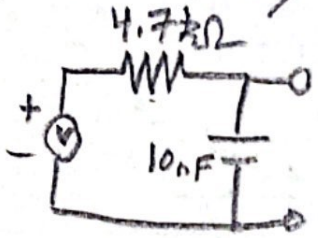
Deriving transfer functions

- Electrical System



$R = 4.7\,k\Omega \quad L = 10nF$

$V_o(s) = I(s) \cdot Z_c$

$V(s) - Z_R(I(s)) - Z_c(I(s)) = 0$

$I(s) = \frac{V_o(s)}{Z_c} \rightarrow V(s) = Z_R\left(\frac{V_o(s)}{Z_c}\right) + V_o(s)$

$V(s) = \left(\frac{Z_R}{Z_c} + 1\right) V_o(s) \rightarrow \frac{V(s)}{V_o(s)} = \frac{Z_R + Z_c}{Z_c}$

$$\frac{V_o(s)}{V(s)} = G(s) = \frac{Z_c}{Z_R + Z_c} = \frac{1/Cs}{R + 1/Cs} = \frac{1}{RCs+1}$$

- Thermal System

From thermal pdf

$$G(s) = \frac{1}{R(s+1)}$$

- Water system

$A\dot{h} + \frac{g}{R}h = q_i \rightarrow \mathcal{L} \rightarrow AsH(s) + \frac{g}{R}H(s) = Q(s)$

$\frac{Q(s)}{H(s)} = As + \frac{g}{R} \rightarrow \tau = \frac{AR}{g} \rightarrow C = \frac{A}{g} \rightarrow A = Cg$

$$\frac{H(s)}{Q(s)} = \frac{1}{As + \frac{g}{R}} = \frac{R}{RCgs + g} = \frac{R/g}{RCs+1} = G(s) = \frac{H(s)}{Q(s)}$$

The water system is slightly different.