ME 2450 Assignment 07

Name: ______________________

Due: April 21, 2019 by midnight

Collaborators: ______________________

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I declare that the assignment here submitted is original except for source material explicitly acknowledged.

I also acknowledge that I am aware of University policy and regulations on honesty in academic work, and of the disciplinary guidelines and procedures applicable to breaches of such policy and regulations, as contained in the University website.

Name	Date
Signature	Student ID

Score

Exercise Graded: ________

Presentation: ____/2

Technical Content: ____/8

Total: ____/10

Exercise 1

Use Richardson's extrapolation to estimate the first derivative of

$$y = cos(x) \tag{1}$$

at $x = \frac{\pi}{4}$ using step sizes of $h_1 = \frac{\pi}{3}$ and $h_2 = \frac{\pi}{6}$. Employ centered differences of $\mathcal{O}(h^2)$ for the initial estimates. Compute the true relative percent error. You may complete this exercise by hand or by writing a Matlab or Python code.

Exercise 2

You have measured the following displacements along the length of a simply-supported beam with a linearly increasing load.

x [m]	0.0	0.375	0.75	1.125	1.5	1.875	2.25	2.625	3
y [m]	0.0	-0.2571	-0.9484	-1.9689	-3.2262	-4.6414	-6.1503	-7.7051	-9.275

The slope, θ, of the beam is the first derivative of the displacement with respect to x, as follows:

$$\frac{dy}{dx} = \theta(x) \tag{2}$$

The first derivative of the slope, θ, with respect to x is related to the bending moment, $M(x)$, as follows:

$$\frac{d\theta}{dx} = \frac{d^2y}{dx^2} = \frac{M(x)}{EI} \tag{3}$$

where x is the distance along the beam, y is the displacement, E is the modulus of elasticity, and I is the moment of inertia. Use the following physical parameters:

- $E = 200$ [GPa]
- $I = 0.0003$ [m^4]

Write a Matlab or Python code to complete the following:

1. Numerically differentiate the provided data for displacement, $y(x)$, to produce a table of the slope, $\theta(x)$, data.
2. Use numerical differentiation to compute the moment, $M(x)$, using the following 2 approaches [reference Eqn. 3]:
   (a) Numerically differentiate the first derivative of the $\theta(x)$ approximations obtained in the first part.
   (b) Numerically differentiate the second derivative of the measured $y(x)$ data provided.
3. Plot the moment, $M(x)$, obtained using each of the methods from the previous part. Provide a comment regarding which method is more accurate and why.

Exercise 3

Write a Matlab or Python code for Gauss Quadrature, up to n=3 (3-point Gauss Quadrature). Test it by duplicating the results of Examples 22.3 and 22.4 in the textbook. Submit your code, along with printed outputs verifying the results against the referenced examples.

Exercise 4

Exercise 13.11 in the textbook

Exercise 5

Exercise 14.6 in the textbook