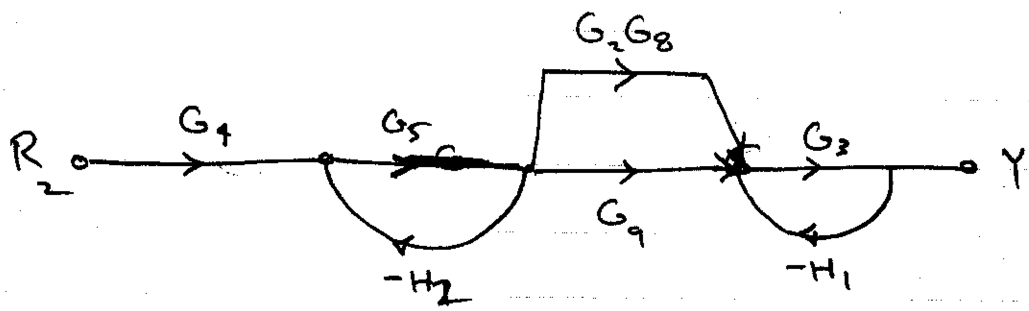
E 2.13

Assume $R_1 = 0$, and removing all gains connected with R_1 we obtain



$P_1 = G_3 G_4 G_5 G_9$, $\Delta_1 = 1$

$P_2 = G_2 G_4 G_3 G_5 G_8$, $\Delta_2 = 1$

$L_1 = -G_5 H_2$, $L_2 = -G_3 H_1$

$$\therefore \frac{Y}{R_2} = \frac{P_1 \Delta_1 + P_2 \Delta_2}{\Delta}$$

$$= \frac{G_3 G_4 G_5 G_9 + G_2 G_3 G_4 G_5 G_8}{1 - (L_1 + L_2) + (L_1 L_2)}$$

$$= \frac{G_3 G_4 G_5 G_9 + G_2 G_3 G_4 G_5 G_8}{1 + G_5 H_2 + G_3 H_1 + G_3 G_5 H_1 H_2}$$

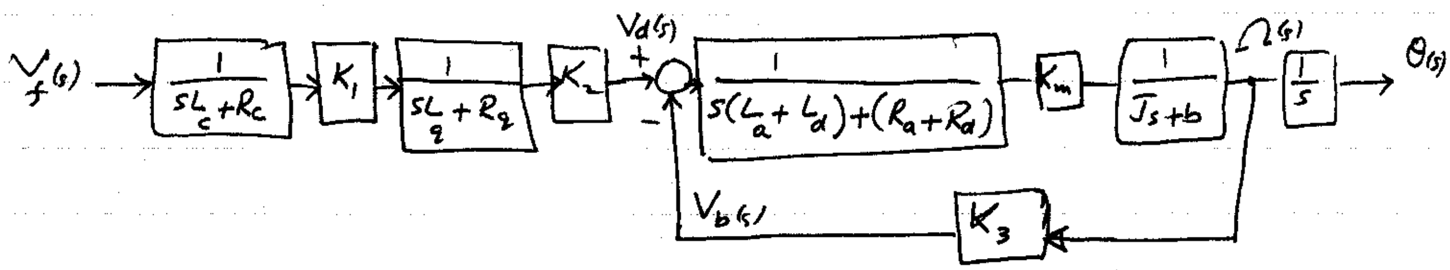
P2.11

$V_c(s) = (sL_c + R_c) I_c \quad ; \quad V_q(s) = K_1 I_c = (sL_q + R_q) I_q$

$V_d - V_b = \left[s(L_a + L_d) + (R_a + R_d) \right] I_d$

$V_d = K_2 I_q$

$T_m = K_m I_d = (Js + bs^2)\, \theta(s) \quad ; \quad V_b = K_3 \Omega(s)$



$$\frac{V_d}{V_f} = \frac{K_1}{(sL_c + R_c)(sL_q + R_q)}$$

$$\frac{\theta(s)}{V_d(s)} = \frac{K_m}{\left\{ \left[s(L_a + L_d) + R_a + R_d \right] (Js + b)) + K_m K_3 \right\} s}$$

$$\frac{\theta(s)}{V_f(s)} = \frac{K_1 K_m}{s(sL_c + R_c)(sL_q + R_q)\left[(Js + b)\left\{ (L_a + d_d)s + (R_a + R_d) \right\} + K_3 K_m \right]}$$

P2.13

$$V_f = (sL_f + R_f)\, I_f(s)$$

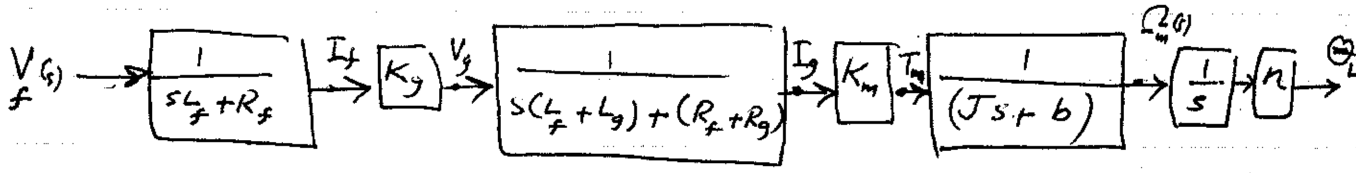
$$V_g = K_g\, I_f(s)$$

$$V_g = [s(L_f + L_g) + (R_f + R_g)]\, I_g(s)$$

$$T_m = K_m\, I_g(s) = [(J_m + n^2 J_L)s + (b_m + n^2 b_L)]\, \Omega_m(s)$$

$$\Omega_m(s) = s\, \Theta_m(s) =$$

$$\Theta_m(s) = \frac{1}{n}\, \Theta_L(s)$$



$$\frac{\Theta_L(s)}{V_f(s)} = \frac{K_g K_m}{\Delta_1(s)\ \Delta_2(s)}$$

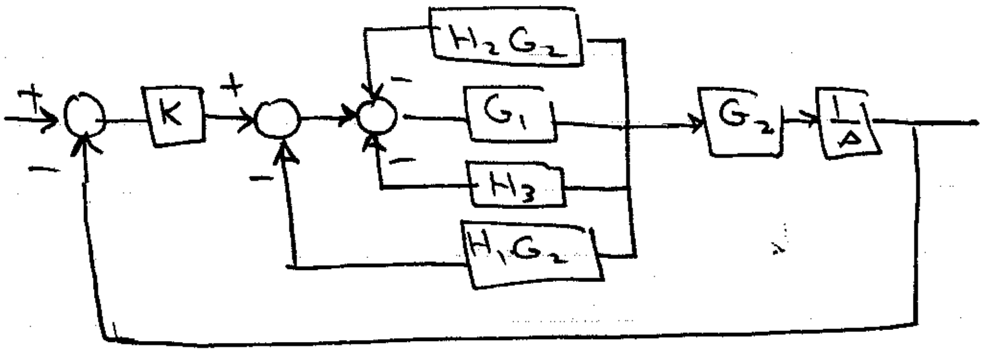
$$\Delta_1(s) = (sL_f + R_f)[s(L_f + L_g) + (R_f + R_g)]$$

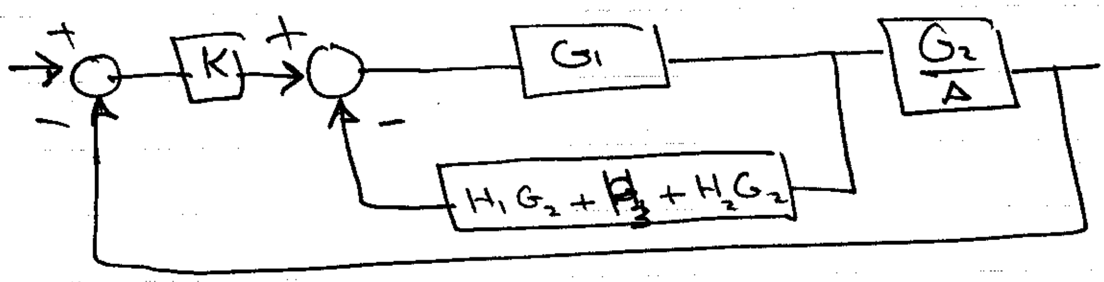
$$\Delta_2(s) = \frac{1}{n}\, s\,(Js + b) \quad ; \quad J = J_m + n^2 J_L, \quad b = b_m + n^2 b_L$$

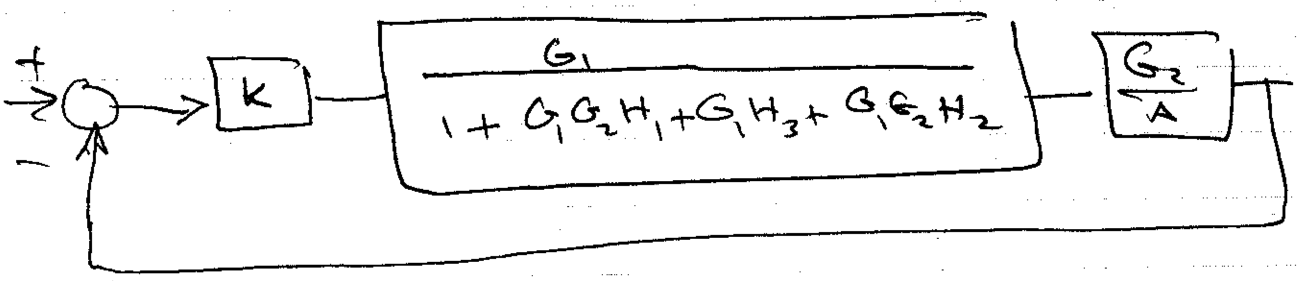
$$= (J_m + n^2 J_L)\frac{s^2}{n} + (b_m + n^2 b_L)\frac{s}{n}$$

E 2.8

Move pickoff point from behind G_2 to front







$$T.F = \frac{KG_1G_2/\Delta}{1 + G_1H_3 + G_1G_2(H_1+H_2) + \frac{KG_1G_2}{\Delta}}$$