# Assignment 1

Due: Thursday October 8, 2020 at 11:59pm
MAE 107 Computational Methods for Engineers
Professor Michael Tolley

## Homework Submission

- Homework submission is through Gradescope. Please leave extra time for submission, especially if you have not used Gradescope previously.
- Assignments are graded based on correctness, how well you organize your homework (i.e. it should be easy to understand your thinking and easy to find your responses), and how well you follow the submission instructions below.
- You will not receive credit if you just give an answer. Your solution must demonstrate how you got the answer.
- If you ever think a problem is stated incorrectly, not enough information is given, or it is impossible to solve, don't panic! Simply make a reasonable assumption that will allow you to solve the problem (but clearly state what this assumption is), or indicate why it is not possible to solve the problem.
- Please attend office hours (listed in the syllabus) if you have any questions regarding the assignment.
- You are welcome to discuss the assignment with other members of the class, but everything you submit should be your own (i.e. you wrote it, typed it, or generated the plot in Matlab).

## Problem 1: Skydiving simulation

Consult the example from the first lecture about using Euler's method to numerically solve for the velocity of a skydiver after he/she jumps out of a plane.

a) Given $m = 74.8$ kg, $c = 13.3$ kg/s, and a timestep $\Delta t = 3$ s. By hand (as Prof. Tolley did in class), calculate the velocity of the skydiver after 9 s (three timesteps). You can use a calculator but write out the steps by hand, and make sure to include units so you can check for errors.

b) Write code in Matlab with a For loop to check your answer from Part a). Hint: you can start your For loop with the line "for t = 0:3:9". Plot the velocity versus time (there should be three data points on your plot). Use the"Publish" option in Matlab to save your code and output as a pdf that you can include in your submission.

c) Now change the timestep in your code from Part b) to 0.1 s. Generate a new plot that includes both the data from Part b), and this new data. Looking at $t = 3$, 6, and 9s, what is the % difference between these two numerical approximations? Which one do you expect is more accurate? Explain your reasoning.

d) Now, imagine that after 9 s on free-fall, the skydiver opens their parachute. The skydiver now experiences an aerodynamic drag force of $F_a = c_2 V^2$ with $c_2 = 108.1$ kg/m. Using the final velocity $V(t = 9s)$ from Part c) as a starting point, use the same numerical approach (Euler's method) to compute how the velocity of the skydiver changes for the next 9 s (i.e. until $t = 18$ s), using a 0.1 s timestep. Plot both the velocity of the skydiver during both the initial freefall (Part c), and then after they open their parachute. Use the publish function in Matlab to save your code and plot as a pdf.