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PROBLEM 1

```matlab
close all

Fs = 1000;

L = 256;

Lfft = L;

evenL = L-mod(L,2);

% part 1 a
t = (0:L-1)*1/Fs;

% part 1 b
x = sin(2*pi*100*t);

subplot(3,2,[1,2]);
plot(t,x);
xlabel("Time (s)");
title("Signal in Time Domain");
xlim([min(t),max(t)]);
ylim([min(x),max(x)]);

% part 1 c
P2 = fftshift(abs(fft(x, Lfft))/L);

k2 = (-evenL/2:L-1-evenL/2);

P1 = P2(length(k2)/2: length(k2)-1);

k1 = k2(length(k2)/2: length(k2)-1);

% part 1 d
f2 = (0:L-1)*(Fs/L) - (Fs-(mod(L,2)*(Fs/L)))/2;

f1 = f2(length(k2)/2: length(k2)-1);


subplot(3,2,3);
plot(k1, P1);
xlabel("Sample Number, k");
title("P1 vs. Sample Number");
```
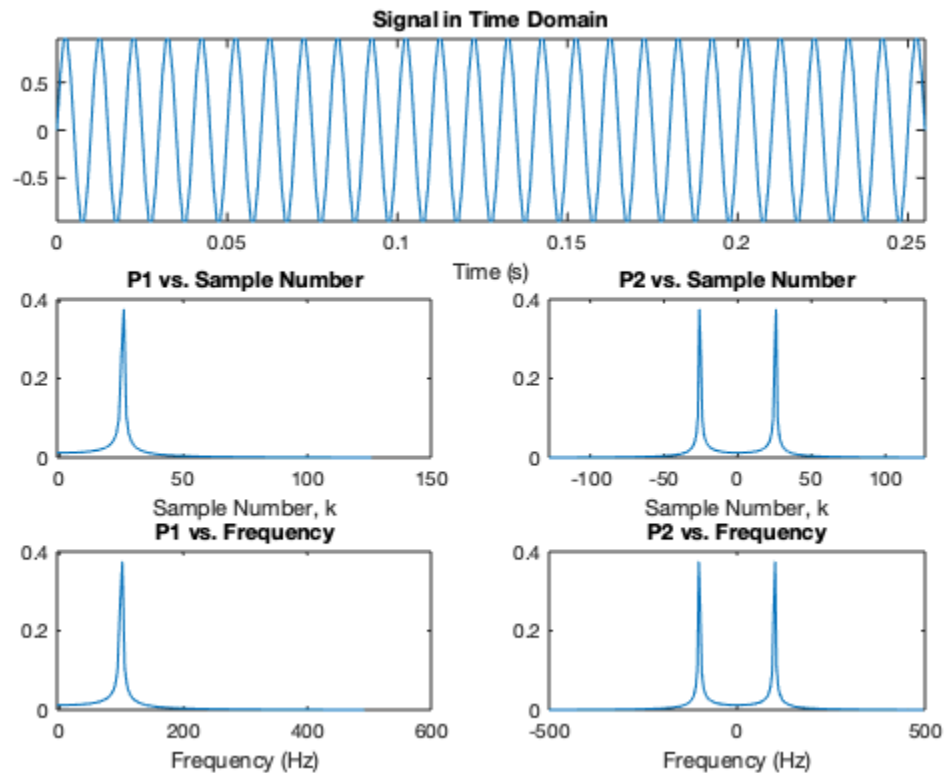
```
subplot(3,2,4);
plot(k2, P2);
xlabel("Sample Number, k");
title("P2 vs. Sample Number");

subplot(3,2,5);
plot(f1, P1);
xlabel("Frequency (Hz)");
title("P1 vs. Frequency");

subplot(3,2,6);
plot(f2, P2);
xlabel("Frequency (Hz)");
title("P2 vs. Frequency");
```


PROBLEM 2

```
close all

y = sin(2*pi*200*t) + cos(2*pi*340*t);


Fs = 1000;
L = 256;
Lfft = L;
```

```matlab
evenL = L-mod(L,2);

t = (0:L-1)*1/Fs;

x = sin(2*pi*200*t) + cos(2*pi*340*t);

subplot(3,2,[1,2]);
plot(t,x);
xlabel("Time (s)");
title("Signal in Time Domain");
xlim([min(t),max(t)]);
ylim([min(x),max(x)]);

P2 = fftshift(abs(fft(x, Lfft))/L);

k2 = (-evenL/2:L-1-evenL/2);

P1 = P2(length(k2)/2:length(k2)-1);

k1 = k2(length(k2)/2:length(k2)-1);

f2 = (0:L-1)*(Fs/L) - (Fs-(mod(L,2)*(Fs/L)))/2;

f1 = f2(length(k2)/2:length(k2)-1);


subplot(3,2,3);
plot(k1, P1);
xlabel("Sample Number, k");
title("P1 vs. Sample Number");

subplot(3,2,4);
plot(k2, P2);
xlabel("Sample Number, k");
title("P2 vs. Sample Number");

subplot(3,2,5);
plot(f1, P1);
xlabel("Frequency (Hz)");
title("P1 vs. Frequency");

subplot(3,2,6);
plot(f2, P2);
xlabel("Frequency (Hz)");
title("P2 vs. Frequency");
```
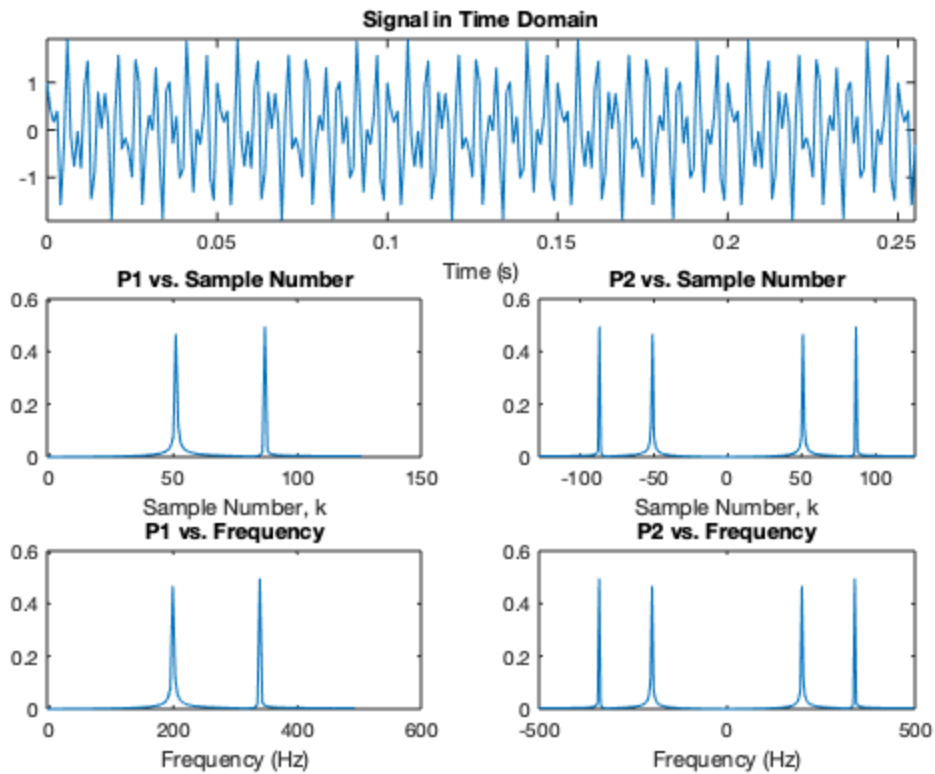
Signal in Time Domain / P1 vs. Sample Number / P2 vs. Sample Number / P1 vs. Frequency / P2 vs. Frequency

PROBLEM 3

```
close all

load x.mat;

L = length(x);
Fs = 1000000;
Lfft = L;

evenL = L-mod(L,2);

t = (0:L-1)*1/Fs;


subplot(3,2,[1,2]);
plot(t,x);
xlabel("Time (s)");
title("Signal in Time Domain");
xlim([min(t),max(t)]);
ylim([min(x),max(x)]);

% part c

P2 = fftshift(abs(fft(x, Lfft))/L);
```

```matlab
k2 = (-evenL/2:L-1-evenL/2);

len = length(k2) - mod(length(k2),2);

P1 = P2(len/2:len-1);

k1 = k2(len/2:len-1);

f2 = (0:L-1)*(Fs/L) - (Fs-(mod(L,2)*(Fs/L)))/2;

f1 = f2(len/2:len-1);


subplot(3,2,3);
plot(k1, P1);
xlabel("Sample Number, k");
title("P1 vs. Sample Number");

subplot(3,2,4);
plot(k2, P2);
xlabel("Sample Number, k");
title("P2 vs. Sample Number");

subplot(3,2,5);
plot(f1, P1);
xlabel("Frequency (Hz)");
title("P1 vs. Frequency");

subplot(3,2,6);
plot(f2, P2);
xlabel("Frequency (Hz)");
title("P2 vs. Frequency");

fprintf("3a) The noise makes it nearly impossible to distinguish the
 center frequencies. " + newline);
fprintf("3b) Two speaks in frequencies stand out making it easier to
 detect the center frequency." + newline);
fprintf("3c) The two frequencies observed are 49950 Hz and 349600
 Hz.");
%49950 Hz and 349600 Hz

3a) The noise makes it nearly impossible to distinguish the center
 frequencies.
3b) Two speaks in frequencies stand out making it easier to detect the
 center frequency.
3c) The two frequencies observed are 49950 Hz and 349600 Hz.
```
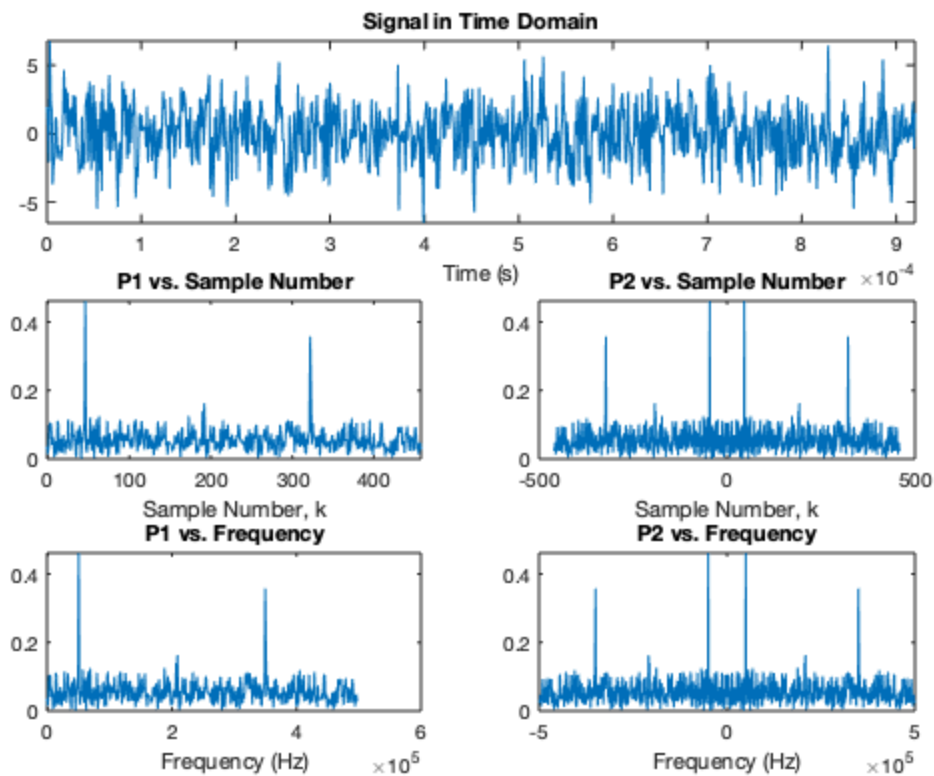
Signal in Time Domain / P1 vs. Sample Number / P2 vs. Sample Number / P1 vs. Frequency / P2 vs. Frequency

PROBLEM 4

```
close all

load y.mat;


L = length(y);
Fs = 1000000;
Lfft = L;

evenL = L-mod(L,2);

t = (0:L-1)*1/Fs;


subplot(3,2,1);
plot(t,real(y));
xlabel("Time (s)");
title("Real Part of Signal in Time Domain");
xlim([min(t),max(t)]);
ylim([min(real(y)),max(real(y))]);

subplot(3,2,2);
plot(t,imag(y));
```

```matlab
xlabel("Time (s)");
title("Imaginary Part of Signal in Time Domain");
xlim([min(t),max(t)]);
ylim([min(imag(y)),max(imag(y))]);


P2 = fftshift(abs(fft(y, Lfft))/L);

k2 = (-evenL/2:L-1-evenL/2);

len = length(k2) - mod(length(k2),2);

P1 = P2(len/2:len-1);

k1 = k2(len/2:len-1);

f2 = (0:L-1)*(Fs/L) - (Fs-(mod(L,2)*(Fs/L)))/2;

f1 = f2(len/2:len-1);


subplot(3,2,3);
plot(k1, P1);
xlabel("Sample Number, k");
title("P1 vs. Sample Number");

subplot(3,2,4);
plot(k2, P2);
xlabel("Sample Number, k");
title("P2 vs. Sample Number");

subplot(3,2,5);
plot(f1, P1);
xlabel("Frequency (Hz)");
title("P1 vs. Frequency");

subplot(3,2,6);
plot(f2, P2);
xlabel("Frequency (Hz)");
title("P2 vs. Frequency");


fprintf("4) There were 5 frequencies observed:" + newline);
fprintf("s1 freq = 300100 Hz" + newline);
fprintf("s2 freq = 399800 Hz" + newline);
fprintf("s3 freq = 99690 Hz" + newline);
fprintf("s4 freq = -269600 Hz" + newline);
fprintf("s5 freq = -199400 Hz" + newline);
```
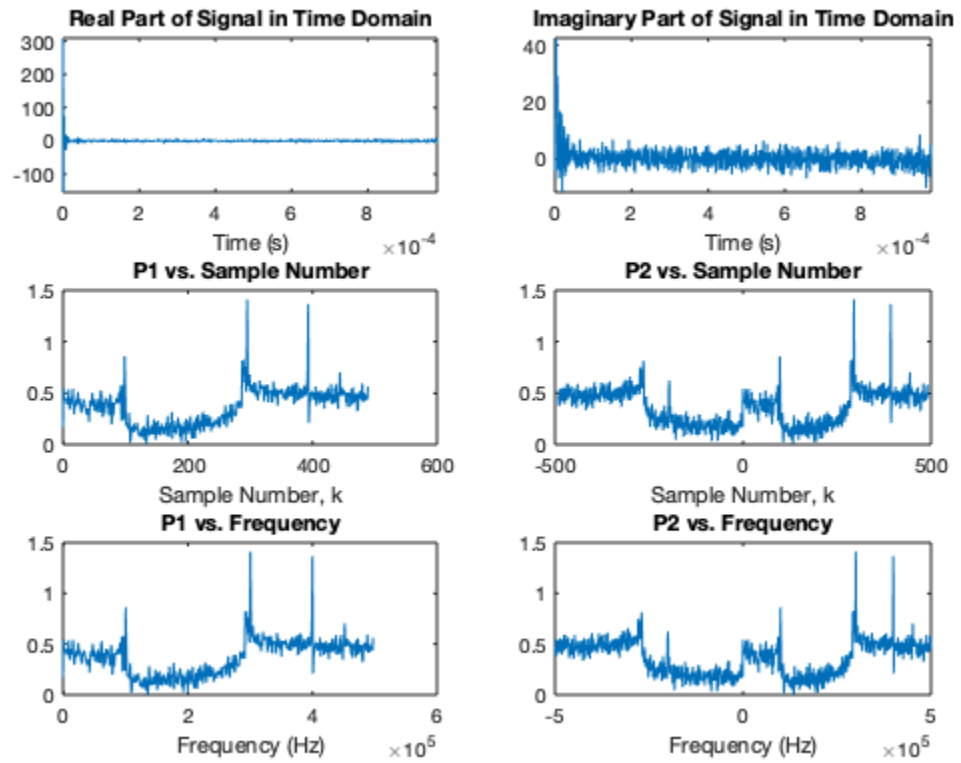
4) There were 5 frequencies observed:
s1 freq = 300100 Hz
s2 freq = 399800 Hz
s3 freq = 99690 Hz
s4 freq = -269600 Hz

```
s5 freq = -199400 Hz
```

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