

E2.4  $Y(s) = \frac{5(s+100)}{s^2 + 60s + 500} R(s)$

(a)  $r(t) = 1$   $R(s) = \frac{1}{s}$

$$Y(s) = \frac{5(s+100)}{s(s^2 + 60s + 500)} = \frac{5(s+100)}{s(s+10)(s+50)}$$

$$= \frac{A}{s} + \frac{B}{s+10} + \frac{C}{s+50}$$

$A = 1$   $B = -\frac{9}{8}$   $C = \frac{1}{8}$

$$y(t) = e^{-t} - 1.125e^{-10t} + 0.125e^{-50t}$$

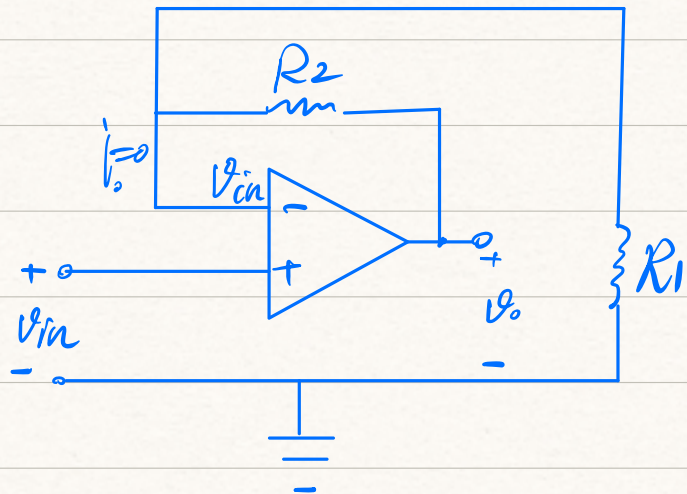
(b)  $y_{ss} = 1$

E2.5

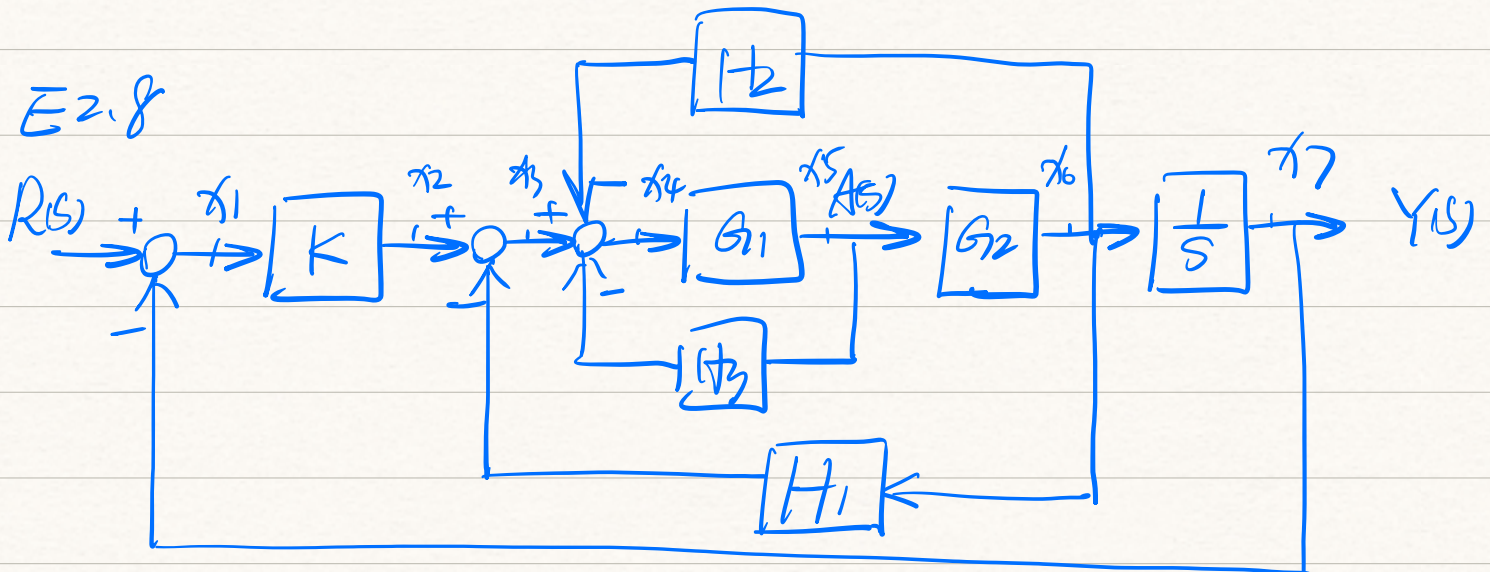
$$V_{in} = i \cdot R_1$$

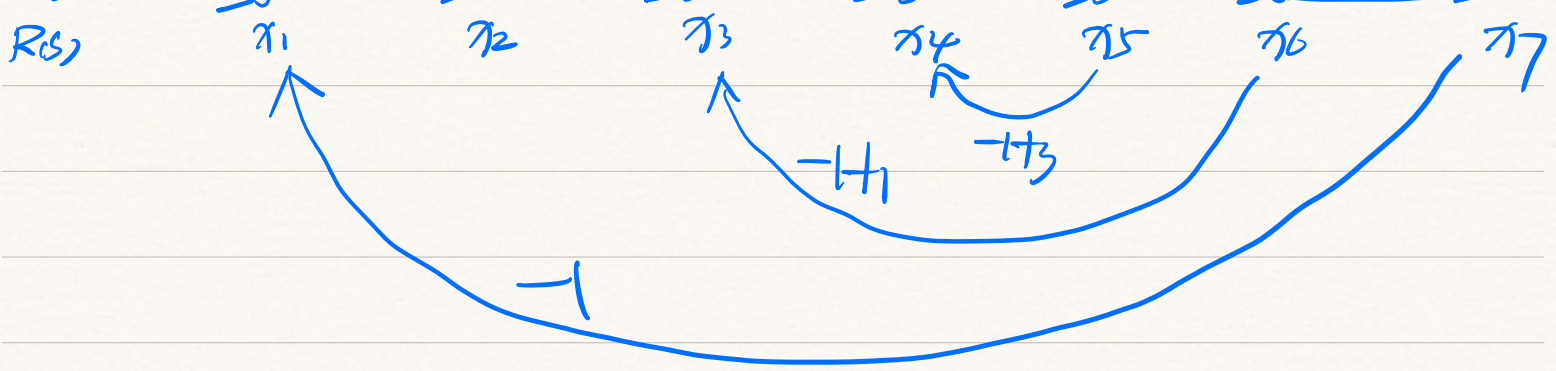
$$V_o = i \cdot (R_1 + R_2)$$

$$\frac{V_o}{V_{in}} = \frac{R_1 + R_2}{R_1}$$



E2.8





$$n=1 \quad p_1 = \frac{k G_1 G_2}{s}$$

$$l_1 = -G_1 H_3$$

$$l_2 = -G_1 G_2 H_2$$

$$l_3 = -G_1 G_2 H_1$$

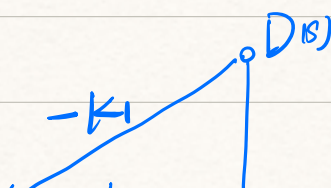
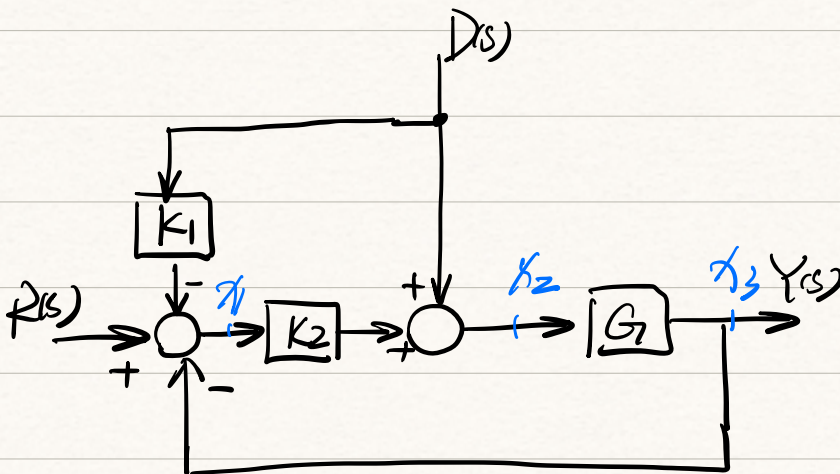
$$l_4 = -\frac{k G_1 G_2}{s}$$

$$\Delta = 1 + \frac{k G_1 G_2}{s} + G_1 H_3 + G_1 G_2 H_2 + G_1 G_2 H_1$$

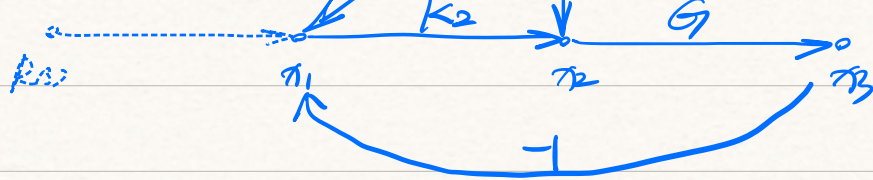
$$\sum_{k=1}^n P_k K = \frac{k G_1 G_2}{s}$$

$$\frac{Y(s)}{R(s)} = \frac{\sum_{k=1}^n P_k K}{\Delta} = \frac{\frac{k G_1 G_2}{s}}{1 + \frac{k G_1 G_2}{s} + G_1 H_3 + G_1 G_2 H_2 + G_1 G_2 H_1}$$

E 2.12







$$R(s) = 0$$

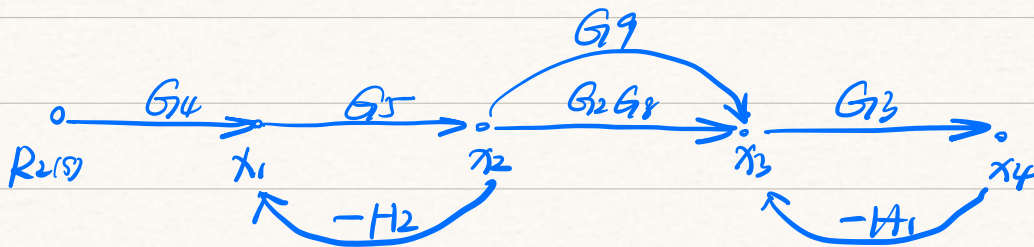
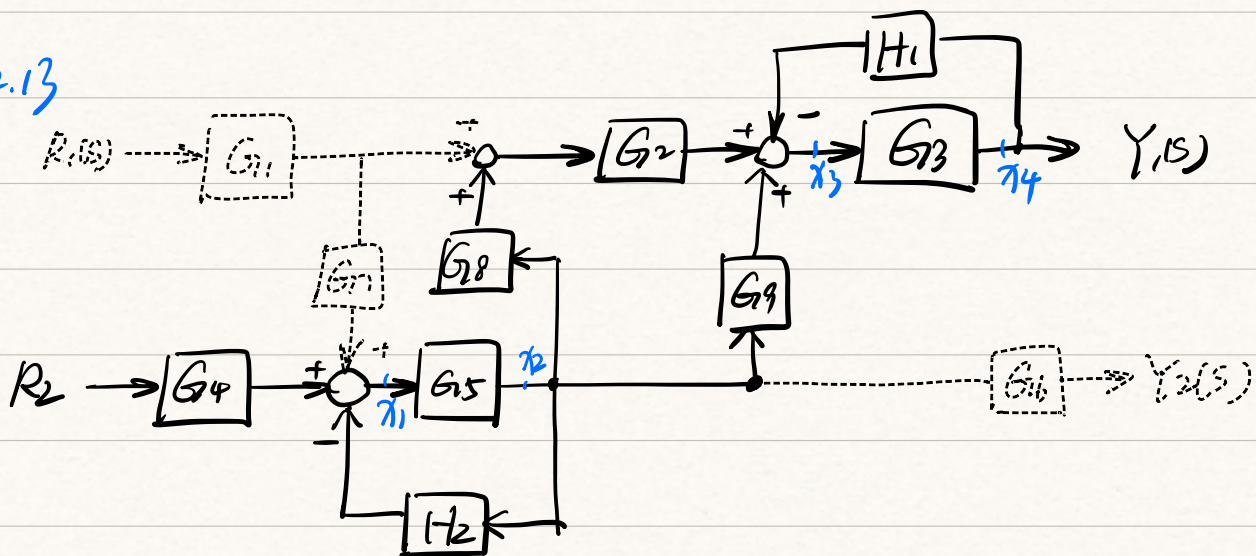
$$n=2 \quad p_1 = -k_1 k_2 G \quad p_2 = G \quad \Delta_1 = -k_2 G$$

$$\Delta = 1 + k_2 G$$

$$\sum_{i=1}^n P_i \Delta_i = -k_1 k_2 G \cdot 1 + G \cdot 1$$

$$\frac{Y(s)}{R(s)} = \frac{-k_1 k_2 G + G}{1 + k_2 G} = 0 \Rightarrow k_1 k_2 = 1$$

E 2.13



$$n=2 \quad p_1 = G_3 G_4 G_5 G_9$$

$$\Delta_1 = -G_5 H_2$$

$$p_2 = G_2 G_3 G_4 G_5 G_8$$

$$\Delta_2 = -G_3 H_1$$

$$\Delta = 1 + G_5 H_2 + G_3 H_1 + G_3 G_5 H_1 H_2$$

$$\sum_{i=1}^n P_i \Delta_i = G_3 G_4 G_5 G_9 \cdot 1 + G_2 G_3 G_4 G_5 G_8 \cdot 1$$

$$1 = 1 - G_3 G_4 G_5 G_7 - 1 + G_{12} G_{13} G_{14} G_{15} G_{18} \dots$$

$$\frac{Y(s)}{R(s)} = \frac{\sum_{i=1}^n P_i \Delta_i}{\Delta} = \frac{G_3 G_4 G_5 G_7 + G_{12} G_{13} G_{14} G_{15} G_{18}}{1 + G_5 H_2 + G_{13} H_1 + G_3 G_{15} H_1 H_2}$$

E 2.18  $\frac{Y(s)}{R(s)} = \frac{10(s+2)}{s^2 + 8s + 15}$

$$R(s) = \frac{1}{s} \quad \begin{matrix} 1 \\ 3 \\ 5 \end{matrix}$$

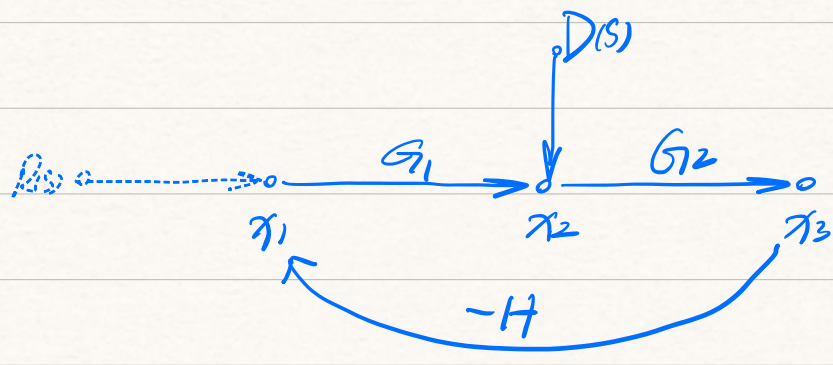
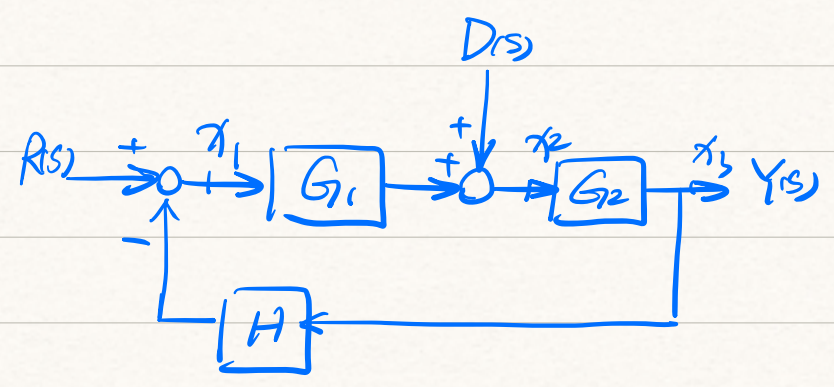
$$Y(s) = \frac{1}{s} \cdot \frac{10(s+2)}{(s+3)(s+5)}$$

$$= \frac{A}{s} + \frac{B}{s+3} + \frac{C}{s+5}$$

$$A = \frac{4}{3} \quad B = \frac{5}{3} \quad C = -3$$

$$y(t) = \frac{4}{3} + \frac{5}{3} e^{-3t} - 3e^{-5t}, \quad t \geq 0$$

E 2.26



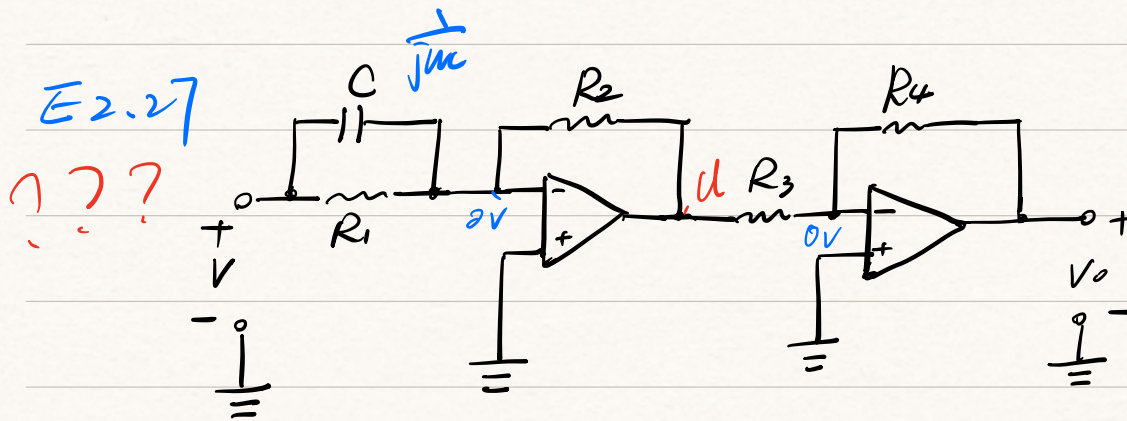
$$n = 1 \quad p_1 = G_2 \quad l_1 = -G_1 G_2 H$$

$$\Delta = 1 + G_1 G_2 H$$

$$\sum_{i=1}^n P_i \Delta_i = G_2 \cdot 1$$



$$\frac{Y(s)}{D(s)} = \frac{G_2}{1 + G_1 G_2 H}$$



$$\frac{U}{R_3} = \frac{V_0}{R_4}$$

$$\frac{U}{R_2} = \frac{\frac{V}{R_1 + \frac{1}{Cs}}}{R_1 + \frac{1}{Cs}} = \frac{V(1 + R_1 Cs)}{R_1}$$

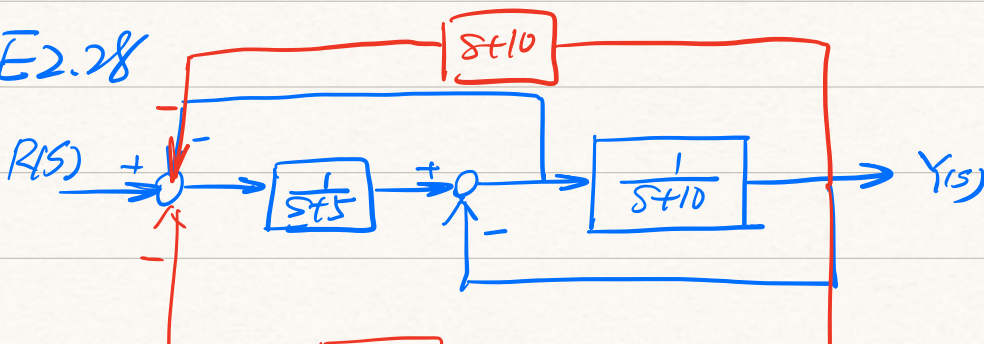
$$V_0 = \frac{R_4}{R_3} U$$

$$V = \frac{R_1}{R_2(1 + R_1 Cs)} U$$

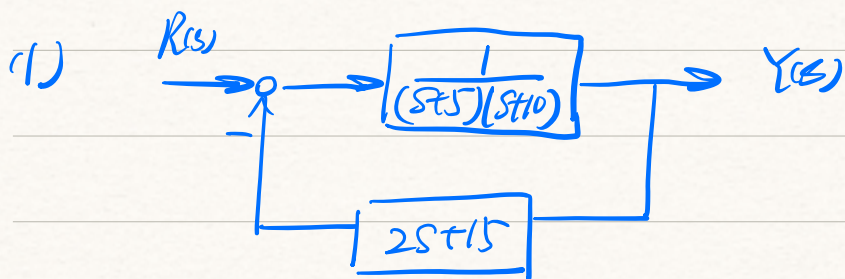
$$\begin{aligned} \frac{V_0}{V} &= \frac{\frac{R_4}{R_3}}{\frac{R_1}{R_2(1 + R_1 Cs)}} = \frac{R_2 R_4}{R_1 R_3} (1 + R_1 Cs) \\ &= \frac{R_2 R_4}{R_3} Cs + \frac{R_2 R_4}{R_1 R_3} \end{aligned}$$

$$= 2Cs + 1/4$$

E2.28



$$\boxed{s+5}$$



(2)

$$\frac{Y(s)}{R(s)} = \frac{\frac{1}{(s+5)(s+10)}}{1 + (2s+15) \cdot \frac{1}{(s+5)(s+10)}}$$

$$= \frac{1}{s^2 + 17s + 65}$$

E 2.30

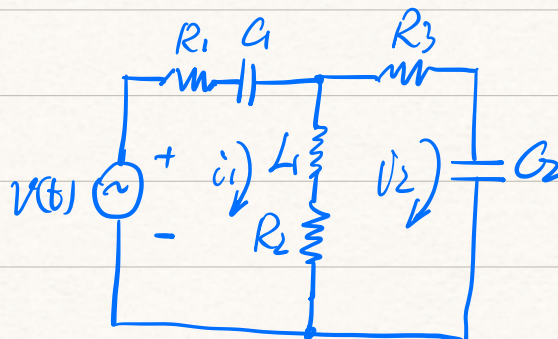
$$V(s) = \frac{400}{s^2 + 8s + 400} = \frac{400}{[s - (-4 + 19.6j)][s - (-4 - 19.6j)]}$$

$$= \frac{A}{s + 4 - 19.6j} + \frac{B}{s + 4 + 19.6j}$$

$$A = -10.2j \quad B = 10.2j$$

$$V(t) = -10.2e^{(-4+19.6j)t} + 10.2e^{(-4-19.6j)t}$$

P2.1



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

$$R_3 \dot{i}_2 + \frac{1}{C_2} \int \dot{i}_2 dt + R_2 (\dot{i}_2 - \dot{i}_1) + L_1 \frac{d(\dot{i}_2 - \dot{i}_1)}{dt} = 0$$