Kinematic Positioning and Navigation – Winter 2018: Homework #3
Inertial Navigation Systems

Note: problems 5-7 make use of the file xnav_inertial_meas.csv, which is available on the course Canvas site. The measurement rate for the data in this file was 100 Hz.

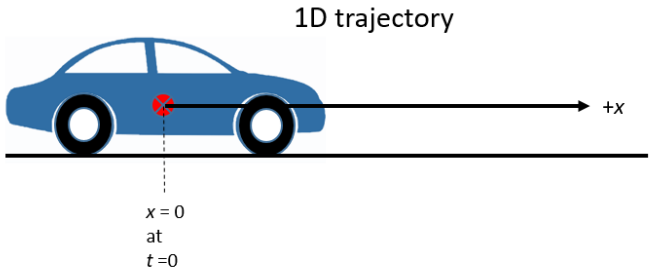
1. Book problem 3.1

2. What do gyros and accelerometers measure? Be as specific as possible in your answer, including information such as measurement units and frames of reference.

3. Book problem 3.5. Explain your answer.

4. Explain the difference between gimbaled and strapdown INS implementations and the advantages and disadvantages of each.

5. 1D navigation problem: for this problem consider only the first column of data in the file xnav_inertial_meas.csv: the column labeled AccelForward (m/s²). Assume that these data represent the accelerometer measurements from a vehicle traveling in 1D along a straight trajectory aligned with the IMU's x-axis. Further assume that the position of the vehicle at time $t = 0$ is $x = 0$. The measurement rate for the data in the file is 100 Hz. Write a script in MATLAB (or Python or whatever programming language you prefer) to perform numerical integration and use it to calculate and plot (as a function of time):
   a. Velocity, $v_x(t)$
   b. Position, $x(t)$



6. If the x-axis accelerometer in the previous problem has an *uncorrected* bias of 70 μg, plot the resulting errors in position and velocity as a function of time.

7. For the xnav_inertial_meas.csv file, what is the mean acceleration in the "down" direction? Does this value make sense? What can you infer about the orientation of the IMU? (Hint: the host vehicle was a car driving around the OSU campus.)