xt).*dt;
ysubl = 2*Gw-Xw;
```

```matlab
figure(3);
stem(f(1:50),abs(ysubl(1:50)));
xlabel('f');
ylabel('2*G(w)-X(w)');
title('linearity property pt 2');
figure(4);
stem(f(1:50),angle(ysubl(1:50)));
xlabel('f');
ylabel('phase of 2*G(w)-X(w)');
title('linearity property pt 2');

% time-shifting property

precede = zeros(1,700);
trail = zeros(1,300);

yts = [precede sig trail];

z1 = fft(yts).*dt;

figure(5);
stem(f(1:50),abs(z1(1:50)));
title('time shifting property pt 1');
xlabel('f');
ylabel('fft x(t-t0)');
figure(6);
stem(f(1:50),angle(z1(1:50)));
title('time shifting property pt 1');
xlabel('f');
ylabel('phase fft x(t-t0)');

expo = exp(-1.*i.*2.*pi.*f.*t);
expon = [precede expo trail];

cap_yts = expon .* Xw;
figure(7);
stem(f,abs(cap_yts(1:N/2)));
title('time shifting property pt 2');
xlabel('f');
ylabel('X(w)e^-jwt0');
figure(8);
stem(f(701:750),angle(cap_yts(701:750)));
title('time shifting property pt 2');
xlabel('f');
ylabel('phase X(w)e^-jwt0');

% frequency shifting property

precede = zeros(1,500);
trail = zeros(1,500);
expo = exp(1.*i.*100.*pi.*t);
expon = [precede expo trail];

yfs = expon .* xt;
```
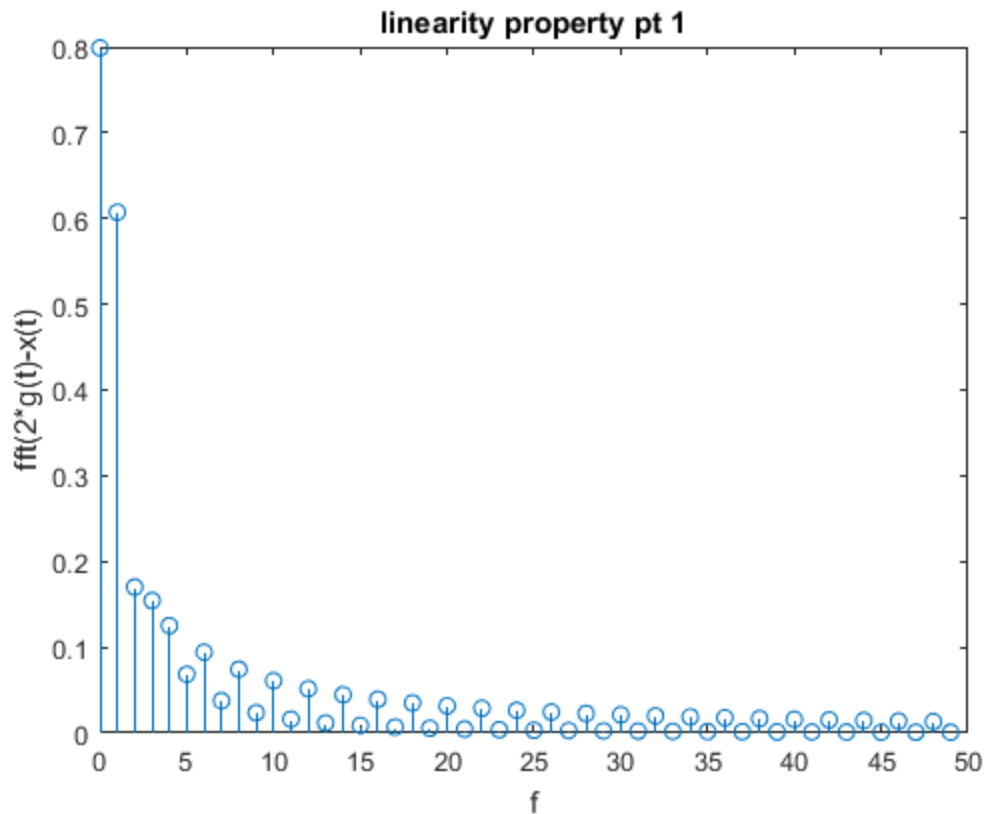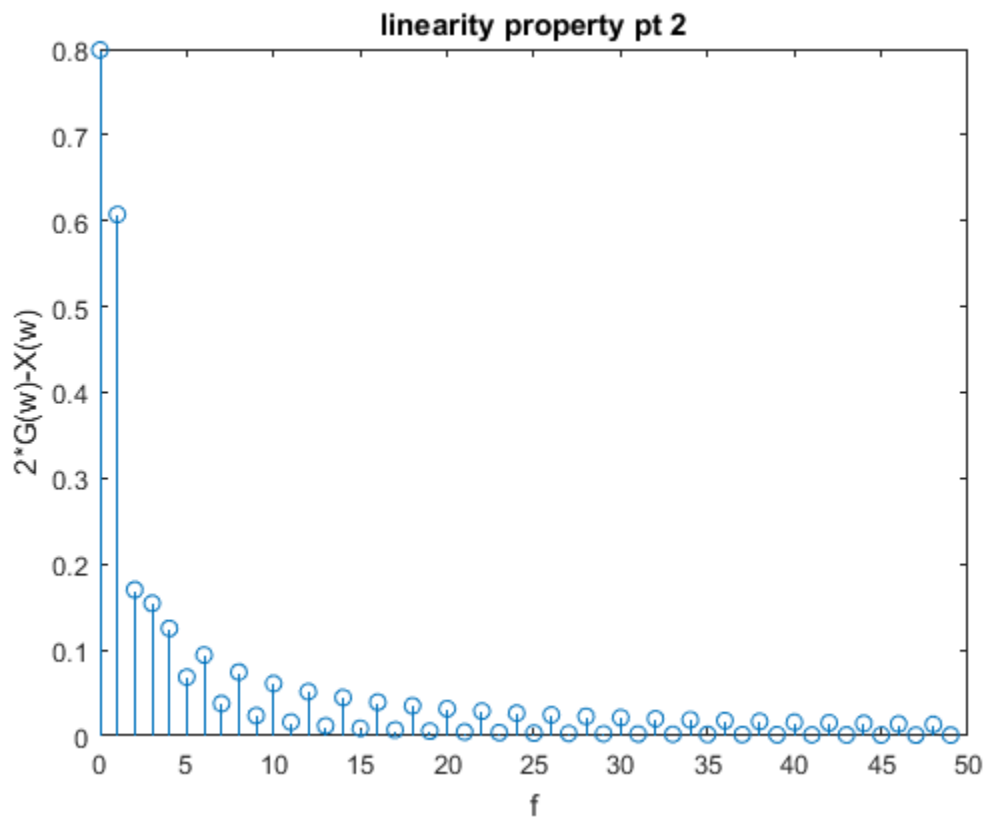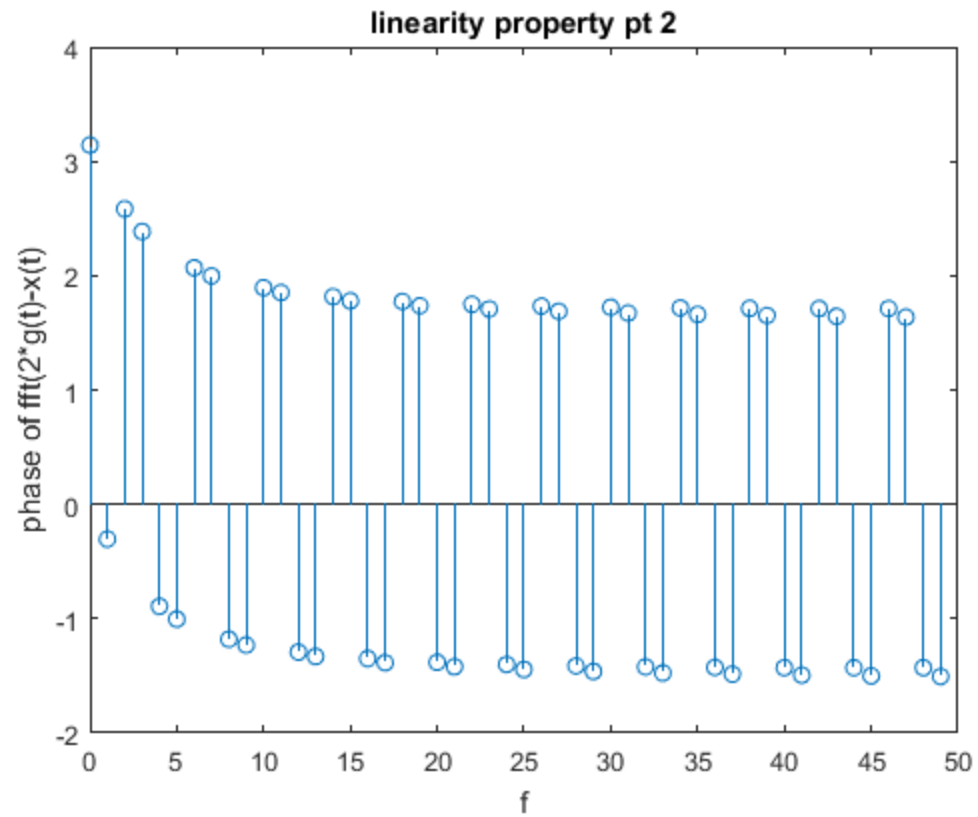
```matlab
z3 = fft(yfs).*dt;
figure(9);
stem(f(1:50),abs(z3(1:50)));
title('frequency shifting pt 1');
xlabel('f');
ylabel('fft e^jwct * x(t)');
figure(10);
stem(f(1:50),angle(z3(1:50)));
title('frequency shifting pt 1');
xlabel('f');
ylabel('phase fft e^jwct * x(t)');

figure(11);
stem(f(51:100),abs(Xw(51:100)));
title('frequency shifting pt 2');
xlabel('f');
ylabel('X(f-50');

figure(12);
stem(f(51:100),angle(Xw(51:100)));
title('frequency shifting pt 2');
xlabel('f');
ylabel('phase X(f-50');
```
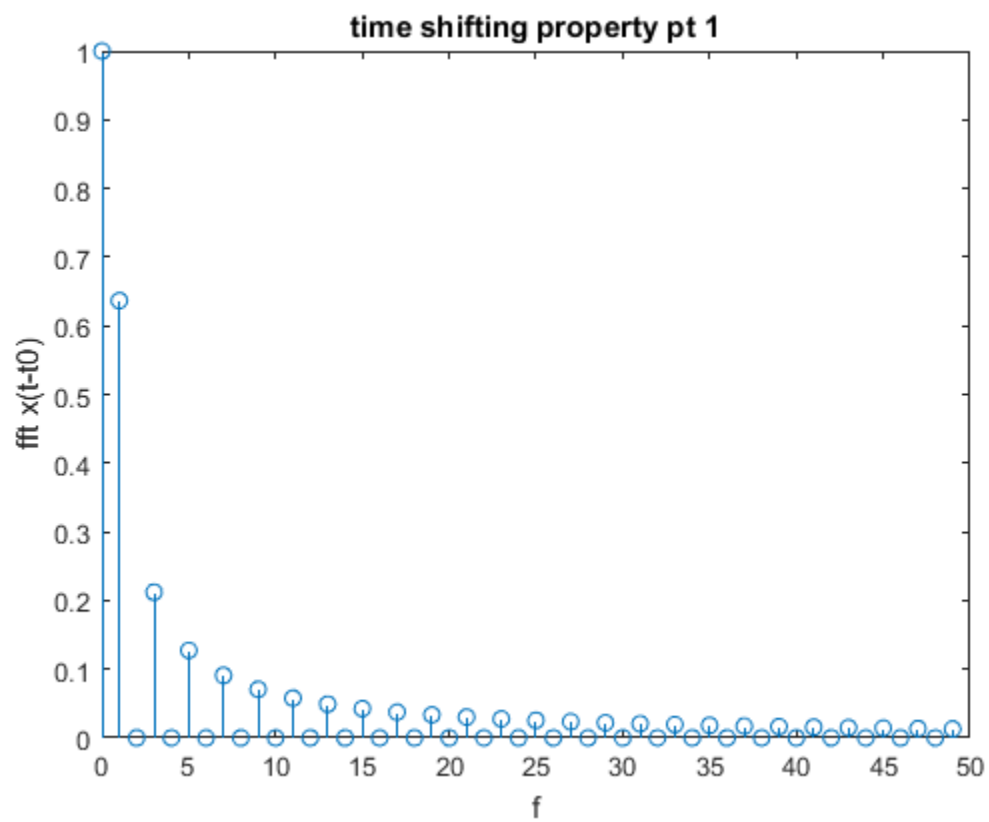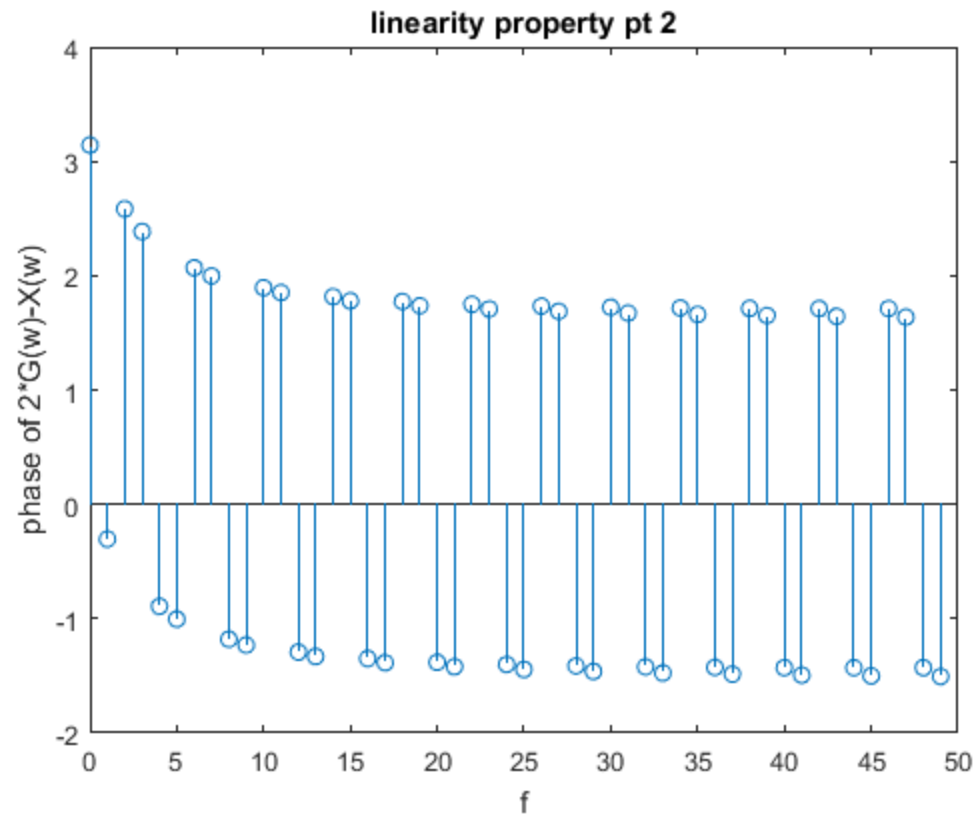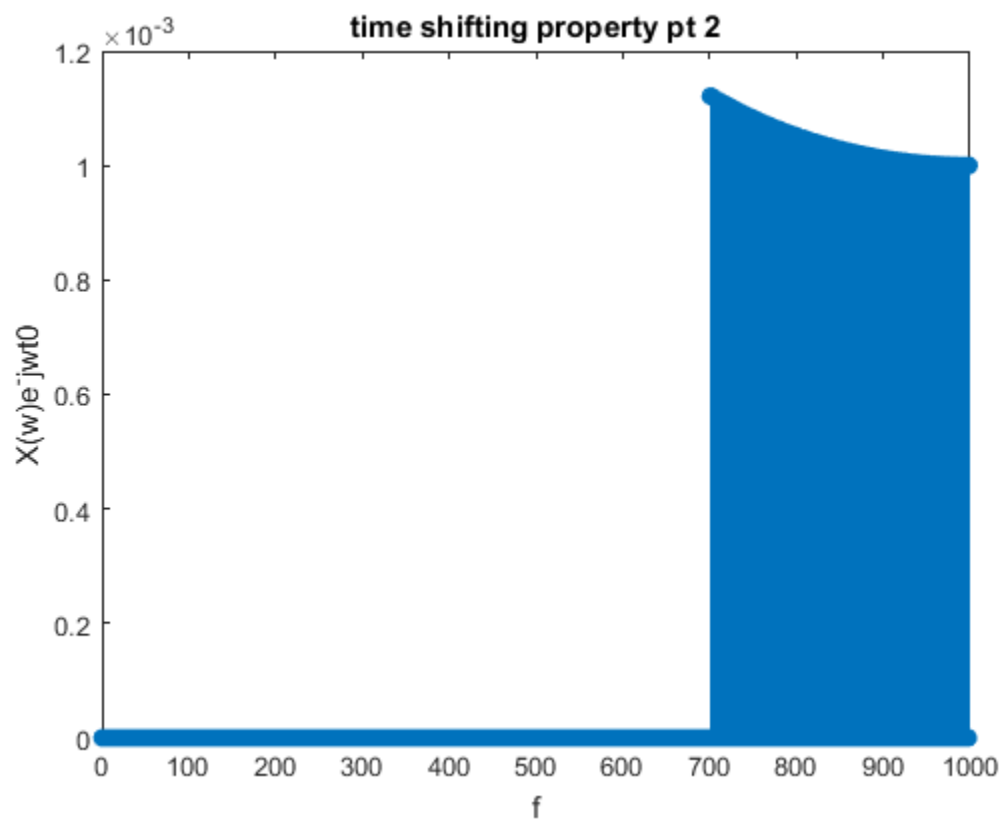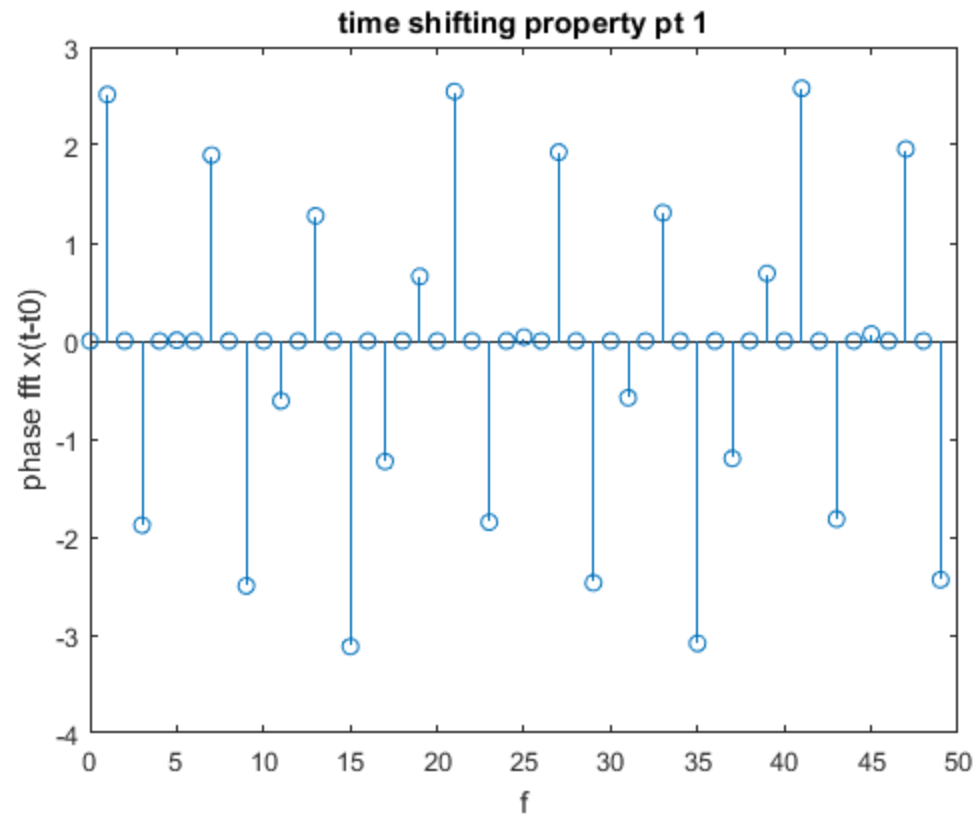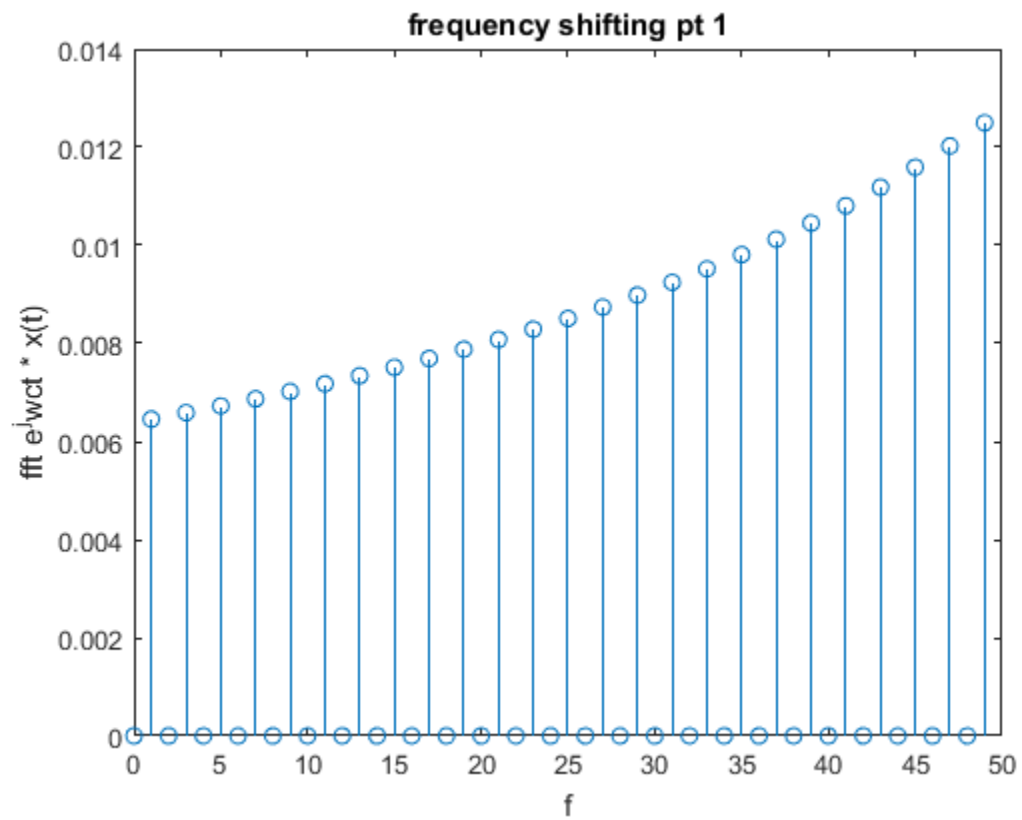
linearity property pt 2

linearity property pt 2

linearity property pt 2

phase of 2*G(w)-X(w) vs *f*

time shifting property pt 1

fft x(t-t0) vs *f*

time shifting property pt 1

time shifting property pt 2

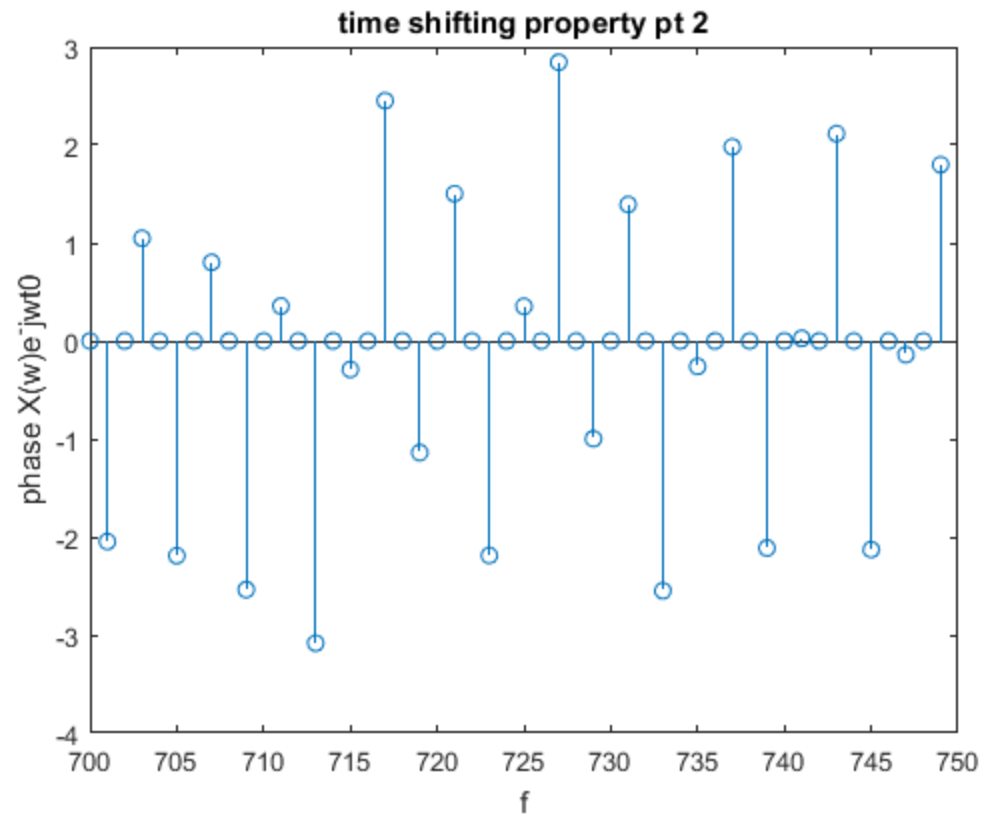time shifting property pt 2

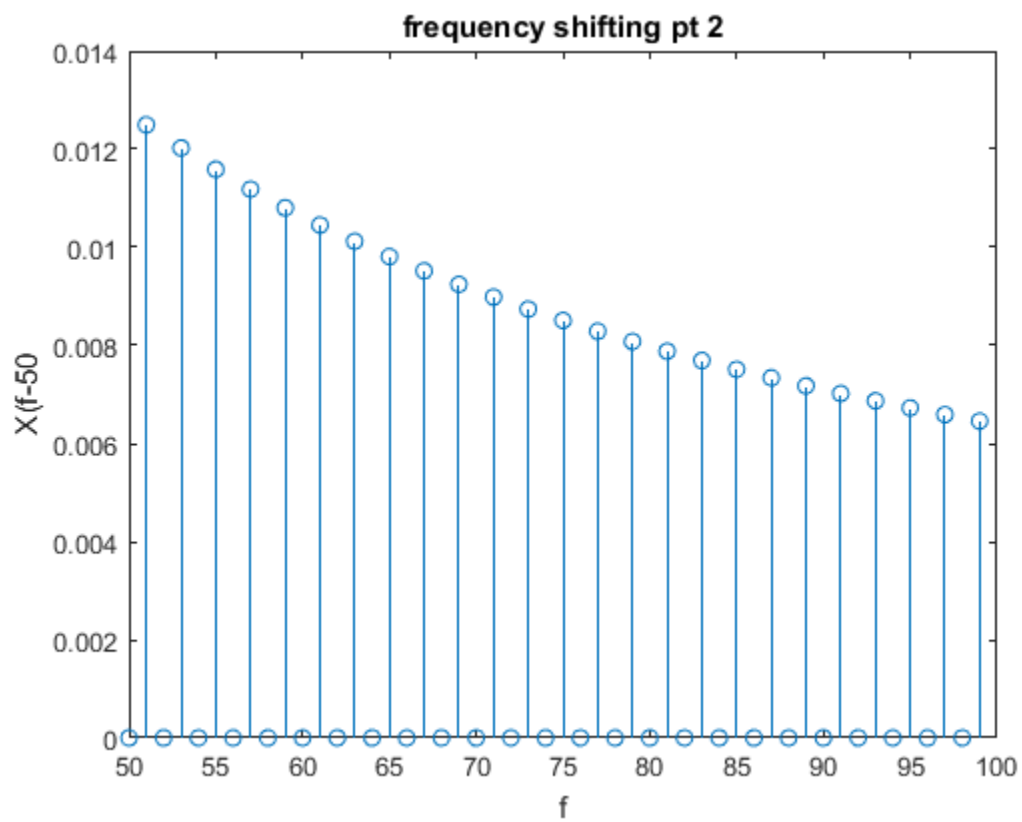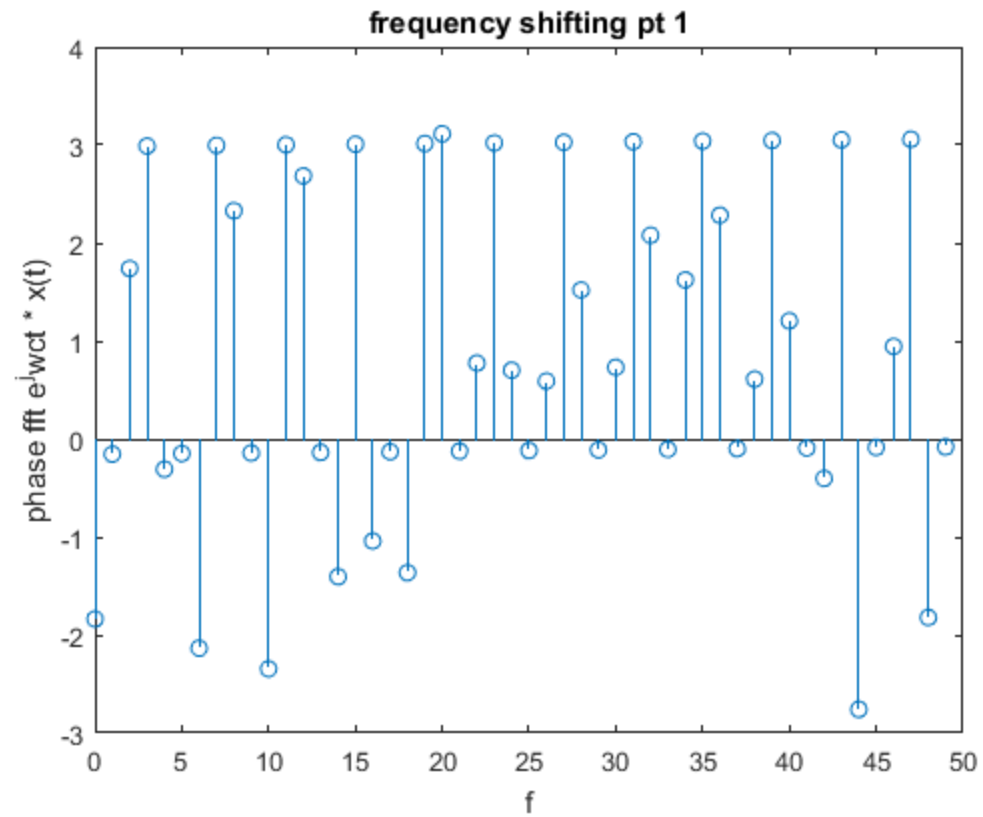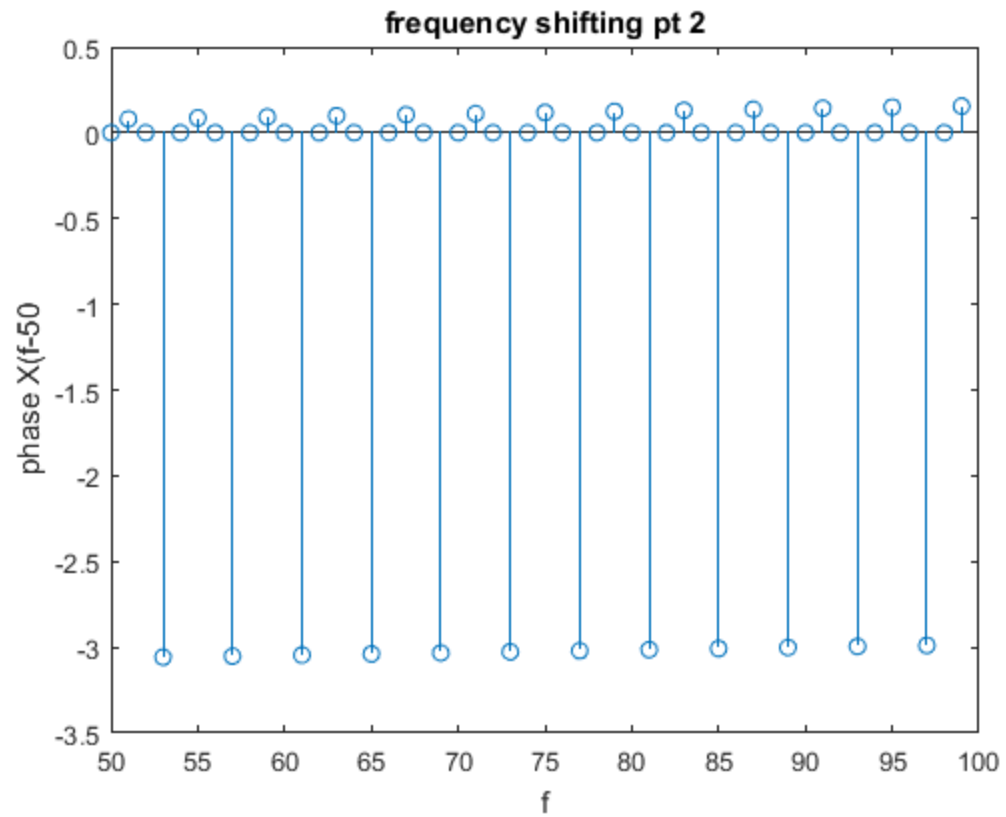frequency shifting pt 1

frequency shifting pt 1

frequency shifting pt 2

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