ME598/494 Homework 1

1. Solve the following problem using two of the three solvers: Excel Solver, Matlab's *fmincon*, and Scipy optimization. Use initial point: $\mathbf{x}_0 = (1, 1, 1, 1)$. (15 points each, 30 in total)

$$\text{minimize:} \quad 24.55x_1 + 26.75x_2 + 39.00x_3 + 40.50x_4$$
$$\text{subject to:} \quad 2.3x_1 + 5.6x_2 + 11.1x_3 + 1.3x_4 - 5 \geq 0$$
$$12x_1 + 11.9x_2 + 41.8x_3 + 52.1x_4 - 21$$
$$- 1.645(0.28x_1^2 + 0.19x_2^2 + 20.5x_3^2 + 0.62x_4^2)^{1/2} \geq 0$$
$$x_1 + x_2 + x_3 + x_4 - 1 = 0$$
$$0 \leq x_i, \ i = 1, \ldots, 4$$

Note: Here are some common programming issues:

(a) First and foremost, please learn how to use **break points**. I will not address your programming questions if you have not learned how to debug your code.

(b) Please note that your solutions from all solvers should be **the same**.

(c) For some versions of Matlab, **space** is interpreted as comma when there is a bracket around. For example, $[2 + 3]$ could be considered an array with two elements $[2, 3]$ rather than a single number 5.

(d) For some versions of fmincon, treating linear constraints as nonlinear ones will lead to different local solutions. Regardless, it is always recommended that linear constraints are treated as linear, as they directly provide gradient information (no finite difference is needed).

2. Design a **cylindrical** cola can of volume V to minimize material usage. Formulate an optimization problem by the following steps: (1) Define design variables and the objective (10 points), (2) state constraints (5 points), (3) discuss assumptions made during modeling (5 points).

   Solve your optimization problem with a realistic cola can volume. Is your optimal solution close to the reality? If not, briefly discuss why (not restricted to engineering considerations). (20 points)

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3. Consider the problem of grocery shopping with a budget of 30 dollars. You will need 10 units of protein and 20 units of vitamin. You can choose from Products A, B, and C. The (protein, vitamin) values for them are (5,0), (0,6), and (3,2) per unit, and their unit prices are 5, 6, 7 dollars, respectively. What is the best way to spend your money? Define "best". (30 points)