**ME 261** **Final Exam** **Fall 2020**

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**Name (Print) ________________________________**

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## Instructions:

1. The first line of your program should contain your first and last names.
2. You are required to type the honor code "On my honor as a student, I have neither given or received aid on this exam" and type your name at the beginning of the MSWord or PDF file of your solution.
3. The output of the problems should be given in a MSWord or a PDF file. The plot of Problems 2 should also be given in the same MSWord or PDF file.
4. Upload FOUR m-files (each problem has a main program and a function program) and ONE MSWord or PDF file

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## Problem 1 (10 points):

The flow rate through a channel can be computed as

$$Q = \int_0^B U(x)H(x)dx$$

where *B* is the total channel width (m), *U* is the water velocity (m/s), *H* is the channel depth (m), and *x* is the distance from the bank (m). Use **two methods**: (1) MATLAB built-in function **'trapz'** and (2) your own function program based on **Trapezoidal Rule,** to determine Q for the following data:

| x, m | 0 | 2 | 4 | 5 | 6 | 9 |
|---|---|---|---|---|---|---|
| H, m | 0.5 | 1.3 | 1.25 | 1.8 | 1 | 0.25 |
| U, m/s | 0.03 | 0.06 | 0.05 | 0.13 | 0.11 | 0.02 |

**Requirements**

1. You need to develop a main program and a function program.
2. Main program:
   a. Define the vectors that you are going to use for the problem
   b. Call MATLAB built-in function 'trapz' to calculate the flow rate Q (see page 14 of Lecture 23. 'trapz' can be used for unequally spaced data) (method 1)
   c. Call your own function program to calculate the flow rate Q (method 2)
   d. Print out the results. Output should be as follows:
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The flow rate using MATLAB built-in function is: #.#####
The flow rate using User-defined function is: #.#####
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3. Function Program
   a. Inputs to function program are the vectors that you are going to use
   b. The values of x are **unequally** spaced, so you have to use a '**for loop**' to loop through every segment, apply the trapezoidal rule for every segment, and add the area of each segment to a running sum. (see page 13 of Lecture 23)
   c. Output will be the flow rate Q.

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## <u>Problem 2 (10 points):</u>

Solve the following ordinary differential equation using the fourth-order Runge-Kutta (RK4) method over the interval from x = 2 to 5**.**

$$\frac{dy}{dx} = y(x-1)^{2/3} - 2y$$

where y(2) = 10. Display your result (y vs. x) using a plot.

**<u>Requirements:</u>**

1. Write a main program and a SEPARATE function program for RK4 method.
2. Main Program
   a. Define step size h using 50 points for x.
   b. Define function handle for the increment function (right side of the ODE)
   c. Call function program for RK4 method
   d. Generate a plot for y vs. x from x = 2 to 5.
3. Function programs
   a. Write a function program for RK4.

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