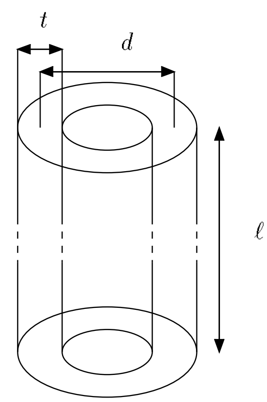
**Math 4630/6630 - Nonlinear Optimization - Spring 2021**

**Formulation of Optimization Problems**

**Example:** A uniform tubular column must handle a compressive load of $P = 25,000$ N (newton). The column is to be made of a material with yield stress $\sigma_y = 5,000$ N/cm$^2$, modulus of elasticity $E = 8.5 \times 10^6$ N/cm$^2$, and weight density $\rho = 2.0 \times 10^{-2}$ N/cm$^3$. The length is to be $\ell = 250$ cm. The mean diameter $d$ must be between 2 cm and 14 cm, and the thickness $t$ between 0.2 cm and 0.8 cm. The induced stress $\sigma_i = P/(\pi dt)$ must not exceed either $\sigma_y$ or the buckling stress $\sigma_b = \pi^2 E(d^2 + t^2)/(8\ell^2)$. Design the column to minimize its overall cost, which is $c = 0.5W + 2d$, where $W = \pi \ell d t \rho$ is the weight (in N) and $d$ is the mean diameter (in cm).




**Steps:**

**(1) Variables:** choose 'design variables', those over which you have control.

**(2) Objective:** formulate objective function as function of design variables and determine whether it is to be maximized or minimized.

**(3) Constraints:** formulate restrictions given in problem as equations or inequalities involving design variables (including perhaps upper and lower bounds on the variables).