ENG202: Numerical Methods for Engineering
Lab. Assignment 1 (A1)
Week 3 (27 Jan. – 31 Jan.), Spring 2020

Note:

- Each student has to implement **2 out of the 4** exercises specified in the manual.
- Create a folder using the nomenclature: A1_*yourname_yourID*.
- Create a new file in the folder for each programming exercise and name it as Exercise*X*, where *X* denotes the exercise number.
- Zip your folder and upload it to your Moodle account before the end of the lab session.
- Any queries during the lab hours should be discussed only with the Instructor/T.A.s.
- Each implementation should be done individually. Sharing your code (in entirety or partially) will be considered as plagiarism.

Exercise 1: The saturation concentration of dissolved oxygen in freshwater can be calculated with the equation:

$$\ln o_{sf} = -139.34411 + \frac{1.575701 \times 10^5}{T_a} - \frac{6.642308 \times 10^7}{T_a^2} + \frac{1.243800 \times 10^{10}}{T_a^3} - \frac{8.621949 \times 10^{11}}{T_a^4}$$

where o_{sf} is the saturation concentration of dissolved oxygen in freshwater at 1 atm (mg/L) and T_a is the absolute temperature (K). Remember that $T_a = T + 273.15$, where T is the temperature (°C).

(a) Develop the program using the false-position method to determine the temperatures T for three saturation concentrations $o_{sf} = 8, 10, 12$ mg/L with at least four significant digits. Use the initial temperature guesses of 0 and 40°C. Print out the saturation concentration o_{sf}, temperature in °C, number of iterations, and approximate relative error for three values of the saturation concentration.

Exercise 2: Design a spherical tank to hold water for a small village, as shown in Fig.1 below. The volume of liquid it can hold can be computed as:

$$V = \pi h^2 \frac{[3R - h]}{3}$$

where V is the liquid volume (m^3), h is the depth of the water in the tank (m), and R is the tank radius (m).

(a) If R=3m, what depth must the tank be filled so that it holds 30 m^3?

Develop the program using the Newton-Raphson method to determine your answer with at least three significant digits. Print out the iteration number, depth, function, and approximate relative error after each iteration.

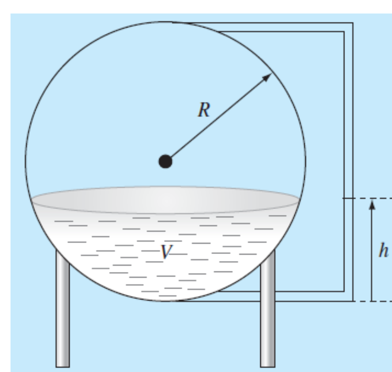

Fig. 1. Illustration for Exercise 2.

***Exercise 3*:**

(a) Write a program to find the root of the following equation with at least three significant digits using either the bisection method or the false-position method: $2x^2 - 5x + 3 = 0$.

(b) Tabulate the results obtained from your method of choice as follows:

Number of Iterations	**Approximated Root Value**	**Approximate Relative Error (ε_a)**

***Exercise 4*:**

The Taylor series expansion for the sine function is given as below:

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$

where $\sin x = x$ is the first estimate, $\sin \mathrm{x} = x - \frac{x^3}{3!}$ is the second estimate, and so on.

(a) Write a program that takes the following parameters as input from the user:

- n: a positive integer indicating the n-th estimate.
- x: a real-value at which the sine function should be computed.

The program should then compute and print the true percent relative error (ε_t) and approximated error (ε_a) for the n-th estimate of the series only.