

Exam 2

Name _____

Section _____

CM# _____

Email _____@Rose-Hulman.edu

Separate your code in two m-files. Your top level code must be called (all lower case)

lastname_firstname.m

while the function must be called

lastname_firstname_euler.m

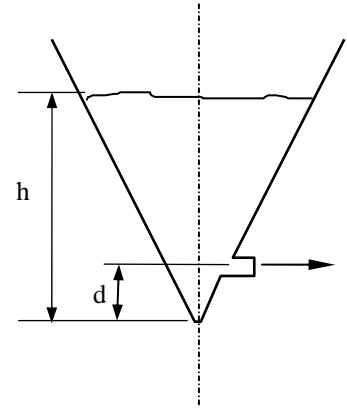
Include your name, section number, and CM number in the comments in the header of each file. There should be no output other than what we request.

How to post your files:

1. Double-click on "My Network Places". If it is not on your desktop, look in your start menu.
2. Double-click on "[DFS] Root". *Not [AFS] Root.*
3. Log in with your email address and password.
4. Double-click on Academic Affairs.
5. Double-click on ME.
6. Double-click on ME123.
7. Double-click on Exams.
8. Double-click on the folder with your section number.
9. Copy and paste your m-files into this folder.

Next year you will take a great class called ES205 – in this course you will do a lot of system identification. We will preview this activity in this problem. The formula for a conical draining tank can be written as

$$\frac{dh}{dt} = \frac{-K\sqrt{h-d}}{h^2} \quad h(0) = 10$$



where d is the height of the orifice above the bottom of the tank and K is a constant that depends on a number of system parameters such as the area of the exit, the discharge coefficient, *etc.*

- (a) (10 pts) In the space below, write the Euler formula that you could use to solve this problem. For full credit, use "n" as the index and Δt as your interval. Express your answer in the form $h_{n+1} = \dots$

- (b) (50 pts) Create a function to find the height of the fluid in the tank as a function of time (using Euler's method). You should have the function loop until the height of the fluid drops below d . The inputs to the function must be K , d and Δt . The outputs must be the vectors t and h . Create a top level program which calls the Euler function and plots h as a function of t . Use a solid red line for the curve. Use $K = 0.9$, $d = 1$, and $\Delta t = 1$ s, and assume that all the units in the problem are consistent. Give your plot a good title and label your axes.
- (c) (20 pts) Experimental data has been taken and you are to use it to help identify K . Load the Excel data called `h_exp.xls`. The file contains two columns of experimental data corresponding to the height of fluid in the tank: the first column is the time in seconds and the second column is the height of the fluid in meters. On a separate figure, plot the experimental data and the results from (b) on the same figure. Give your plot a good title, label your axes, and provide a legend.
- (d) (20 pts) Calculate the performance index, J , which is a measure of how close the Euler solution is to the experimental data. The formula for J is:

$$J = \frac{1}{140} \sum_{i=1}^{140} \left(h_{i_{\text{experimental}}} - h_{i_{\text{euler}}} \right)^2$$

Print out the result for J to the screen showing 7 decimal places, with some appropriate words (e.g. "The performance index J is ...").