Optimization

Single Variable

Multivariable - No Constraints

Multivariable - With Constraints

Single variable examples

Find location of cable attachment to minimize tension in cable

Find angular orientation of crank that will maximize velocity of piston

Multivariable - No Constraints

Find the values of x_1 and x_2 that will yield the **minimum potential energy** for the given spring system:



Multivariable with Constraints

Maximize $\frac{6xyz}{x+2y+2z}$ subject to xyz = 16

Cable problem—minimize tension

Objective function:

$$T = \frac{L_{pole}}{x\sqrt{1 - \frac{x^2}{L^2_{cable}}}}$$

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design variable:

constraints:

 $\begin{array}{l} x \leq 8.0 \text{ m} \\ x \geq 0.0 \text{ m} \end{array}$

Velocity problem

Objective function:

$$\dot{x} = r\boldsymbol{w}\sin(\boldsymbol{q}) + 2\boldsymbol{w}\left(\frac{r^2}{4L}\right)\sin(2\boldsymbol{q})$$

design variable:

constraints:

$$\theta \le 2 \pi$$
$$\theta \ge 0$$

Multivariable problems – No constraints

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Potential Energy

Minimize: U =
$$\left[\frac{1}{2}k_2x_1^2 + \frac{1}{2}k_3(x_2 - x_1)^2 + \frac{1}{2}k_1x_2^2\right] - Px_2$$

design variables: x_1 and x_2

Necessary condition:	gradient must be 0.0
Sufficient condition:	Hessian must be positive definite

Multivariable problems with constraints

Maximize: $\frac{6xyz}{x+2y+2z}$ subject to xyz = 16

Objective function:

 $\frac{6xyz}{x+2y+2z}$

design variables: x, y, z

constraints

subject to xyz = 16

Necessary condition: Gradient of Lagrangian is 0.0

Sufficiency condition: Hessian of Lagrangian is + definite