AE/ME 5830 Spring 2021, Homework IV, Due Wednesday March 31 by midnight

1. Develop a computer routine to minimize a one-dimensional function $F(x)$ in positive x domain. Your routine should include four parts:

   (a) Finding the bounds on the minimum of the function assuming that the function has a negative slope at x=0.0.

   (b) Reduction of the original interval found in Part (a) using the golden section algorithm

   (c) Cubic polynomial fit to the points obtained at the last iteration of the golden section algorithm

   (d) Determining the location of the minimum (x_{min}) and the corresponding value of the objective function (f_{min}) .

   Use your routine to find the minimum of the following function:

   $$F(x) = x^4 - x^3 - Sin^2 x + Cos^2 x + 2 \tag{1}$$

   Solve the problem for $n = 2$, $n = 5$, $n = 10$, and $n = 15$ where n is the number of iterations for the golden section search. For each case, report x_{min} and f_{min}. (Hint: Use $a = 0.0$ and $b = 0.1$ for the starting values of the bounds in part (a)).

2. The drag (D) of a wide-body passenger aircraft can be estimated by

   $$D = 6.62725\sigma V^2 + \frac{1.31493 \times 10^{-4}}{\sigma}\left(\frac{W}{V}\right)^2 \tag{2}$$

   where σ = ratio of air density between the flight altitude and sea level, W = weight of the aircraft in Newtons, V = velocity of the aircraft in m/s, and D is obtained in Newtons. In the above equation, the first term corresponds to the drag due to friction and the second term represents the drag due to lift. At a given altitude and aircraft weight, there will be an optimum value of the velocity which will minimize the total drag (e.g., maximize L/D value). Using the optimization routine you have written, determine the minimum drag and the corresponding velocity for this aircraft at cruise weight and altitude ($W = 3.7278 \times 10^6$ N and $\sigma = 0.31$). Use 100 m/s $\leq V \leq$400 m/s for the initial interval in the golden section search and use a relative convergence criteria of $\epsilon = 10^{-3}$ for interval reduction.