Summary of First Order Systems

Thermal Perfectly Insulated First Order

$$\tau \frac{dT}{dt} + T = T_{in} \qquad \text{where} \quad \tau = \frac{VD}{W}$$

$$\frac{T_S}{T_{IN}} = \frac{1}{\tau s + 1}$$

For a step change of Tin of 100 C degrees:

$$T(s) = T_{IN}(s)\,\frac{1}{\tau s + 1}$$

$$= \frac{100}{s}\,\frac{1}{\tau s + 1}$$

Electronic RC First Order

$$\tau \frac{de_o}{dt} + e_o = e_{IN} \text{ where } \tau = RC$$

$$\frac{E_O(s)}{E_{IN}(s)} = \frac{1}{\tau s + 1}$$

For a step change in input voltage of 0 to 10 V

$$E_O(s) = \frac{E_{IN}(s)}{s}\,\frac{1}{\tau s + 1}$$

$$= \frac{10}{s}\,\frac{1}{\tau s + 1}$$

Electronic RC First Order with and Amplifier Gain of K

$$\tau = \frac{de_O}{dt} + e_O = Ke_{IN} \text{ where } \tau = RC$$

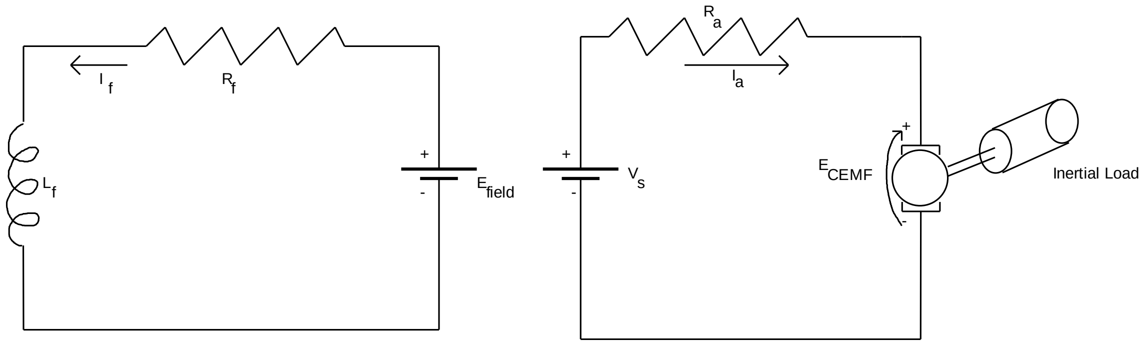
$$\frac{E_O(S)}{E_{IN}(S)} = \frac{K}{\tau\, S + 1}$$

For an Amplifier gain of 10 step change in input voltage of 0 to 2 V

$$E_O(S) = \frac{E_{IN}(S)}{S}\,\frac{1}{\tau\, S + 1}$$

$$= \frac{2}{S}\,\frac{10}{\tau\, S + 1}$$

Electromechanical First Order:



$$\tau = \frac{J}{\frac{K_T K_g + R_a F}{R_a}}$$

$K_S = \dfrac{K_T}{K_T K_g + R_a F}$, K_S is referred to as the speed constant

$\tau \dfrac{d\omega}{dt} + \omega = K_S V_S$, units of K_S are $\dfrac{\text{Rads / sec}}{\text{volt}}$

$$\frac{\omega(S)}{V_S(S)} = \frac{K_S}{\tau S + 1}$$

For an Speed Constant of 10 Rad/sec/volt and step change in input voltage of 0 to 20 V

$$\omega(S) = \frac{20}{s}\frac{10}{\tau S + 1}$$