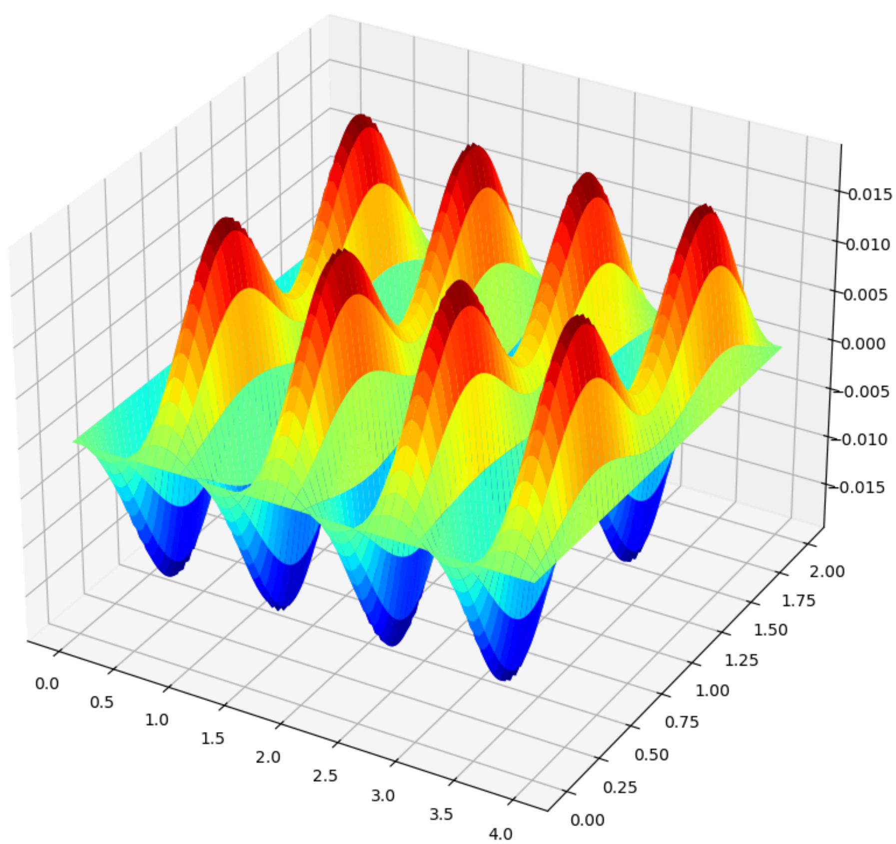
Savannah Smith

PHYS 305 homework 7 write-up

1. To determine the electric potential inside the domain, I used the code written in class for the Laplacian equation. The height and width of the rectangle are given by the indices (0,0), (0,2), (4,0), and (4,2). Because the surface of the rectangular region is grounded, the electric potential at the surface is zero. The charge density equation given below is used for the solution vector *b* using lowercase x and y from the code for every entry:

$$\rho(x, y) = sin(2\pi x)sin^2(\pi y)$$

   Below is the resulting 3D plot of the electric potential inside the domain:



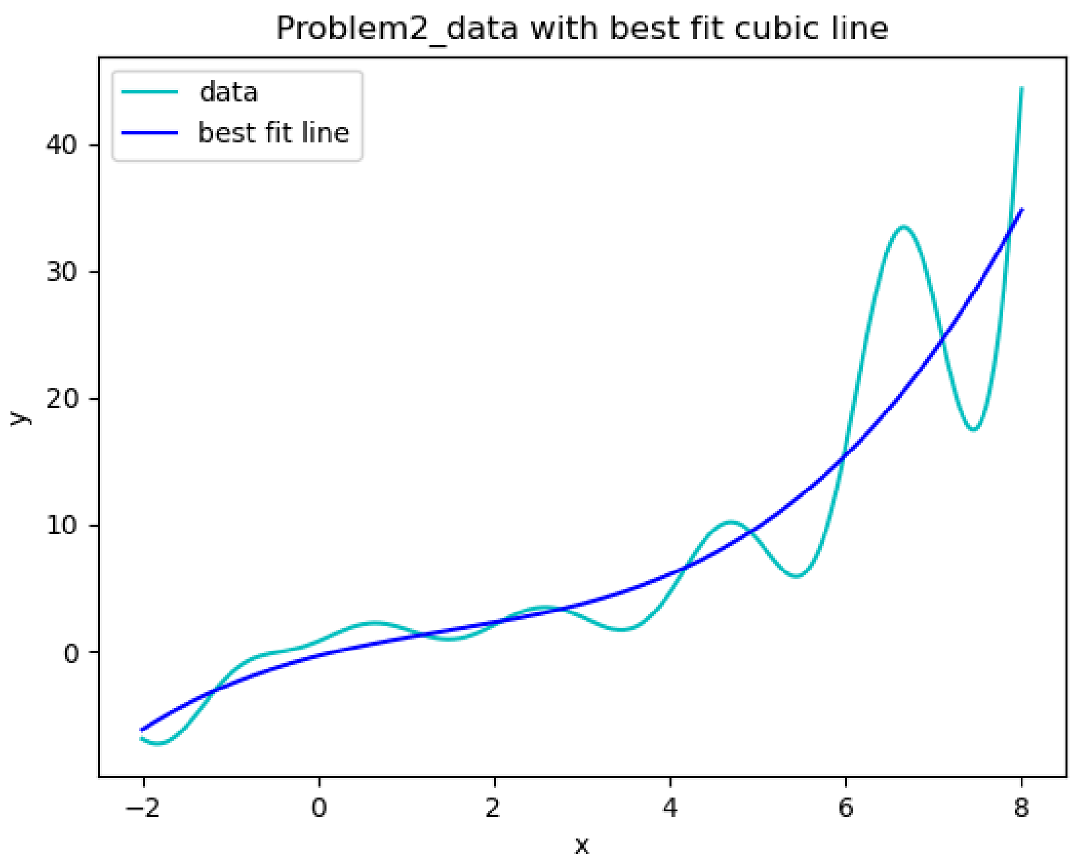
   We can see in the above 3D plot that the surface of the rectangular region remains grounded, marked by the bright green color, which is to be expected.

2. To fit the given data in the text file Problem2_data.txt to a cubic line, I used the code we wrote in class that uses the cubic equation for the least square, leading to a system of four linear equations that were converted into a 4x4 matrix. The solution vector (noted as *b*) was calculated as y from the data file multiplied by x^0, x^1, x^2, and x^3. With this matrix and

the solution vector, I used the linear algebra solver built into numpy to solve for the *a* vector which becomes the coefficients for the equation of the best-fit line below:

$$y_{data} \approx a_0 + a_1 x_{data} + a_2 x_{data}^2 + a_3 x_{data}^3$$

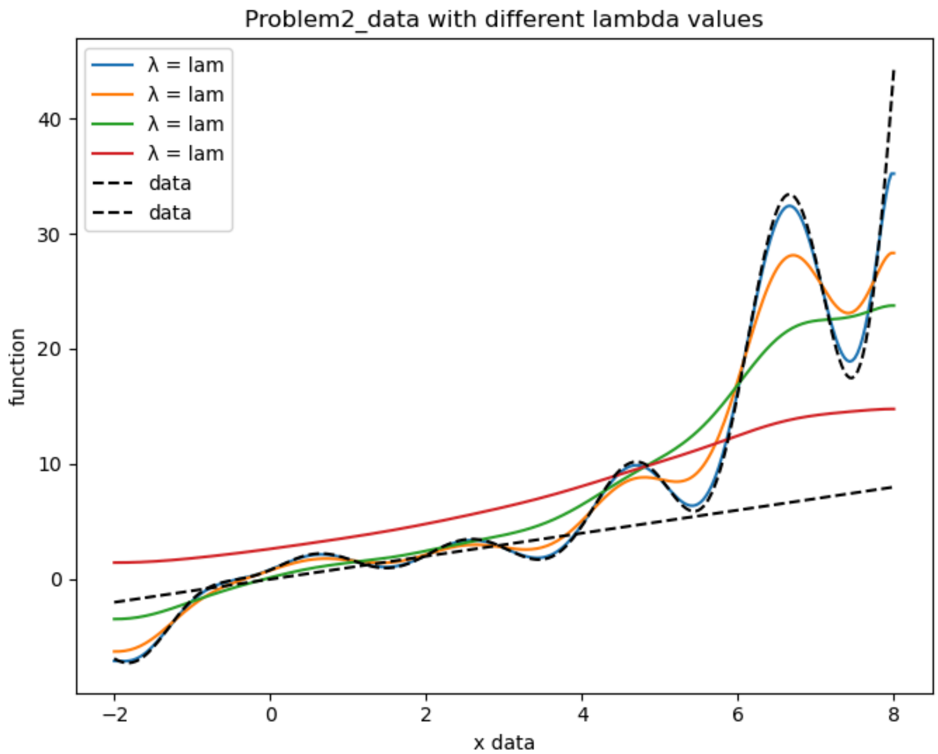
Below is the resulting graph from the code which displays the original data from Problem2_data.txt and the best-fit cubic line from the code.



3. The equation below is a result of the euler-lagrange equation that ensures that the fit stays close to the data and the fit is smoother than the data. Lambda is the parameter that defines how much we penalize the derivative:

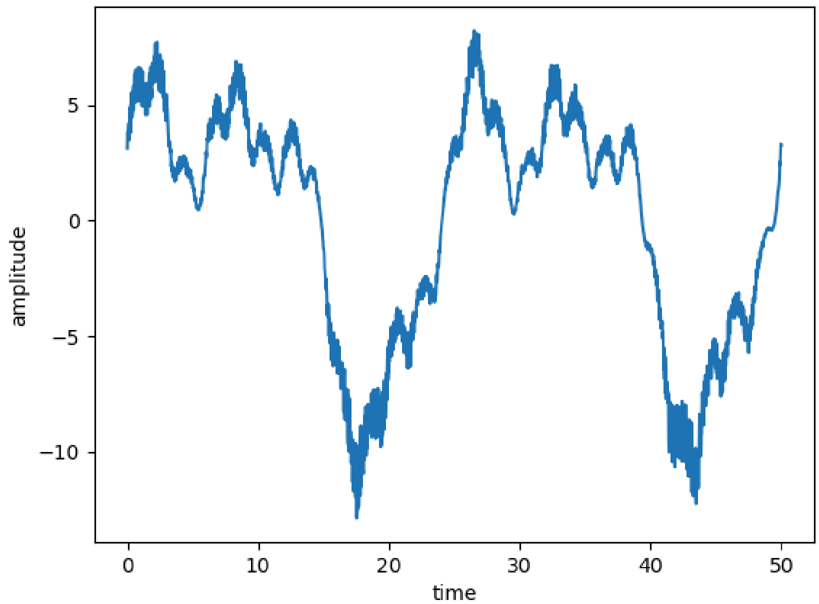
$$\lambda \frac{\partial^2 f}{\partial x^2} - f = f_{data}$$

The graph below shows Problem2_data.txt with different lambda values:

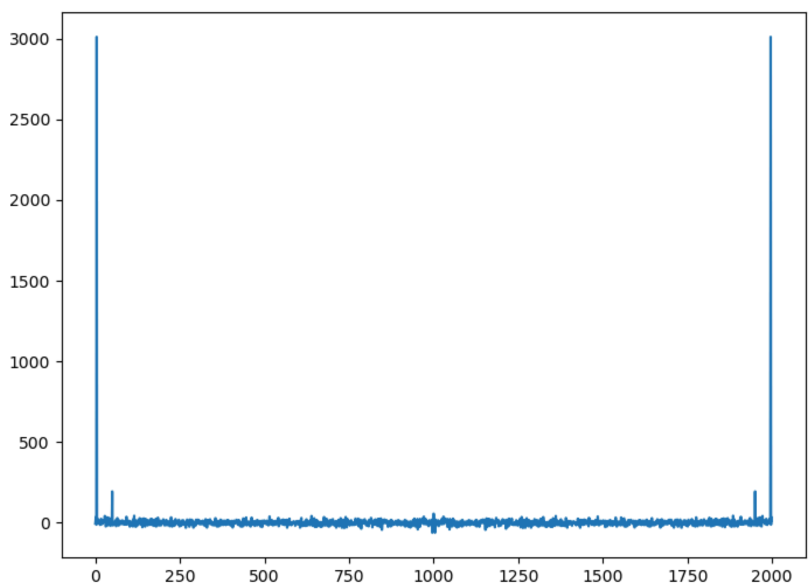


For the given data, we can see that a smaller lambda results in a better fit for the data. I was unable to correctly assign lambda values in the legend but they were written in my code for 0.01, 0.1, 1, and 10.

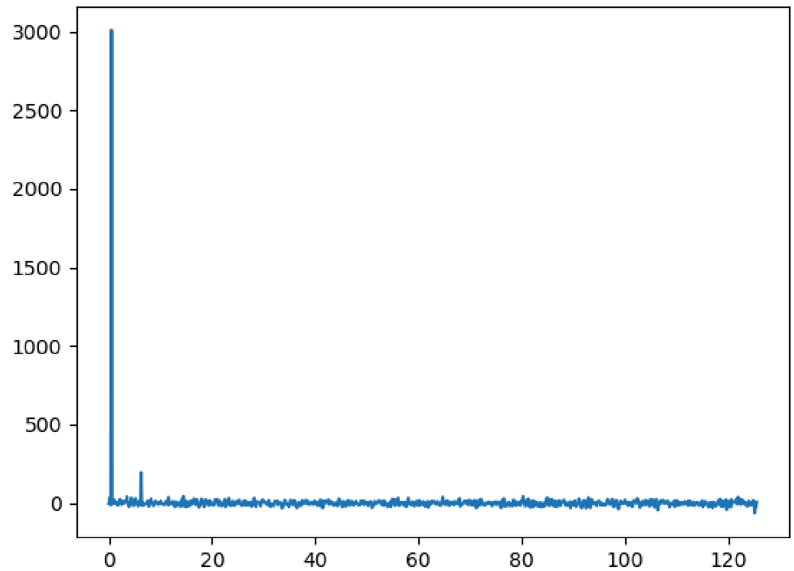
4. Given that the first column in the datafile is time and the second column in the datafile is the amplitude of the wave, below is a plot of the raw data with time on the x-axis and amplitude on the y-axis, followed by many other plots with their captions:



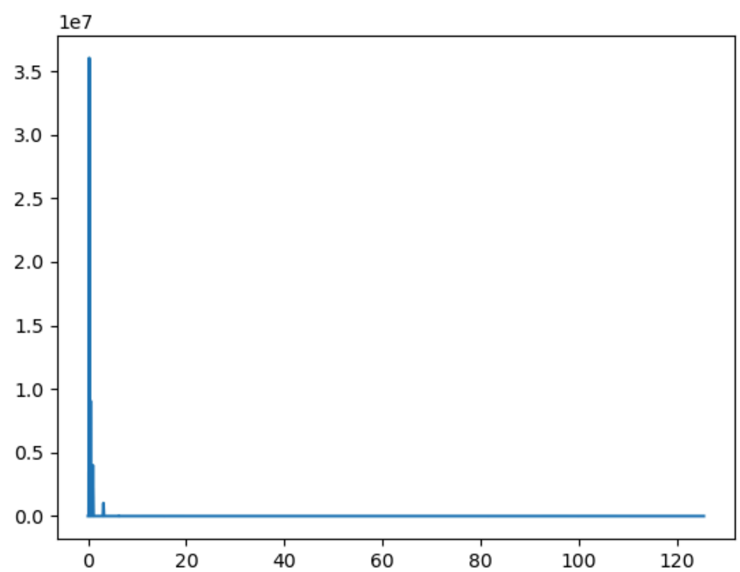
Graph 1: displays the raw data from Problem4_data.txt



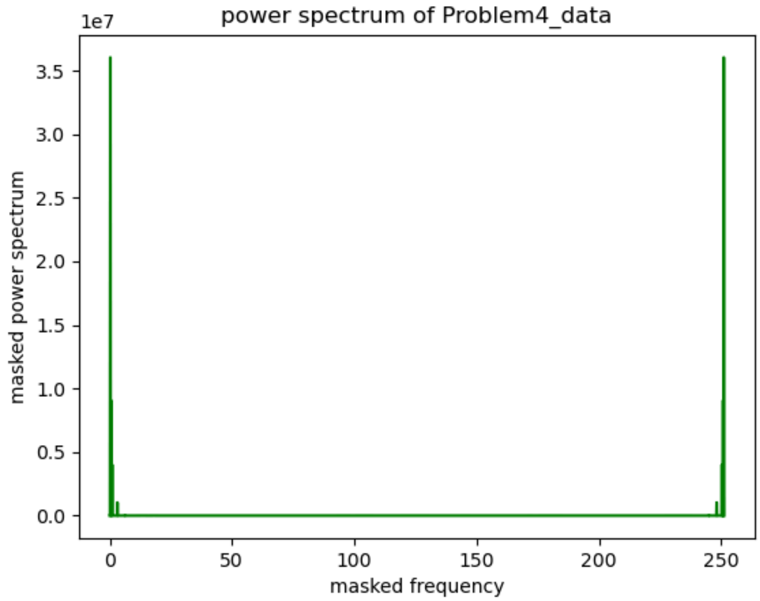
Graph 2: displays the fast Fourier transform (fFFT)



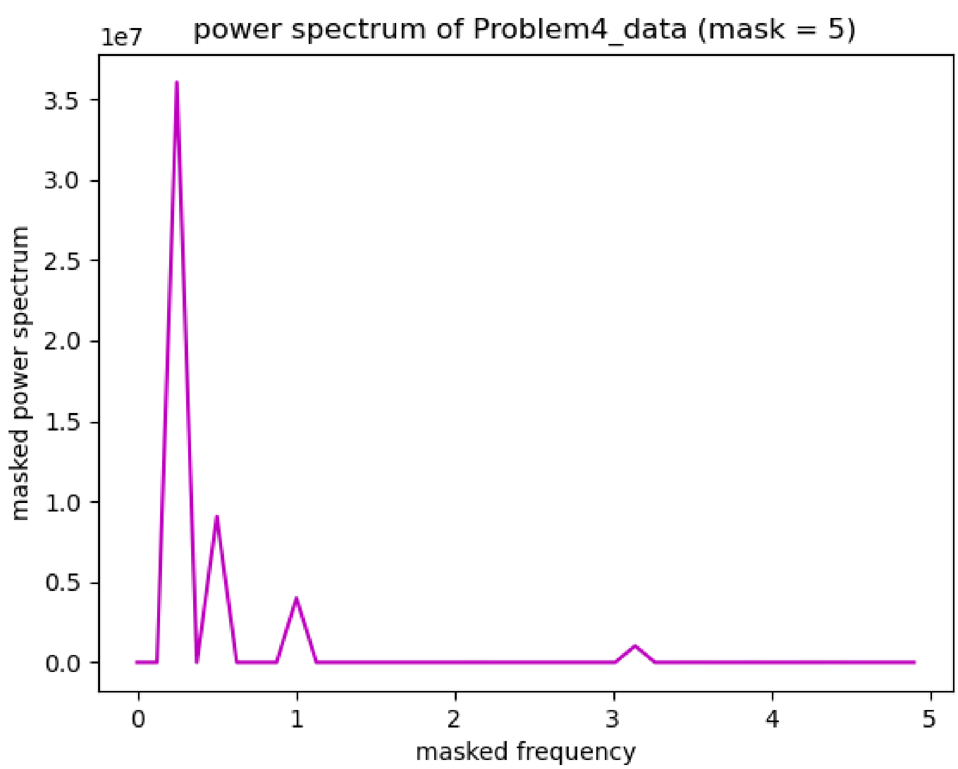
Graph 3: displays the fast Fourier transform versus the frequency with only N/2 points (so there are no duplicates)



Graph 4: displays the power spectrum versus the frequency with only N/2 points



Graph 5: displays the masked power spectrum versus the masked frequency but with the mask used in class (10000) which is too large to view the frequencies



The above plot shows that **the three most dominant frequencies are 0.25 Hz, 0.5 Hz, and 1 Hz** (3.15 Hz is a smaller peak than the others). Due to the smaller mask (frequency < 5), we can see these frequencies much more clearly than in graph 5.