Physics Assignment 1

PHY410: Do problems 1 and 2.
PHY 505: Do all three problems.

Accept the assignment from github classroom: https://classroom.github.com/a/U98cZCKK. You will then get a link to your own github area.
You should submit your code through github classroom. Submit your writeup, and a link to your github classroom area where your code is, on UBLearns.

Problem 1 (25 points):

You are free to use either python or C++ in this problem, but please make your writeup and plots in jupyter in a file called “PhysicsAssignment1/Problem1.ipynb” (worth 5 points).

a. (15 pts) Modify the linear "chi_square_fit" functions (either c++ or python) to fit an exponential function to the CO2 data in the DataAnalysis/FFT directory by taking the logarithm of the concentration, and fitting that logarithm.

At 50,000 ppm CO2 concentration, the atmosphere will become toxic to oxygen-breathing life. Assuming the current exponential trend, on what date will the atmosphere become toxic?

b. (10 pts) Repeat part a, but instead of an exponential fit, use the numpy polyfit function for a second-degree polynomial (quadratic). Now when does the atmosphere become toxic?

Problem 2 (25 points):

You are free to use either python or C++ in this problem, but please make your writeup and plots in jupyter in a file called “PhysicsAssignment1/Problem2.ipynb” (worth 5 points).

We analyzed the sunspot number dataset in DataAnalysis/FFT/fft_filtering.ipynb and fft_padding.ipynb. Repeat these exercises with the full CO2 data from Mauna Loa. Using some combination of waveform modification (which may include padding, windowing, taking the FFT, manipulating the waveforms, inverse FFT, and undoing the window+padding), do the following:

a. (15 pts) Plot the default and smoothed power spectrum of the full CO2 data. You will need to pad the values so be sure to apply a window!

b. (10 pts) Clean up the jitters (high frequency noise, index > 100) in the time domain by zeroing the appropriate waveform coefficients in the frequency domain. Plot both the "raw" and "cleaned" spectra in the time domain. (Note: this is for demonstration and educational purposes, it is not what you would do in real life). Show a zoomed-in plot to see (and demonstrate) the effect, as well as the full time-domain spectrum to see any negative consequences.

Problem 3 (PHY505 only - 25 points):

You are free to use either python or C++ in this problem, but please make your writeup and plots in jupyter in a file called “PhysicsAssignment1/Problem3.ipynb” (worth 5 points).

a. (10 pts) Subtract the quadratic fit of the Mauna Loa CO2 data from Problem 1, and present the resulting waveform and Fourier transform (i.e. in both in the “time” and “frequency” domains). Do not apply a window. Instead, truncate to the highest power of 2 for which you have data (it should be 512)
b. (15 pts) Zero all components of the power spectrum except the second-largest peak of the Fourier transform with a band-pass filter from 25-60, then take the inverse FFT and plot the results.