ME 355 – System Modeling and Numerical Methods
Fall 2023

Homework 2

Due Friday, September 8 by 11:59 pm
Preliminary function is due Friday, September 1 by 11:59 pm
This project must be turned in on Blackboard

This homework is to get you acquainted with MATLAB as well as the project format for this course. For this assignment, you will need the *eulerSolver.p* and *homework2.m* files located on Blackboard. Go ahead and download both files and put them in the same directory. When you are ready to test your *slope* function from Functions section, use the information in the Test Data section.

1 Introduction

You have just been hired for an internship at a small startup that designs custom extreme sport activities! The first project you are assigned to is a bungie jumping service for pets. As a safety requirement, the lead engineer wants to know the velocity of the pet over time as the animal is falling to the ground.

You can estimate the force of drag (F_D) using

$$F_D = (c_0 + \gamma)v - c_2\frac{dv}{dt}$$

where c_0 and c_2 are drag coefficients and γ is white noise from a uniform distribution from 0 to 1.

You will need to specify the system, create a free body diagram of the system, create your mathematical model, and then solve your mathematical model for dv/dt. Assume positive acceleration is towards the ground.

2 Functions

To complete this task, you will need to create 1 MATLAB function. A preliminary version of this function is due on the date specified above. To get full credit for the preliminary function, you must have made a legitimate attempt. You may make changes to the functions after the preliminary function due date and prior to the final due date.

Note: All functions will be run through an auto grader and a similarity checker, with the code reviewed manually for comments and oddities. All inputs and outputs must be **EXACTLY** as listed below.

1. **slope.m**
   acceleration = slope(gravity, mass, velocity, c0, c2)
   This function calculates the acceleration (dv/dt) of a falling object based on the current gravity, mass, velocity, and drag coefficients (c_0 and c_2). Create and use the model from Section 1.

3 Figure Outline

For your first test subject you are asked to examine the velocity of a corgi over the course of 20 seconds where the initial time and velocity are both 0. You should use a mass of 11.5 kg, c_0 of 2.1 kg per second, and c_2 of 7.2 kg. You can assume that we are on Earth such that gravity is 9.81 meters per second squared.

You should complete the following tasks by editing the *homework2.m* file provided.

a) Using the *slope* function created in Section 2 and the *eulerSolver* function given to you, plot the Euler solutions for a step size of 2 and 0.5 seconds all on the same plot. For the Euler solutions, when plotting, use **points** of different colors. (The reason you use points instead of lines is because this is **discrete** data. Experimental data is an example of discrete data.)
b) Display on the command window the final velocity of the 0.5 second time step case in a nicely formatted string with a reasonable number of significant figures. This must be presented as a sentence with enough information (including units) for someone who is not familiar with your code to understand the output.

For this project, you want to provide a figure outline to prove to the lead engineer that you did your work. Your figure outline should include the following sections.

1. Title
2. Figures
   All plots are listed in the form of y-axis versus x-axis.
   All plots and figures must have a **descriptive** caption. The caption should be the main point!
   All plots must be created in MATLAB!
   a. Figure of your free body diagram. (This can be hand drawn, but it must be neat.)
      Put your acceleration equation in the figure caption.
   b. Plot of the velocity (v) versus time (t) for the Euler's method (2.0 and 0.5 seconds timestep).
      Be sure to label axis correctly (with units) and a legend.
      Axis labels of "v" and "t" is NOT correct. These labels are not descriptive.
      Having a title in your plot is NOT correct and will result in a loss of points.
      Do not take a screenshot of plots from MATLAB! Instead, copy and paste them!
      https://www.mathworks.com/help/matlab/creating_plots/copy-figure-to-clipboard-from-edit-menu.html
   c. A screenshot of the command window showing the MATLAB output from part b).

4 Deliverables

Be sure to submit all 3 files! MATLAB files must always be submitted as .m files.

1. homework2.m
2. slope.m
3. Figure Outline PDF (**The Figure Outline must be submitted as a PDF. No other filetype will be accepted!)**

5 Rubric (Total 100 Points)

Turned in preliminary function on time – **10 Points**
slope.m file – **10 points**
Figure Outline – **30 Points**
    Free Body Diagram – **10 points**
    Plot of Euler's method – **10 points**
    MATLAB output – **10 points**
Figure Outline format and Code Comments – **10 Points**
Vague attempt at the assignment – **40 Points**
Figure Outline submitted as anything other than a PDF – **-20 Points**

6 Notes for Figure Outline

For any **equations**, use the equation editor.
For **Figures**, **Tables**, and **Pseudocode**, follow the guidelines outlined in the example report on Blackboard.

7 Notes for Functions

These notes do not apply to the *homework2.m* file.
All functions must be named EXACTLY as listed above. This includes capitalization.
Functional inputs and outputs must be EXACTLY as defined in the Functions section.

8 Fun Fact

The Euler function is a .p file which is called P-Code! *doc pcode* in MATLAB for more information!

9 Test Data

If you run the following code below in the MATLAB command window, you should get the following output. Do note, this does NOT guarantee your code is correct.

CODE

```
rng(0)
a = slope(0.3, 3.1, 9.9, 31, 10)
```

OUTPUT

```
a = 45.5124
```