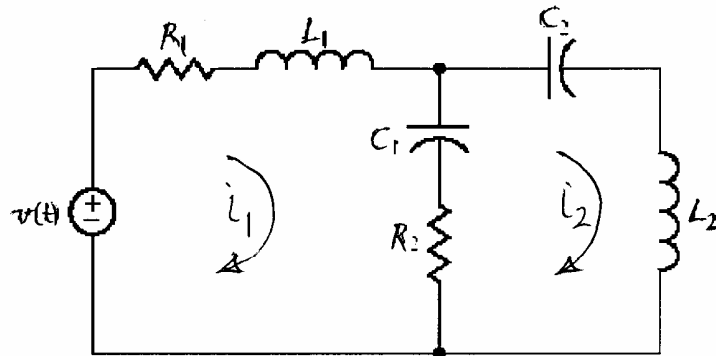


E2.14



Loop 1

$$R_1 i_1 + L_1 \frac{di_1}{dt} + R_2 (i_1 - i_2) + \frac{1}{C_1} \int (i_1 - i_2) dt = v(t)$$

Loop 2

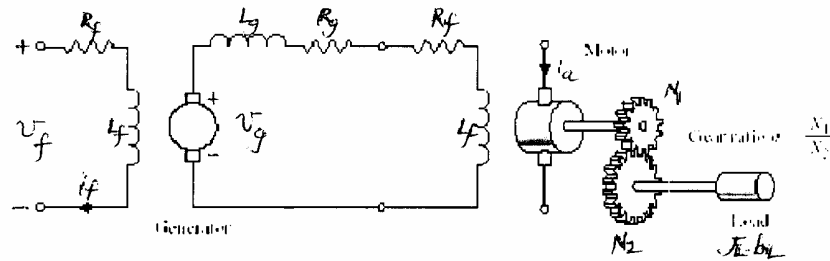
$$\frac{1}{C_2} \int i_2 dt + L_2 \frac{di_2}{dt} + R_2 (i_2 - i_1) + \frac{1}{C_1} \int (i_2 - i_1) dt = 0$$

P2.1

Loop 1: 
$$v(t) = R_1 i_1 + \frac{1}{C_1} \int i_1 dt + L_1 \frac{d(i_1 - i_2)}{dt} + R_2 (i_1 - i_2)$$

Loop 2: 
$$0 = R_3 i_2 + \frac{1}{C_2} \int i_2 dt + L_1 \frac{d(i_2 - i_1)}{dt} + R_2 (i_2 - i_1)$$

P2.13



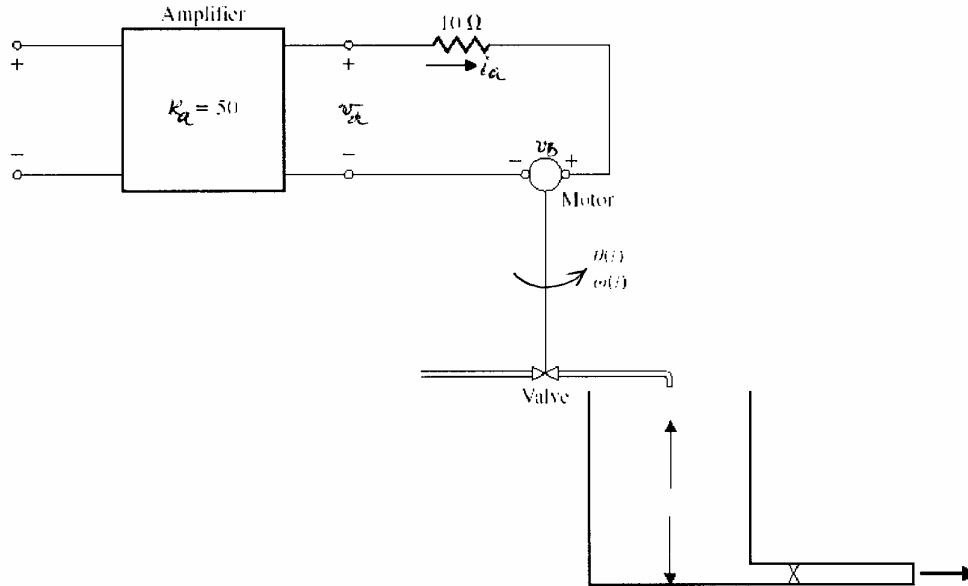
$$\frac{V_g(s)}{V_f(s)} = \frac{K_g(s)}{R_f + L_f s} \quad ; \quad \frac{\theta_L(s)}{\theta_m(s)} = n$$

$$\frac{\theta_m(s)}{V_g(s)} = n \frac{K_m}{s(Js + b)(Ls + R)} \quad ;$$

$$J = J_m + n^2 J_L \quad ; \quad b = b_m + n^2 b_L \quad ; \quad L = L_g + L_f \quad ; \quad R = R_g + R_f$$

$$\frac{\theta_L(s)}{V_f(s)} = \frac{K_g(s)}{(R_f + L_f s)} \frac{n K_m}{s([J_m + n^2 J_L]s + [b_m + n^2 b_L])([L_g + L_f]s + R_g + R_f)}$$

P2.48



$$\text{Given: } h(t) = \int [1.6\theta(t) - h(t)] dt$$

$$\ddot{h}(t) = 1.6 \dot{\theta}(t) - \dot{h}(t) \quad \Rightarrow \quad \dot{\theta}(t) = [\ddot{h}(t) + \dot{h}(t)] \frac{1}{1.6}$$

$$\ddot{h}(t) = 1.6 \ddot{\theta}(t) - \ddot{h}(t)$$

$$\ddot{h}(t) = 1.6 \left[ \frac{K_m}{J} i_a \right] - \ddot{h}(t)$$

$$\ddot{h}(t) = 1.6 \left[ \frac{K_m}{J R_a} (v_a - K_b \omega) \right] - \ddot{h}(t)$$

$$\ddot{h}(t) = 1.6 \left[ \frac{K_m}{J R_a} \left( K_a v - \frac{K_b}{1.6} \{ \ddot{h}(t) + \dot{h}(t) \} \right) \right] - \ddot{h}(t)$$

$$\ddot{h}(t) + \left( 1 + \frac{K_m K_b}{J R_a} \right) \ddot{h}(t) + \frac{K_m K_b}{J R_a} \dot{h}(t) = 1.6 \frac{K_m}{J R_a} K_a v$$

$$J = 6 \times 10^{-3} ; R_a = 10 ; K_m = K_b = 10 ; K_a = 50$$