ME 355 – System Modeling and Numerical Methods
Fall 2022

Homework 1

Due Friday, September 2 by 11:59 pm
Preliminary function is due Monday, August 29 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 *euler.m* and *homework1.m* files located on Blackboard. Go ahead and download both files and put them in the same directory. Run *homework1.m*. This is the main code file. You should see two vectors outputted. Once you have confirmed that the code is working, modify *euler.m* and *homework1.m* to complete the assignment below.

1 Functions

To complete this task, you will need to modify 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, with the code reviewed manually for comments. All inputs and outputs must be **EXACTLY** as listed below.

1. **euler.m**
   [x_array, y_array] = euler(func, y_initial, x_initial, x_final, x_delta)
   The *euler* function has inputs of dy/dx, y_0, x_0, x_{final}, and Δx and returns a x-vector and y-vector for the entire x space.
   Modify the *euler* function to convert the *while* loop to a *for* loop. Additionally. Modify the output variables as such that they have been pre-allocated. For more information about pre-allocation, read https://www.mathworks.com/help/matlab/matlab_prog/preallocating-arrays.html.

2 Figure Outline

You must solve the following tasks.

a) Using the *euler* function created above, plot the Euler solutions for a step size of 2, 1, and 0.5 seconds all on the same plot. Use a final time of 20 seconds. For the Euler solutions, 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) Plot the exact solution for the velocity of the falling object from time = 0 to 20 seconds on the same plot as from part a). Be sure to use at least 100 points to plot as a **line**. (The reason you use a line is because this is known **continuous** data. Functions are *almost* always continuous data.)
c) 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 your tech lead that you did your work. Your figure outline should include the following sections.

1. Title
2. Figures and tables
   All plots are listed in the form of y-axis versus x-axis.
   All plots and figures must have a **descriptive** caption.
   All plots must be created in Matlab!
   a. Pseudocode of your *for* loop.
   b. Plot of the velocity (v) versus time (t) for the Euler's method (2, 1, and 0.5 seconds timestep) and the exact solution from time = 0 to 20 seconds. 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.
   c. A screenshot of the command window showing the Matlab output from part c).

3 Deliverables

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

1. homework1.m
2. euler.m
3. Memo PDF (**The memo must be submitted as a PDF. No other filetype will be accepted!)**

4 Rubric (Total 100 Points)

euler.m file – **10 points**
Turned in preliminary function on time – **10 Points**
Memo – **30 Points**
    pseudocode of for loop – **10 points**
    plot of Euler's method and exact solution – **10 points**
    Matlab output – **10 points**
Memo format and Code Comments – **10 Points**
Vague attempt at the assignment – **40 Points**

5 Notes for Report

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

6 Notes for Functions

These notes do not apply to the *homework1.m* file.
All functions must be named EXACTLY as listed above. This includes capitalization.
Functional inputs and outputs must be EXACTLY as define din the *Functions* section

7 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.

```
f = @(y) y^2;
a = euler(f, 0, 0, 2, 1)
b = euler(f, 1, 2, 4, 0.5)

a =  0     1     2
b = 2.0000    2.5000    3.0000    3.5000    4.0000
```