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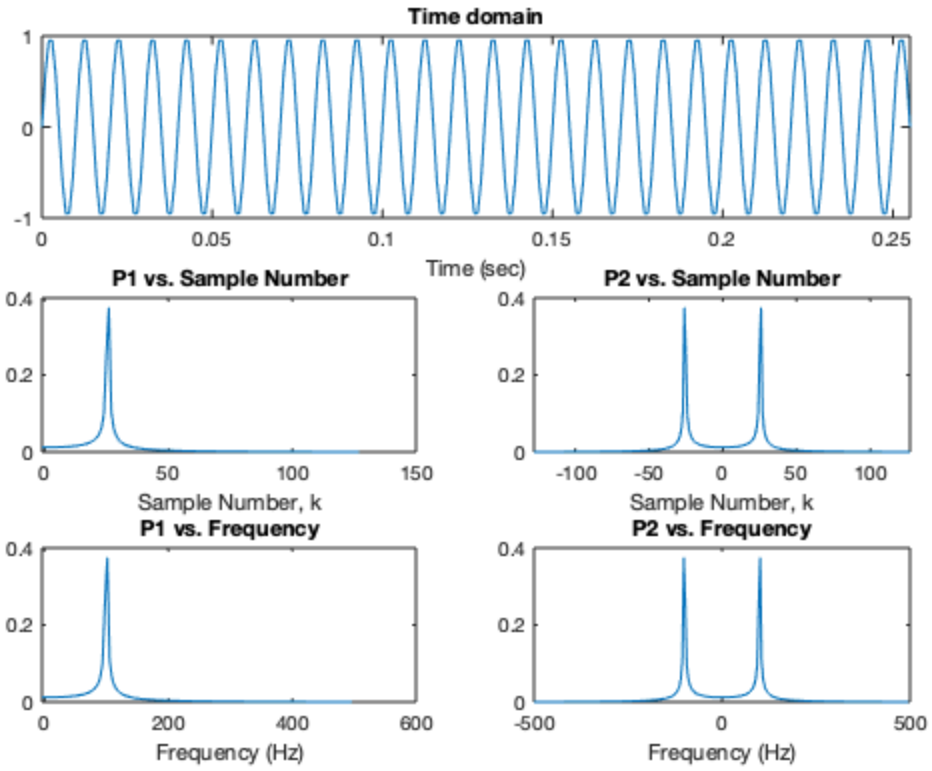
Problem 1

```
clear
close all
% For problems 1 througsh 3, create 5 sub-plots:
%   1. Time domain x[n] vs time (sec)
%   2. One-sided, P1, Frequency domain X[k] vs sample number
%   3. One-sided, P1, Frequency domain X[k] vs frequency (Hz)
%   4. Two-sided, P2, Frequency domain X[k] vs sample number
%   5. Two-sided, P2, Frequency domain X[k] vs frequency (Hz)

% generating the time vector (part a)
Fs = 1000;        % sampling frequency
L = 256;          % length of signal
t = (0:L-1)*1/Fs;

% form the signal (part b)
x = sin(2*pi*100*t);

% convert x into the frequency domain with Nfft = 256
y = fft(x,L);

% set frequency and sampling vectors (depends on whether L is odd or
 even)
f = (0:L-1)*(Fs/L) - (Fs-(mod(L,2)*(Fs/L)))/2;
k = (0:L-1) - (L-mod(L,2))/2;

P2 = fftshift(abs(y/L));

figure
subplot(3,2,[1,2]);
plot(t,x);
xlim([0,0.255]);
xlabel('Time (sec)');
title('Time domain');

subplot(3,2,3);
plot(k(length(k)/2:length(k)),P2(length(k)/2:length(k)));
xlabel('Sample Number, k');
title('P1 vs. Sample Number');

subplot(3,2,4);
plot(k,P2);
xlabel('Sample Number, k');
```

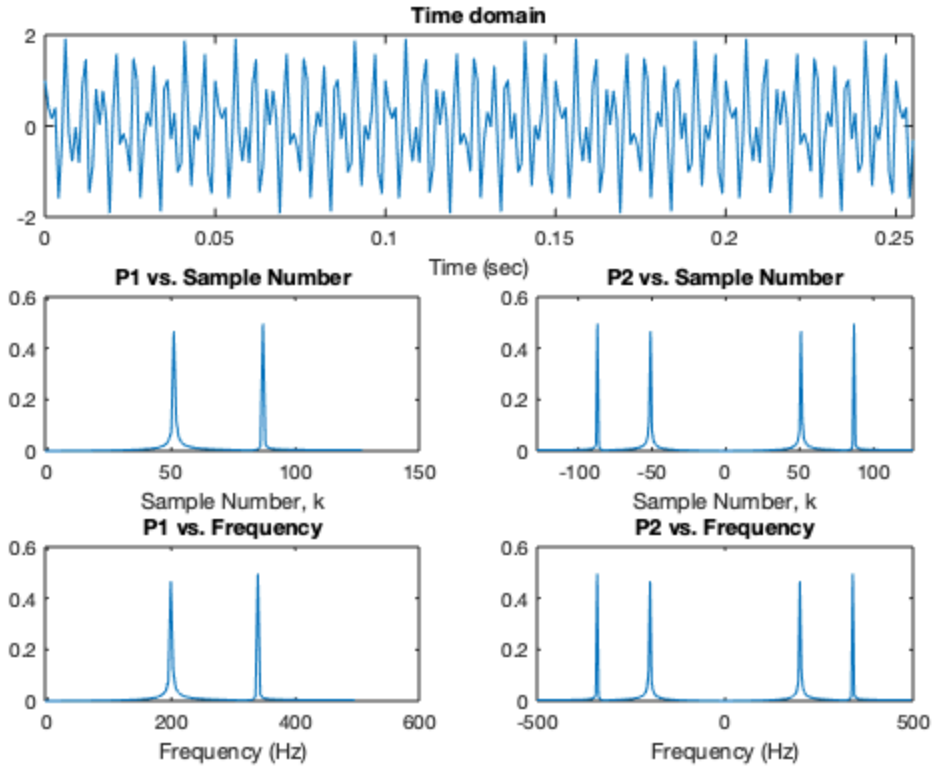
```
title('P2 vs. Sample Number');

subplot(3,2,5);
plot(f(length(f)/2:length(f)),P2(length(f)/2:length(f)));
xlabel('Frequency (Hz)');
title('P1 vs. Frequency');

subplot(3,2,6);
plot(f,P2);
xlabel('Frequency (Hz)');
title('P2 vs. Frequency');
```



Problem 2

```
% generating the time vector
Fs = 1000;          % sampling frequency
L = 256;            % length of signal
t = (0:L-1)*1/Fs;

% form the signal (part b)
x = sin(2*pi*200*t) + cos(2*pi*340*t);

% convert x into the frequency domain with Nfft = 256
y = fft(x,L);
```

```
% set frequency and sampling vectors (depends on whether L is odd or
 even)
f = (0:L-1)*(Fs/L) - (Fs-(mod(L,2)*(Fs/L)))/2;
k = (0:L-1) - (L-mod(L,2))/2;

P2 = fftshift(abs(y/L));

figure
subplot(3,2,[1,2]);
plot(t,x);
xlabel('Time (sec)');
title('Time domain');
xlim([0,0.255]);

subplot(3,2,3);
plot(k(length(k)/2:length(k)),P2(length(k)/2:length(k)));
xlabel('Sample Number, k');
title('P1 vs. Sample Number');

subplot(3,2,4);
plot(k,P2);
xlabel('Sample Number, k');
title('P2 vs. Sample Number');

subplot(3,2,5);
plot(f(length(f)/2:length(f)),P2(length(f)/2:length(f)));
xlabel('Frequency (Hz)');
title('P1 vs. Frequency');

subplot(3,2,6);
plot(f,P2);
xlabel('Frequency (Hz)');
title('P2 vs. Frequency');
```

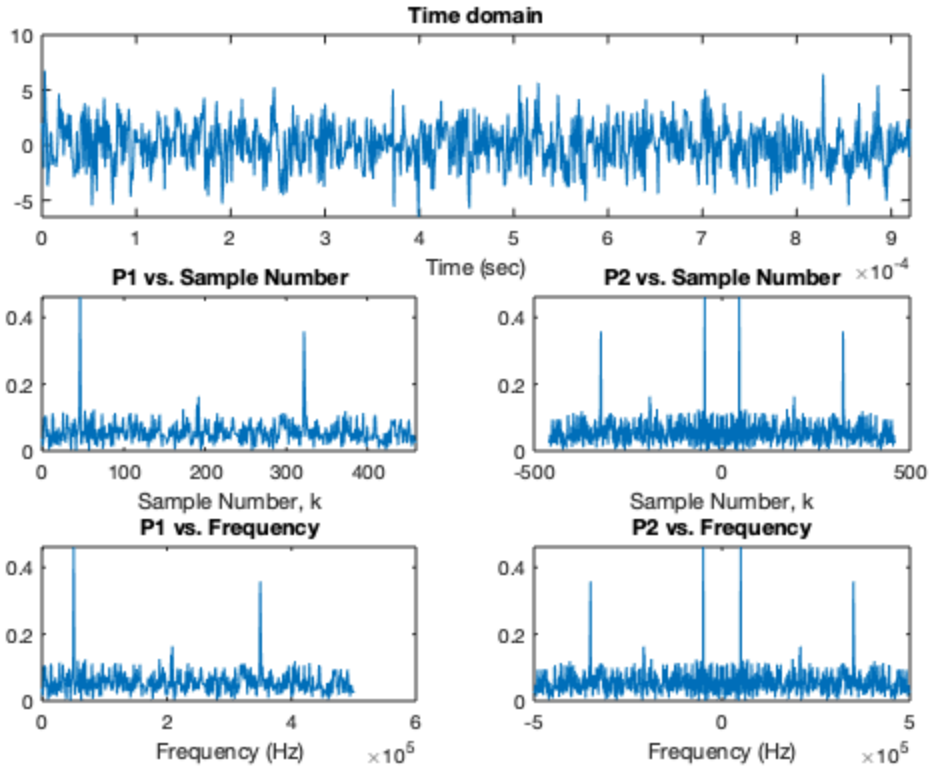


Problem 3

```
clear
close all

load x.mat

% For problems 1 througsh 3, create 5 sub-plots:
%   1. Time domain x[n] vs time (sec)
%   2. One-sided, P1, Frequency domain X[k] vs sample number
%   3. One-sided, P1, Frequency domain X[k] vs frequency (Hz)
%   4. Two-sided, P2, Frequency domain X[k] vs sample number
%   5. Two-sided, P2, Frequency domain X[k] vs frequency (Hz)

Fs = 1*10^6;        % sampling frequency
L = length(x);      % length of signal
t = (0:L-1)*1/Fs;   % create a time vector

f = (0:L-1)*(Fs/L) - (Fs-mod(L,2)*(Fs/L))/2;
k = (0:L-1) - (L-mod(L,2))/2;

% convert x into the frequency domain with Nfft = length(x)
y = fft(x,L);

P2 = fftshift(y/L);
```

```
P2 = abs(P2);

figure
subplot(3,2,[1,2]);
plot(t,x);
xlabel('Time (sec)');
title('Time domain');
xlim([0,(L-1)*1/Fs]);

subplot(3,2,3);
plot(k((length(k)-mod(length(k),2))/2:length(k)),P2((length(k)-
mod(length(k),2))/2:length(k)));
xlabel('Sample Number, k');
title('P1 vs. Sample Number');

subplot(3,2,4);
plot(k,P2);
xlabel('Sample Number, k');
title('P2 vs. Sample Number');

subplot(3,2,5);
plot(f((length(f)-mod(length(f),2))/2:length(f)),P2((length(f)-
mod(length(f),2))/2:length(f)));
xlabel('Frequency (Hz)');
title('P1 vs. Frequency');

subplot(3,2,6);
plot(f,P2);
xlabel('Frequency (Hz)');
title('P2 vs. Frequency');

fprintf("3a. It is not obivous, there is too much noise in the time
 domain graph." + newline);
fprintf("3b. Now it is easier to observe, there are two pairs of
 impulses that stand out." + newline);
fprintf("3c. The estimated frequencies of s1(t): 49950 Hz s2(t):
 349600 Hz.");
```

```
3a. It is not obivous, there is too much noise in the time domain
 graph.
3b. Now it is easier to observe, there are two pairs of impulses that
 stand out.
3c. The estimated frequencies of s1(t): 49950 Hz s2(t): 349600 Hz.
```



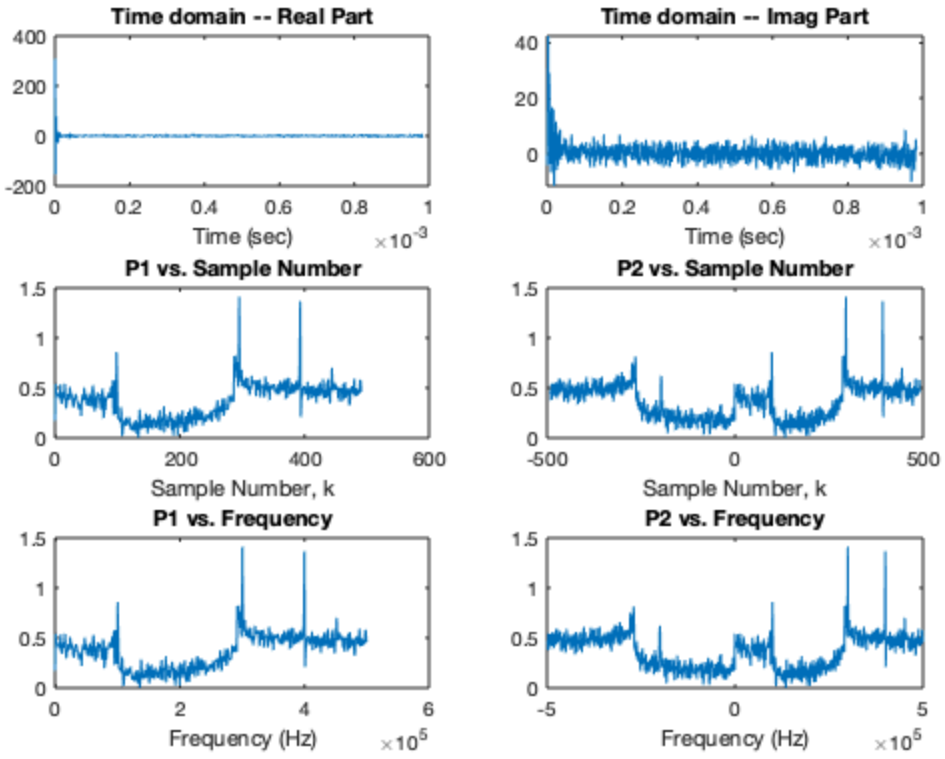
Problem 4

For problem 4, create 6 sub-plots 1. Time domain Re(x[n]) vs time (sec) 2. Time domain Im(x[n]) vs time (sec) 3. One-sided, P1, Frequency domain X[k] vs sample number 4. One-sided, P1, Frequency domain X[k] vs frequency (Hz) 5. Two-sided, P2, Frequency domain X[k] vs sample number 6. Two-sided, P2, Frequency domain X[k] vs frequency (Hz)

```
clear
close all
load y.mat

Fs = 1*10^6;         % sampling frequency
L = length(y);       % length of signal
t = (0:L-1)*1/Fs;    % create a time vector (part a)

f = (0:L-1)*(Fs/L) - (Fs-mod(L,2)*(Fs/L))/2;
k = (0:L-1) - (L-mod(L,2))/2;

% convert x into the frequency domain with Nfft
y_out = fft(y,L);

P2 = fftshift(y_out/L);
P2 = abs(P2);

figure
subplot(3,2,1);
```

```
plot(t,real(y));
xlabel('Time (sec)');
title('Time domain -- Real Part');
subplot(3,2,2);

plot(t,imag(y));
xlabel('Time (sec)');
title('Time domain -- Imag Part');

subplot(3,2,3);
plot(k((length(k)-mod(length(k),2))/2:length(k)),P2((length(k)-
mod(length(k),2))/2:length(k)));
xlabel('Sample Number, k');
title('P1 vs. Sample Number');

subplot(3,2,4);
plot(k,P2);
xlabel('Sample Number, k');
title('P2 vs. Sample Number');

subplot(3,2,5);
plot(f((length(f)-mod(length(f),2))/2:length(f)),P2((length(f)-
mod(length(f),2))/2:length(f)));
xlabel('Frequency (Hz)');
title('P1 vs. Frequency');

subplot(3,2,6);
plot(f,P2);
xlabel('Frequency (Hz)');
title('P2 vs. Frequency');

fprintf("4. Estimated number of signals: 5" + newline);
fprintf("Estimated frequency of signals, listed from most possible to
 least" + newline);
fprintf("Estimated frequency of s1(t): 300100 Hz" + newline);
fprintf("Estimated frequency of s2(t): 399800 Hz" + newline);
fprintf("Estimated frequency of s3(t): 99690 Hz" + newline);
fprintf("Estimated frequency of s4(t): -269600 Hz" + newline);
fprintf("Estimated frequency of s5(t): -199400 Hz");
```

```
4. Estimated number of signals: 5
Estimated frequency of signals, listed from most possible to least
Estimated frequency of s1(t): 300100 Hz
Estimated frequency of s2(t): 399800 Hz
Estimated frequency of s3(t): 99690 Hz
Estimated frequency of s4(t): -269600 Hz
Estimated frequency of s5(t): -199400 Hz
```



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