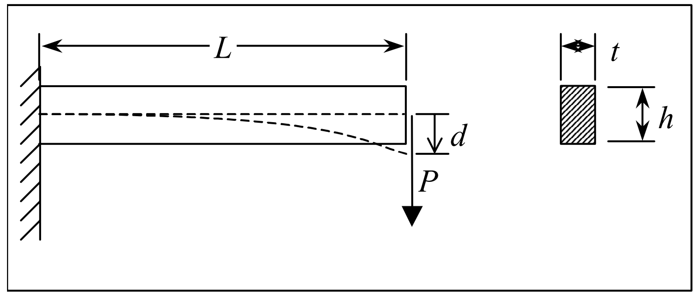
# MEEM 4403 COMPUTER-AIDED DESIGN METHODS
## Optimization Practice

1. Mathematically, a constrained optimization problem is defined as:

$$\mathbf{X}^* \in R^n \text{ so that } F\left(\mathbf{X}^*\right) = \min F(\mathbf{X})$$
$$\mathbf{X}_l \leq \mathbf{X}^* \leq \mathbf{X}_u$$
$$G_i\left(\mathbf{X}^*\right) \geq 0 \qquad i = 1,2,\ldots,m$$
$$H_j\left(\mathbf{X}^*\right) = 0 \qquad j = 1,2,\ldots,q$$




We wish to design a beam with an optimal cross section to minimize the deflection (*d*) due to a load (*P*). The length (*L*) is fixed, but the thickness (*t*) and the height (*h*) of the beam can be varied. The weight of the beam (*W*) must be less than or equal to $W_{max}$, the maximum.

Draw connecting lines to relate each of the elements of the problem on the left to the corresponding mathematical element(s) in which it occurs on the right:

| | |
|---|---|
| *L* | $\mathbf{X}$ |
| *t* | $F(\mathbf{X})$ |
| *h* | $\mathbf{X}_l$ |
| *P* | $\mathbf{X}_u$ |
| *d* | $G_i\left(\mathbf{X}^*\right)$ |
| *W* | $H_j\left(\mathbf{X}^*\right)$ |
| $W_{max}$ | |
| A minimum value for *h* | |
| A maximum value for *h* | |
| The weight calculation | |
| The deflection calculation | |

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2. Which structural optimization technique is best suited for:
   (a) optimizing the shape of a beam's cross-section?

   (b) sizing the thickness of a pressure vessel?

   (c) optimizing the number, shape, and positions of stiffeners in a plastic cover?

   (d) positioning a single stiffener in a plastic cover

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3. Which optimization solution technique is best suited for:
   (a) optimizing the width and height of a rectangular beam's cross-section?

   (b) sizing the thickness of a pressure vessel?

   (c) when there are many closely spaced local minima in the objective function?

   (e) optimizing the number of cooling fins on different surfaces of an air-cooled engine?

   (d) optimizing the positions of components in an engine compartment?

   (e) optimizing the selection of alternators from five different suppliers?