CMPT-439 Numerical Computation
Project 2

1. (**40/100**) Using the algorithms described in the class notes (Lecture-3) design two functions (you may use the m-language and work in Matlab or use any high-level language): one of them should utilize the **secant method** and another one should utilize the **false position** ("**regula falsi**") method for solving nonlinear equations $f(x)=0$.
   These functions must use the following calling arguments:
   - initial approximations x_1, x_2,
   - δ (pre-determined tolerance value),
   - a function utilizing $f(x)$,
   - a flag determining a stopping criterion.

   Your functions shall return a root, which was found, and the number of iterations needed to find it.

   Your function shall give the user 4 options to stop the iterative process and have 3 corresponding branches, accordingly (**an option to be chosen must be the Flag argument** in your respective function):

   a) An absolute approximate error is used to stop the process. You may predict the number of iterations in advance in such a case.
   b) An absolute relative approximate error is used to stop the process.
   c) Estimation of a true absolute error is used to stop the process.
   d) Conjunction of an absolute approximate error and an estimated true absolute error is used to stop the process.

   You need to comment on every single line of your functions explaining what this line of your code stands for.

2. (**10/100**) Ask a generative AI tool (ChatGPT or Copilot or Meta AI) to create two functions in the same language, which you used and utilizing the secant and false position methods while meeting the same requirements as your function had to meet (in particular, utilizing 4 stopping criteria).
   Evaluate differences between your code and generative AI code. **Is an AI-generated code correct? Does it meet requirements?**

3. (**30/100**) The equation $2\sin(x)-e^x/4-1=0$ has one root located in the interval [-7, -5] and another root located in the interval [-5, -3]. Find both roots using the secant and false position methods and the **functions**, **which you designed**. Use **all four options** to stop calculations for each of the roots and then estimate, which root is better (if any) in terms of closeness $2\sin(x)-e^x/4-1$ to 0 after a corresponding root was plugged in. Use $\delta=10^{-6}$ as your tolerance threshold for all four stopping criteria.

4. (**15/100**) Solve the same equation $2\sin(x) - e^x/4 - 1 = 0$ using the functions created by generative AI. Use **all four options** to stop calculations for each of the roots and then estimate, which root is better (if any) in terms of closeness $2\sin(x) - e^x/4 - 1$ to 0 after a corresponding root was plugged in. Use $\delta = 10^{-6}$ as your tolerance threshold for all four stopping criteria.

5. (**<u>15 extra credit points</u>**) Find all roots of the equation $e^{(\cos(2x)+\sin(3x))} - 3\cos x - 2\sin x = 0$ in the interval [-1, 3]. Find all these roots using both functions, which you designed in Task 1. You may use either of 4 options (1a – 1d) to stop an iterative process. You need to find initial approximations for each of your roots and justify your choice.

6. (**5/100**) Write a brief technical report presenting your results (**all roots found**) and **the corresponding number of iterations** in the **table**. Make a conclusion about the best stopping criterion or about their equivalence to each other and justify your conclusion. Make a conclusion about the quality of the AI-generated implementation of the secant and false position methods. Also include a solution for the extra credit Task # 5 (if applicable).

7. Turn in your source code, a screen shot of its test run and your brief technical report in a single zip file.