MECH 577 Optimum Design

Project # 1: Single-Variable Optimization
The Optimum Design of a Truss

Assigned: September 2, 2008 Due: September 23, 2008

Shown in Fig. 1 is a triangular truss, composed of two links of length ℓ, of the same structural steel, of Young modulus E and cross-section area A_1 and A_2. The link axes make an angle $\alpha = 45°$ with the horizontal, while a load, applied at node O_3, makes an angle $\theta = 105°$ with the vertical. For a fixed amount of material, i.e., for $A_1 + A_2 = A$, where A is a constant, find the *optimum values* of A_1 and A_2 that will lead to a *minimum value* of the *total stress* in the structure. Here, if σ_i denotes the stress in the ith link, the total stress is defined as the rms value of σ_1 and σ_2.

Note that, although two design variables are available, these are subject to an *isoperimetric constraint*, and hence, the problem can be formulated as a single-variable one. Find the optimum values required by means of two methods, Fibonacci numbers and golden-section search. *Hint: An expert engineer claims that, given the orientation of the load, link 2 is "more loaded" than link 1, and hence, the latter should be given an area A_1 that is "less than 50% of A, of something between 30% and 45%."*

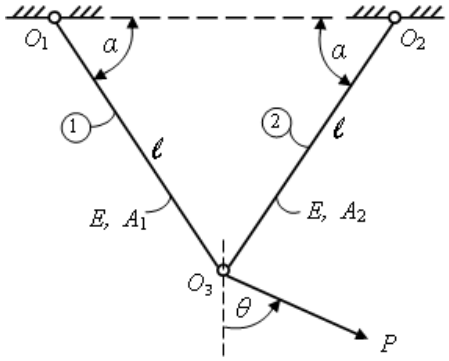

Figure 1: A two-link truss