Introduction

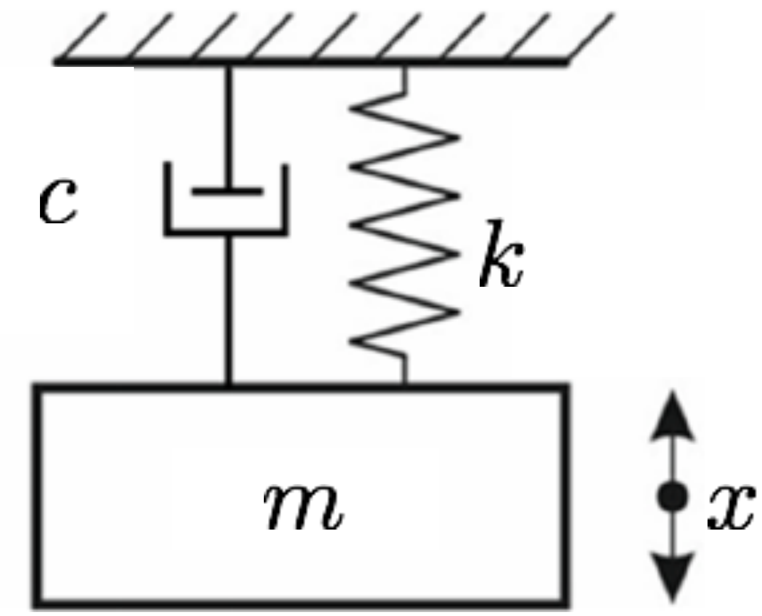
Example: Mass-Spring-Damper, Real World System

Reliable Physical Theory

$$\mathcal{R}(\mathbf{u}, \tau; \mathbf{r}) = \mathbf{0}$$

$$\boxed{m\ddot{x} + c\dot{x} + kx = 0}$$

$$\mathbf{u} = \begin{bmatrix} x \\ \dot{x} \end{bmatrix} \qquad \tau = \begin{bmatrix} c \\ k \end{bmatrix} \qquad \mathbf{r} = \begin{bmatrix} m \\ x(0) \\ \dot{x}(0) \end{bmatrix}$$



Real World Embedded Model

$$\tau = (\mathbf{u}, \mathbf{v}, \mathbf{s}, \theta)$$

$$\boxed{\begin{aligned} k &= \text{const} \\ c(T) &= \exp\left(\frac{T_0}{T} - 1\right) \\ \dot{T} &= c(T)\dot{x}^2 - \frac{T - T_0}{t_T} \end{aligned}}$$

$$\mathbf{v} = T \qquad \mathbf{s} = \begin{bmatrix} T_0 \\ t_T \end{bmatrix} \qquad \theta = k$$

$$\begin{aligned} \mathbf{y} &= x \\ \mathbf{q} &= \max(\dot{x}) \end{aligned}$$

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Note: Displacement or velocity observations (e.g., from proximity sensor or vibrometer) can be represented by:

$$\mathbf{y} = \mathbf{C}^{\mathbf{T}}\mathbf{u}$$

where:

$$\mathbf{C}^{\mathbf{T}} = [\mathbf{1}, \mathbf{0}] \quad \text{or} \quad \mathbf{C}^{\mathbf{T}} = [\mathbf{0}, \mathbf{1}]$$

Real World Embedded Model

$$\tau = (\mathbf{u}, \mathbf{v}, \mathbf{s}, \theta)$$

$$k = \mathrm{const}$$

$$c(T) = \exp\left(\frac{T_0}{T} - 1\right)$$

$$\dot{T} = c(T)\dot{x}^2 - \frac{T - T_0}{t_T}$$

$$\mathbf{v} = T \qquad \mathbf{s} = \begin{bmatrix} T_0 \\ t_T \end{bmatrix} \qquad \theta = k$$

$$\mathbf{y} = x$$
$$\mathbf{q} = \max(\dot{x})$$