MAE 3210 - Spring 2019 - Project 2

Project 2 is due **online** through Canvas by 11:59PM on Wednesday, April 3.

IMPORTANT REMARKS (Please read carefully):

- **Projects are to be treated as take-home exams with NO collaboration or discussion with other students**. Plagiarism will be monitored and considered as cheating. **In addition to your project PDF, you are required to sign and submit an honor pledge which can be found adjacent to the project handout, under assignments in Canvas.** Each project is worth 50 points, and a 10 point loss per day will apply to late projects.

- You are required to submit code for all functions and/or subroutines built to solve these problems, which is designed to be easy to read and understand, in your chosen programming language, **and which you have written yourself**. The text from your code should both be copied into a single PDF file submitted on canvas. **Your submitted PDF must also include responses to any assigned questions, which for problems requiring programming should be based on output from your code**. For example, if you are asked to find a numerical answer to a problem, the number itself should be included in your submission.

- In addition to what is required for homework submission, for each numerical answer you reach based on running code you have written yourself, **your submitted project PDF must include a copy of a screenshot** that shows your computer window after your code has been executed, with the numerical answer displayed clearly on the screen.

- Note that, in problem 3 below, you are asked to use code that you have already written for homeworks 5 and 6. **You need to submit any code that you use for this project, including any code that you already wrote and submitted for homeworks 5 and 6.**

- If you are asked to use code that you have written yourself to solve a given problem (e.g. in problem 3 below), but you are unable to get that code working, you may choose, instead, to submit numerical answers based on running built-in functions (e.g. determinant computation, root finders, algebraic solvers already available in MATLAB), and you will receive partial credit. **However, you are required to write all code yourself, without relying on built-in functions, in order to get full points.**

1. Develop an algorithm that uses the Golden section search to locate the minimum of a given function. Rather than using the iterative stopping criteria we have previously implemented, design the algorithm to begin by determining the number of iterations n required to achieve a desired absolute error $|E_{a,d}|$ (not a percentage), where $|E_{a,d}|$ is input by the user. You may gain insight by comparing this approach to a discussion regarding the bisection method on page 132 of the textbook. Test your algorithm by applying it to find the minimum of $f(x) = 2x + \frac{3}{x}$ with initial guesses $x_l = 1$ and $x_u = 5$ and desired absolute error $|E_{a,d}| = 0.0001$.

2. A manufacturing firm produces and sells four types of automobile parts. Each part is first fabricated and then finished, and the time required to complete these stages varies between the part types. The required worker hours and profit for each part type are given by the following table:

	Part A	Part B	Part C	Part D
Fabrication time (hrs/100 units)	2.5	1.5	2.75	2
Finishing time (hrs/100 units)	3.5	3	3	2
Profit ($/100 units)	375	275	475	325

The capacities of the fabrication and finishing shops for a given month are 640 and 960 hours, respectively. Using MS Excel (or equivalent software), apply the simplex method to determine how many of each part should be produced in order to maximize profit. Submit a screenshot of your completed excel file and generated solution within your project PDF.

3. The dynamic viscosity of water μ (in units of $10^{-3} N \cdot s/m^2$) varies with temperature T (°C), as evidenced from the following measurements

T	0	5	10	20	30	40
μ	1.787	1.519	1.307	1.002	0.7975	0.6529

   (a) Use your polynomial regression algorithm (from homework 5) to fit a parabola to these data points in order to predict μ at $T = 2.5°C$. What is the value you obtained for r^2? Generate a plot comparing the data points to your polynomial fit.

   (b) *Andrade's equation* has been proposed as a model for this relationship, which claims that

$$\mu = De^{B/T_a}, \tag{1}$$

   where T_a = absolute temperature of the water (K), and D and B are constants. Apply a mathematical transformation to (1) that will allow you to solve for B and D by applying the general regression algorithm you developed for homework 5. Use Andrade's equation to predict μ at $T = 2.5°C$. Generate a plot comparing the data points to your fit using Andrade's equation.

(c) Use your Newton's interpolating polynomial algorithm (from homework 6) to predict μ at $T = 2.5^oC$. Generate a plot comparing the data points to your polynomial interpolation.

(d) Use your cubic spline interpolation algorithm (from homework 6) to predict μ at $T = 2.5^oC$. Generate a plot comparing the data points to your cubic spline interpolation.