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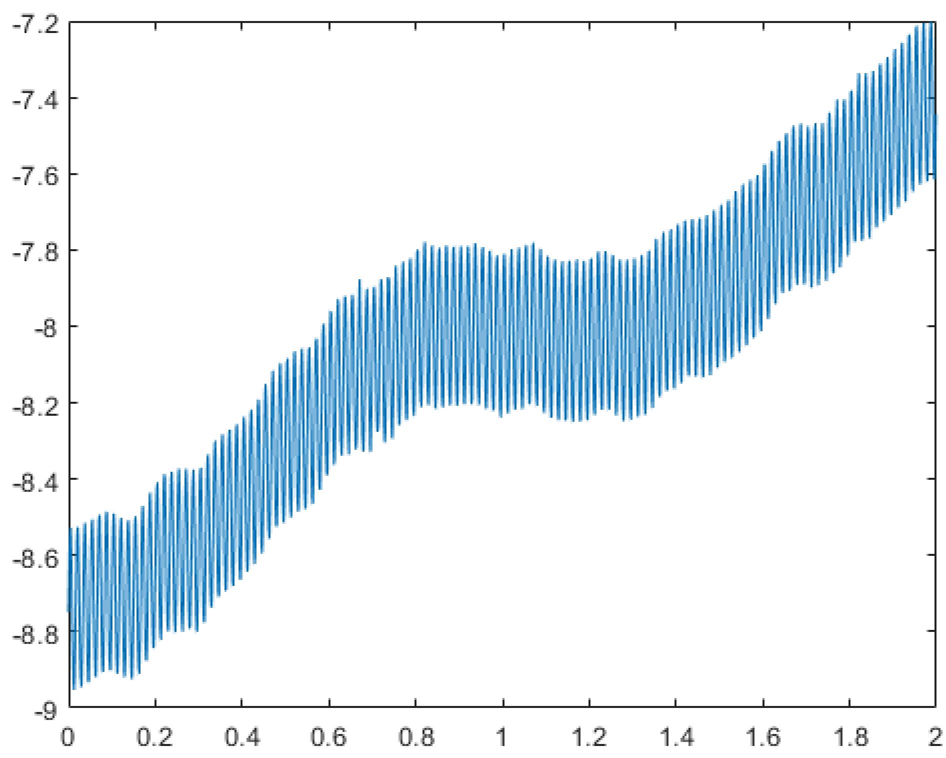
I affirm that I have adhered to the honor code on this assingment

Hello again, scientist! I'll do all my writing in italics, and problems for you will be in **bold.** *Comment your code, and* explain your ideas in plaintext. *As a general rule, I expect you to do at least as much writing as I do. Code should be part of your solution, but I expect variables to be clear and explanation to involve complete sentences. Cite your sources; if you work with someone in the class on a problem, that's an extremely important source. Don't work alone.*

Problem F.03: Kill the noise.

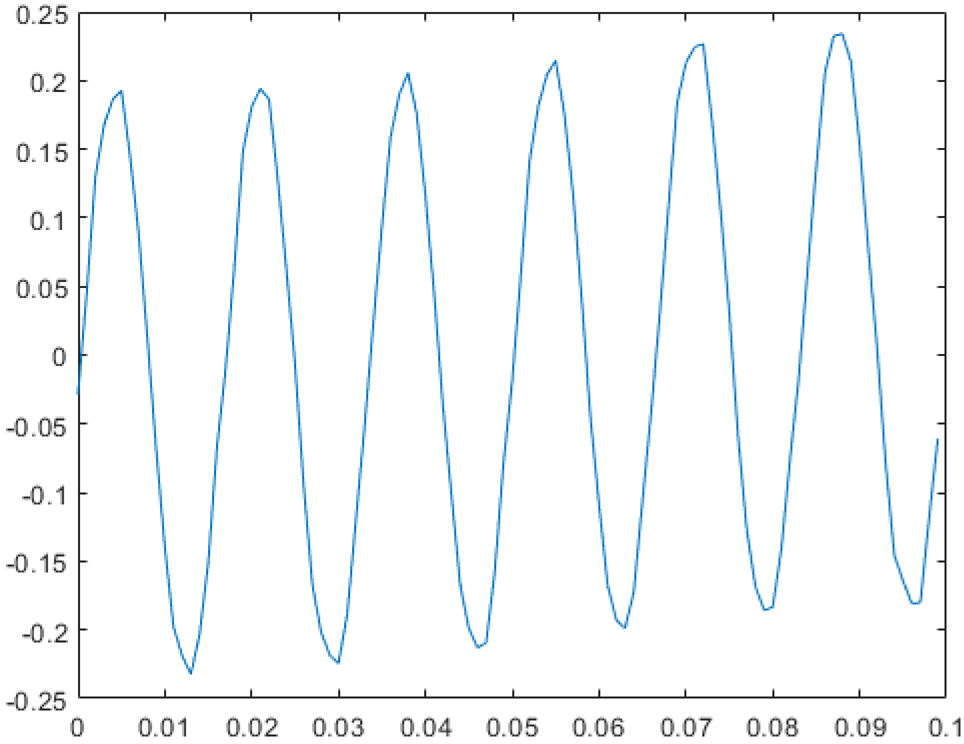
This problem assumes that you have completed most of F.02. *Here's another cool thing we can do with linear regression. We often have a complex signal with some annoying periodic behavior that we want to remove.*

```
L = [0:.001:1.999]';
analog = csvread('analog.csv');
figure;
plot(L,analog)
```



The issue here, well-known to any of you who play electric instruments, is that this signal has a "mains hum." In America, the power line frequency is 60 Hz. What you're looking at is an electrical signal sampled *at 1000 Hz; we want to remove the buzz. Let's start by zooming in to the first 1/10 second to mostly isolate the noise.*

```
A = L(1:100); B = analog(1:100); B = B-mean(B); plot(A,B)
```



Find the period of the hum, then set k = 2*pi/period.

```
k = 2*pi/(1/60)
```

```
k =

  376.9911
```

The hum occurs at 60hz, so the period of the hum is 1/60.

Find the function f(x) = a*cos(k*x) + b*sin(k*x) that best fits the data [A B]. Plot it on the same axes as [A B] to confirm that it's a good fit. *If you find these instructions confusing, that's okay. Look at Lay 6.6 Exercise 9 for inspiration; it's odd, so there's an answer in the back.*

```
data = [A B];
inputs = data(:,1); outputs = data(:,2);
syms x;

functioncoskx = cos(k*x);
functionsinkx = sin(k*x);
```

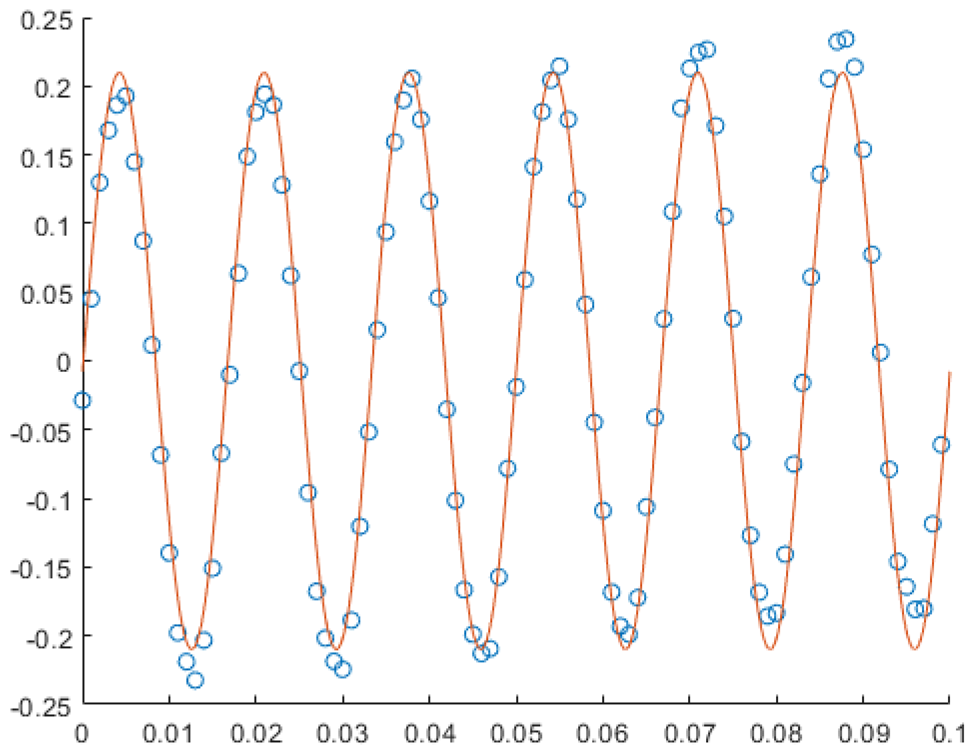
```
X = [subs(functioncoskx,x,inputs) subs(functionsinkx,x,inputs)];

Xtx = X' * X;
Xty = X' * outputs;

b = Xtx^(-1) * Xty;

f = [cos(k*x) sin(k*x)]*b;

figure;
scatter(data(:,1),data(:,2))
hold on
fplot(f, [0 0.1])
```



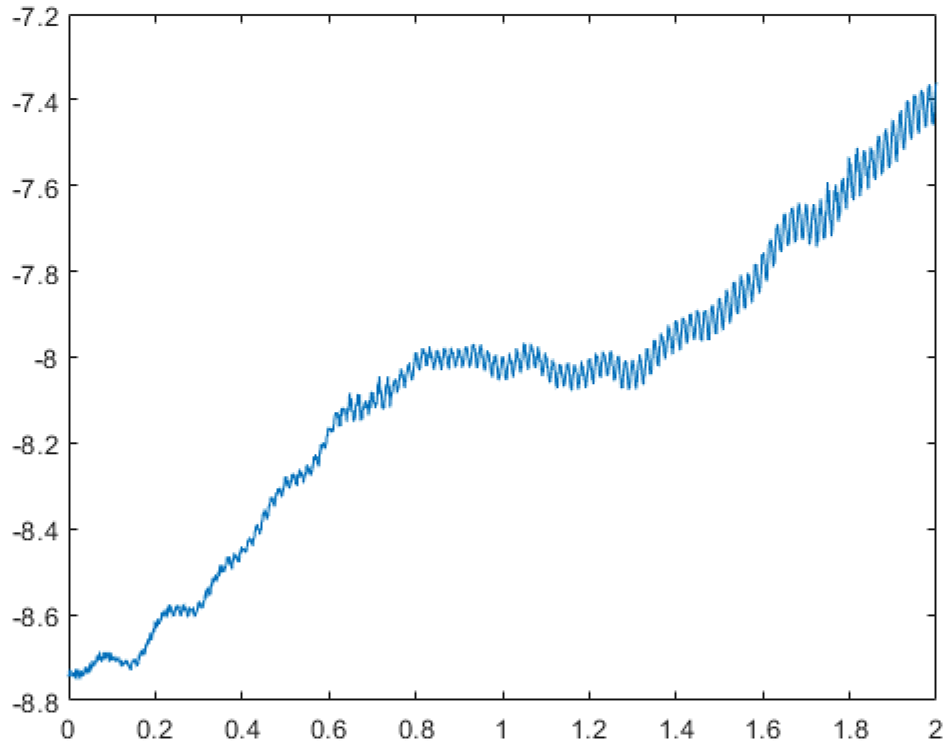
The functions cos(kx) and sin(kx) are represented as symbols. A standard regression run on [A B] generates a vector b that contains the coefficients on cos(kx) and sin(kx) that best fits the function to the data.

Create a new signal S by subtracting f(L) from analog, then plot L against S. *If everything's gone right, you should have gotten rid of at least 80% of the hum. Not bad. (We could do better with Fourier transforms, but that's another topic for another course.)*

```
fL = subs(f,x,L);

S = analog - fL;

figure;
plot(L,S)
```



The function f(L) is created by using the subs command to evaluate the function found previously for L. The resulting signal is subtracted from analog to get S. L is then plotted against S in the graph below. It appears that the majority of the noise is gone.

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