

MECH 4420 Homework #3
(Due Monday 9/15/2025 in class)

1. Using the data from HW #1, take the yaw rate and vehicle speed and produce the vehicle position. Plot East vs. time and North vs. time as well as North vs. East.
Bonus: Assume the starting point is 37.42805 N and -122.17655 E (and zero altitude) with an initial heading of 20 degrees from north, plot the position on google earth (note you will have to convert the north east positions to LLA using the Matlab's function "ned2lla" and use <https://www.gpsvisualizer.com/>). Matlab can also plot on Google Earth with the correct toolboxes. Otherwise you can use the instructions found on the class website.
2. Download the simulated sampled data from the website. The data is sampled at 100 Hz.
 - a) Plot the histogram of the data
 - b) Plot the spectral analysis on each sequence

There are multiple methods to make the Power Spectral Density (PSD):

```
>>periodogram(X)
>>pwelch(X>window_filter)
>>plot(abs(fft(X)))
>>spa
>>etfe
```

3. Using matlab, filter the data from problem #2. For the filtering results you will want to zoom into a section of data.
 - a) Filter the data using a 2nd order butterworth filter with a bandwidth of 10 Hz
 - b) Perform a forward/reverse filter and compare the results to part a
 - c) Repeat part a using a 4th order butterworth filter and compare the results to part a
 - d) Plot the spectral analysis of the filtered data
4. Download one of the vehicle's coast down data sets and attempt to estimate the rolling resistance and air drag using least squares.
 - a) Estimate the coefficients assuming the rolling resistance is not related to velocity
 - b) Estimate the coefficients assuming rolling resistance is related to velocity.
 - c) Write a coast down simulation and compare the results of the simulation to the actual coast down data on the data used for the fit as well as the verification data.
5. **Bonus (or Required if you did #4 for your Lab #1):** Using the data you collected for Lab #1 (or on the website), pick something to do with the data (and provide plots) that you did not do in your groups. Some ideas are plotting position on google maps, estimating wheel slip, integrating wheel speed and yaw rate and comparing to GPS positions, analyzing IMU measurements comparing steer angle to yaw rate, or computing speed and yaw rate from wheel speed.