ME 2450 Assignment 06a

Name: ____________________

Due: April 5, 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 0 (Eigenvalues and Eigenvectors, 5 points)

An axially loaded wood column has the following characteristics:

- $E = 10x10^9[Pa]$
- $I = 1.25x10^{-5}[m^4]$
- $L = 3[m]$

$$P = \frac{n^2\pi^2 EI}{L^2}, \tag{1}$$

where P is the buckling load and n is the mode number.

Reference Equations 27.17, 27.18, 27.20, and Example 27.7 of the textbook for this exercise.

1. Determine the analytical buckling load value using Equation 1.
2. Implement a Power Method function in Matlab or Python which takes as input the coefficient matrix and the number of iterations and returns the resulting eigenvector and eigenvalue. Submit your code.
3. Using finite differences [see Equation 27.18 of the text], set up the coefficient matrix that results from using 5 nodes (2 boundary nodes and 3 interior nodes), evenly distributed along the column. By executing your Power Method function, compute the buckling load after 1, 2, 3, 4, and 5 iterations. Submit your code, the tabulated results of the numerically-approximated buckling load vs. Power Method iterations, and a comment about the convergence.
4. Determine the level of discretization (number of nodes along the column) and Power Method iterations required to obtain the numerically-approximated buckling load to within 1% of the analytical value.

Exercise 1 [17.12], 3 points

An investigator has reported the data tabulated below for an experiment to determine the growth rate of bacteria k (per d) as a function of oxygen concentration c (mg/L). It is known that such data can be modeled by the following equation:

$$k = \frac{k_{\text{max}} c^2}{c_s + c^2}$$

where c_s and k_{max} are parameters. Use a transformation to linearize this equation. Then, use linear regression to estimate c_s and k_{max} and predict the growth rate at $c = 2$ mg/L. Plot the data, along with the resulting linear regression fit. Submit the plot and your code.

c	k
0.5	1.1
0.8	2.4
1.5	5.3
2.5	7.6
4	8.9