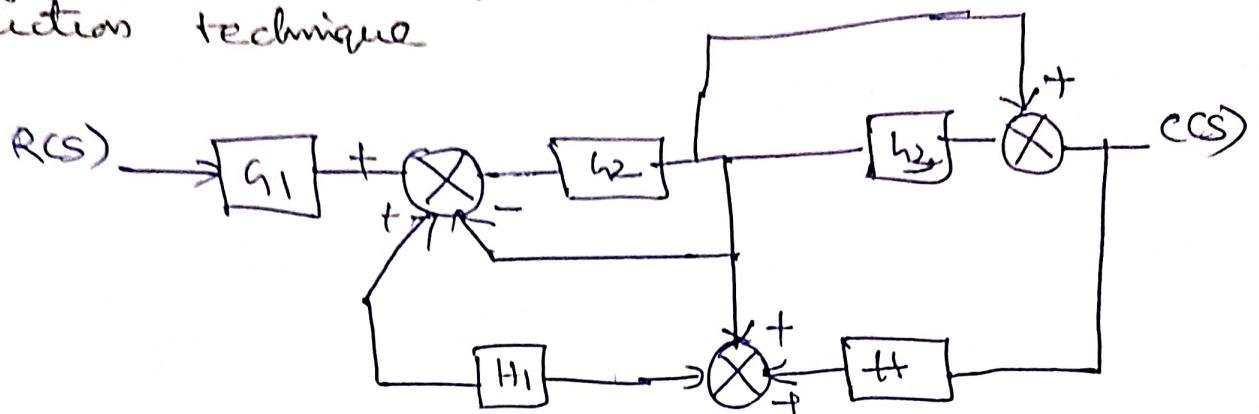
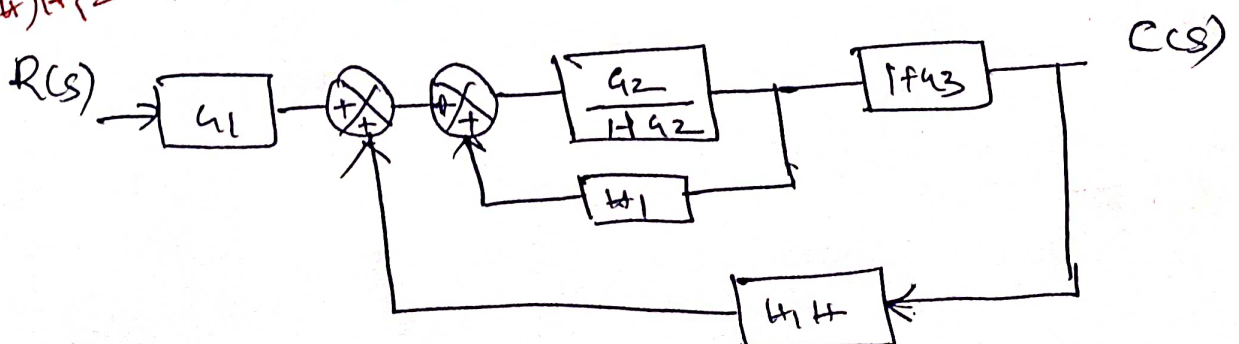
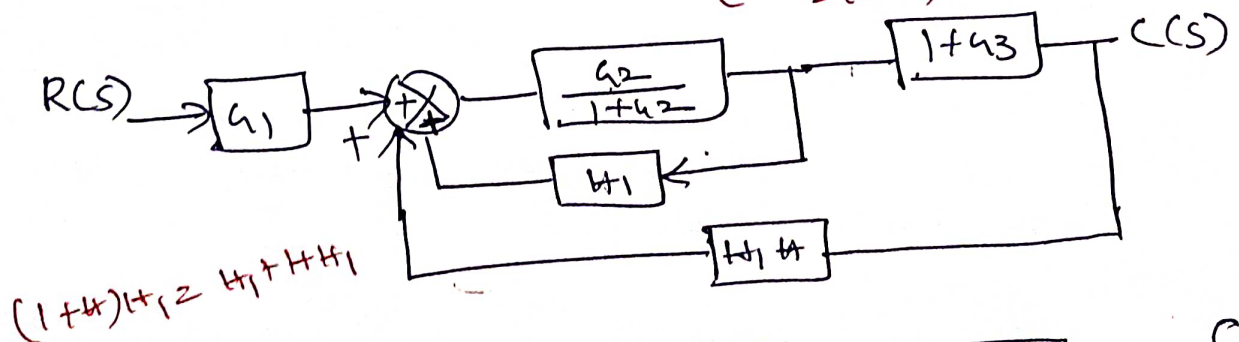
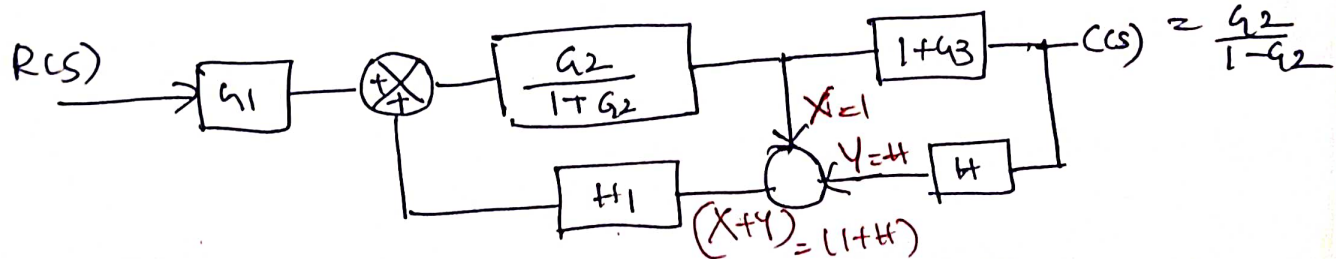
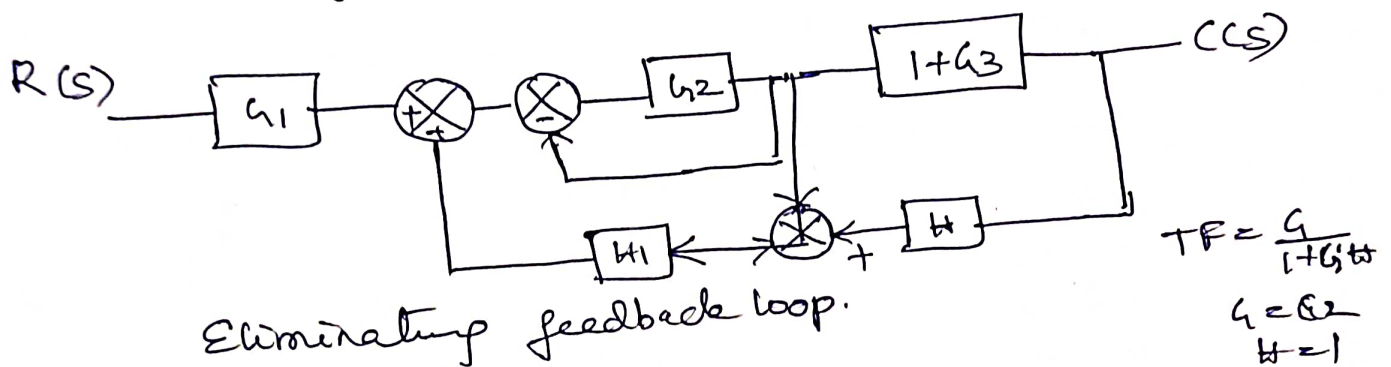


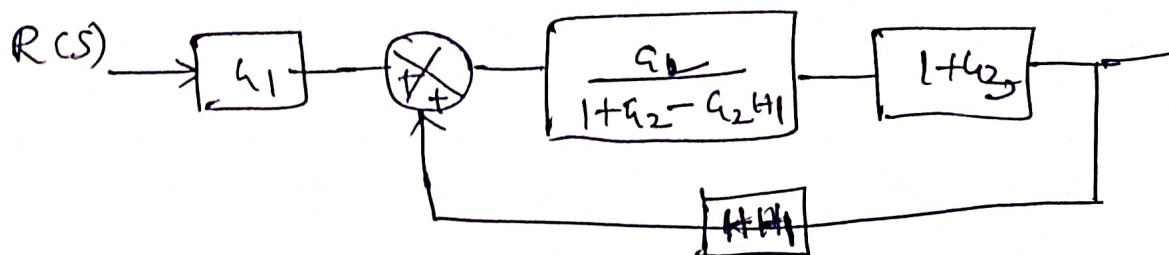
- ① Obtain the transfer function for the block diagram shown in Fig. using block diagram reduction technique



By observing the fig, splitting summing point & combining blocks in parallel.



Eliminating minor feedback loop



$$TF = \frac{G_2(1+G_2)}{1 - \frac{G_2}{1+G_2} \times H_1} = \frac{G_1 / \cancel{1+G_2}}{\frac{1+G_2-G_2H_1}{1+G_2}}$$

$$= \frac{G_2}{1+G_2-G_2H_1}$$

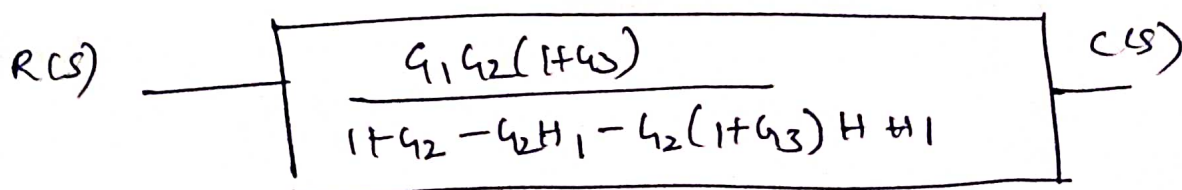
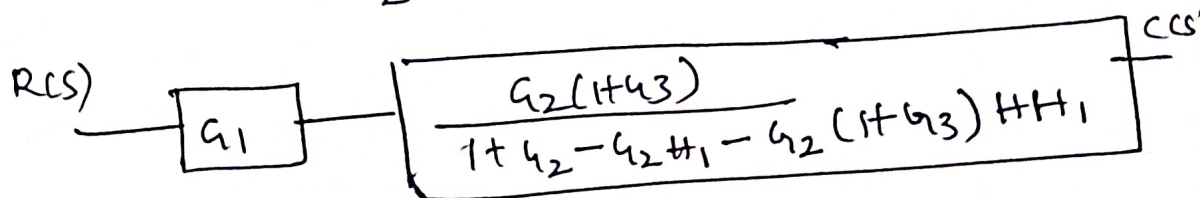
Again eliminating feedback loop

$$TF = \frac{G_2(1+G_2)}{1+G_2-G_2H_1}$$

$$= \frac{G_2(1+G_2)}{1 - \frac{G_2(1+G_2)}{1+G_2-G_2H_1} \times H_1 H_1}$$

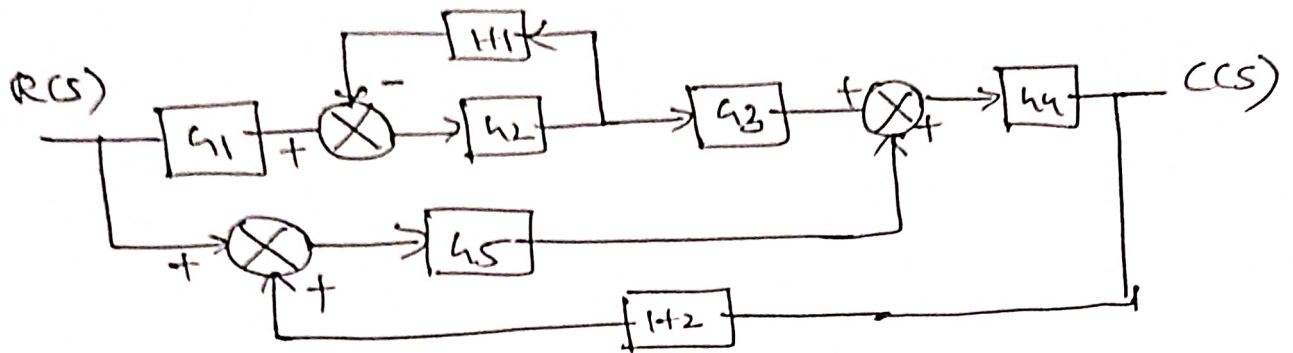
$$= \frac{G_2(1+G_2)}{1+G_2-G_2H_1 - G_2(1+G_2)H_1 H_1}$$

$$= \frac{G_2(1+G_2)}{1+G_2-G_2H_1 - G_2(1+G_2)H_1 H_1}$$

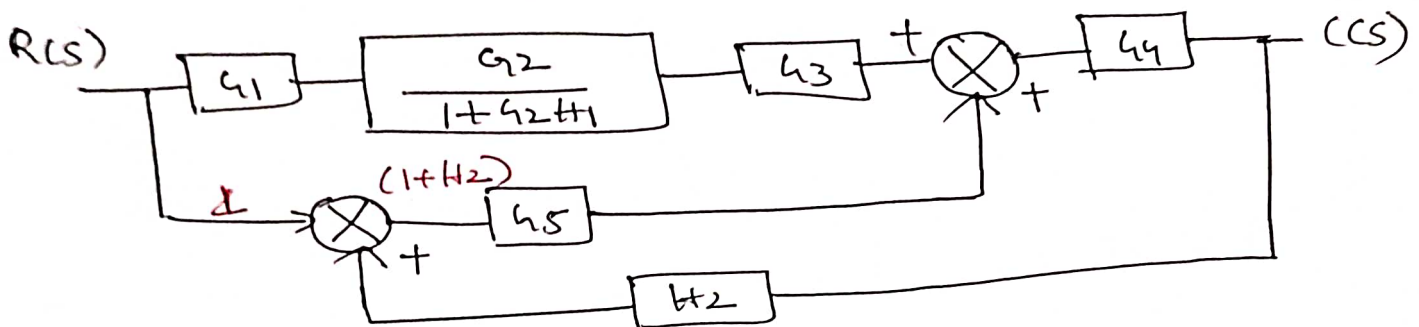


$$\frac{C(s)}{R(s)} = \frac{G_1 G_2 (1+G_3)}{1+G_2-G_2H_1-G_2(1+G_3)H_1 H_1}$$

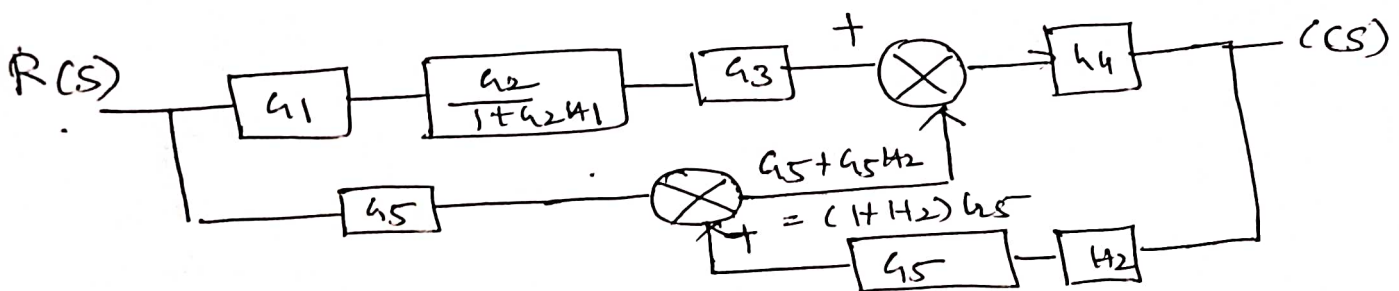
Find the overall transfer function $\frac{C(s)}{R(s)}$ using block diagram reduction technique



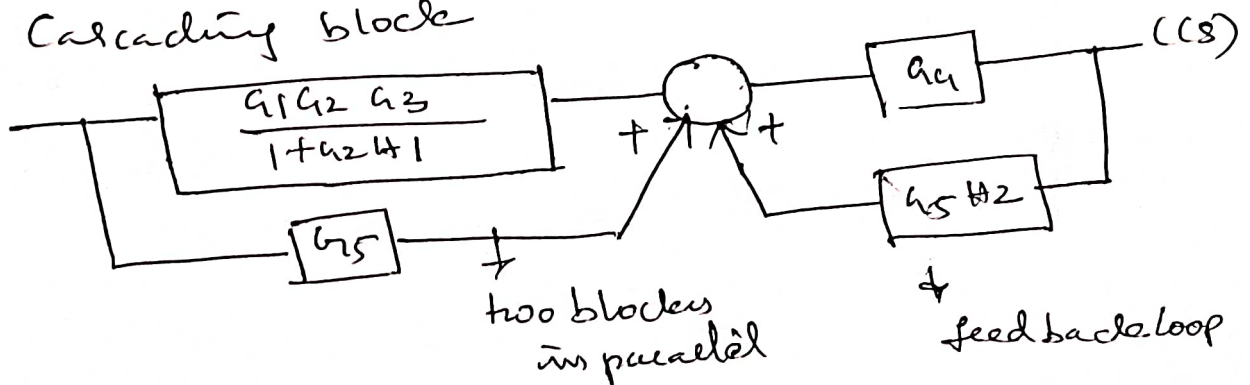
Eliminate feed back loop

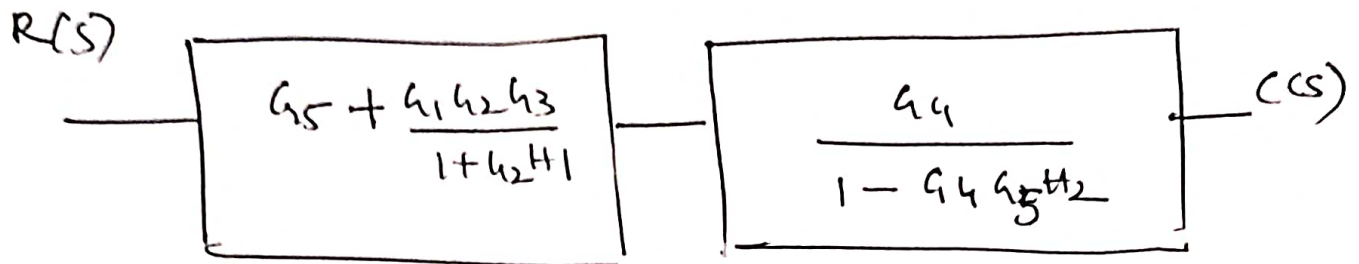
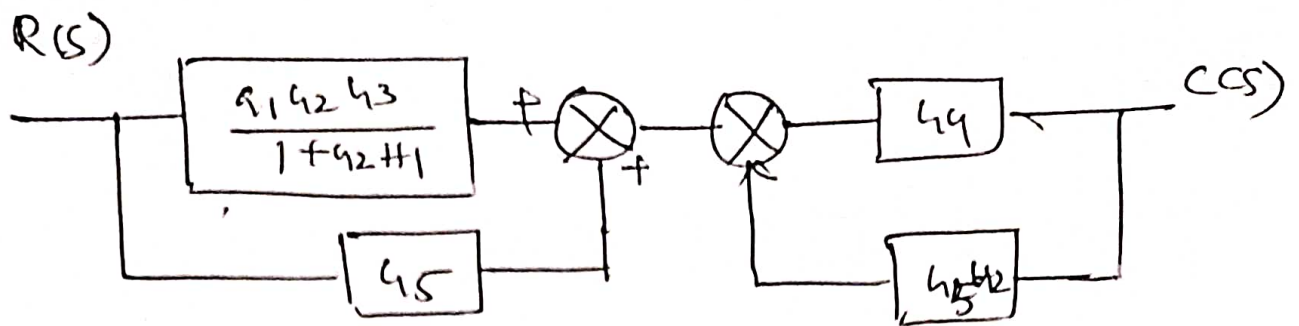


Shifting the summing point after G_2

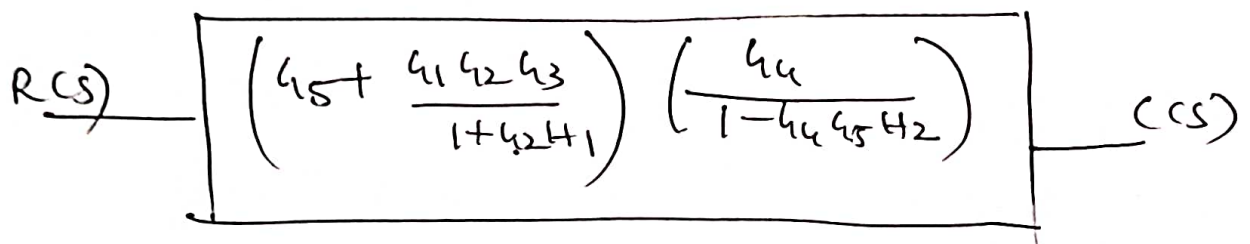


Calculating block





Two blocks in cascade or series



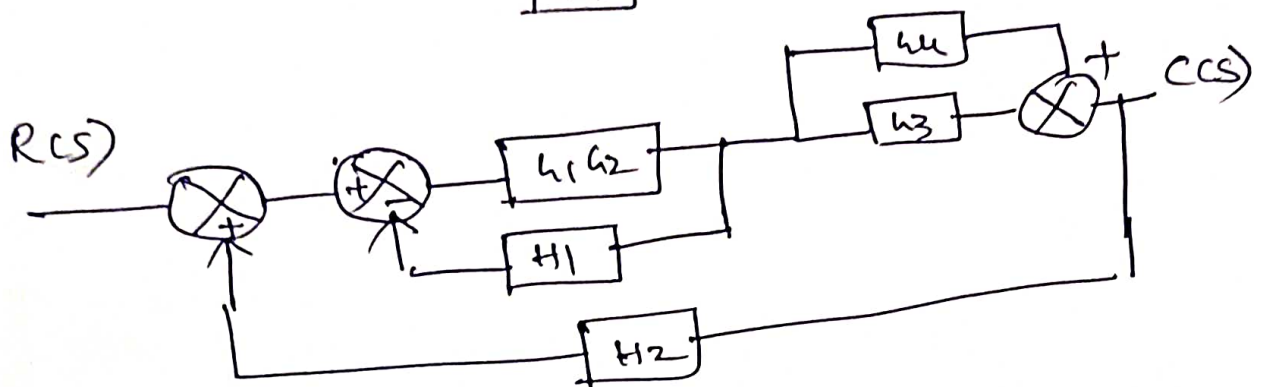
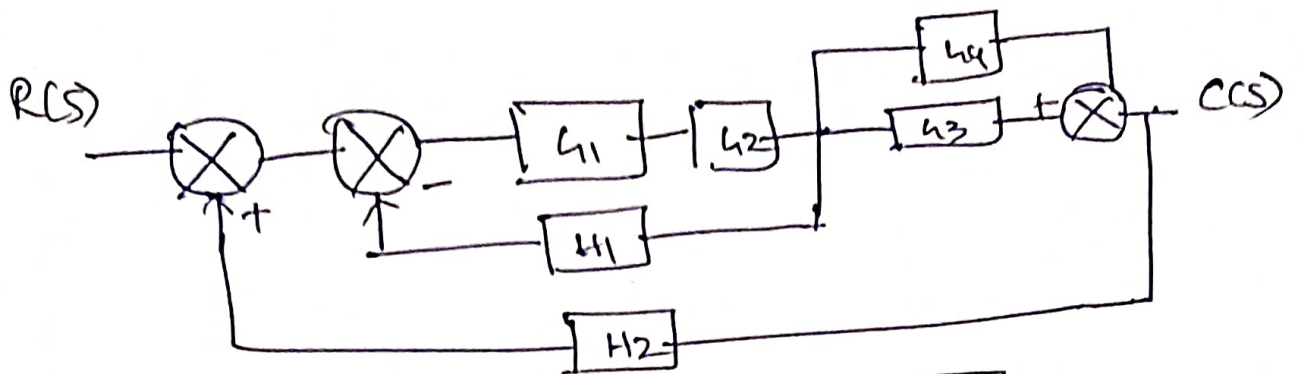
$$\frac{CCS}{R(s)} = \left(\frac{G_5(1 + G_2H_1) + G_1G_2G_3}{1 + G_2H_1} \right) \left(\frac{G_4}{1 - G_4G_5H_2} \right)$$

$$= \frac{(G_5 + G_5G_2H_1 + G_1G_2G_3) G_4}{(1 + G_2H_1)(1 - G_4G_5H_2)}$$

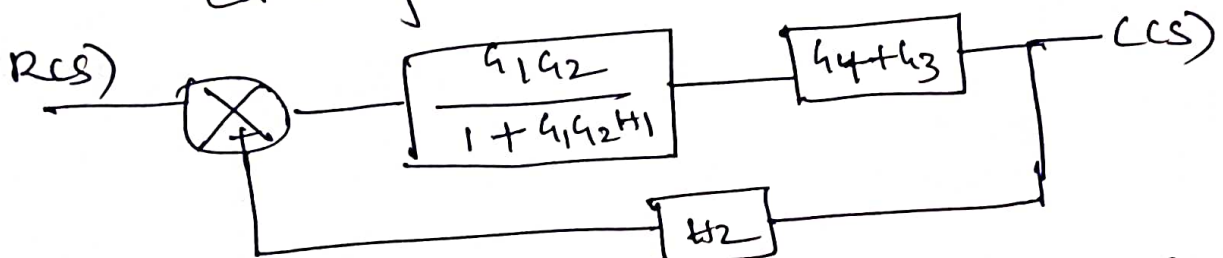
$$\frac{CCS}{R(s)} = \frac{G_4G_5 + G_4G_5G_2H_1 + G_1G_2G_3G_4}{1 - G_4G_5H_2 + G_2H_1 - G_2G_5G_4H_1H_2}$$

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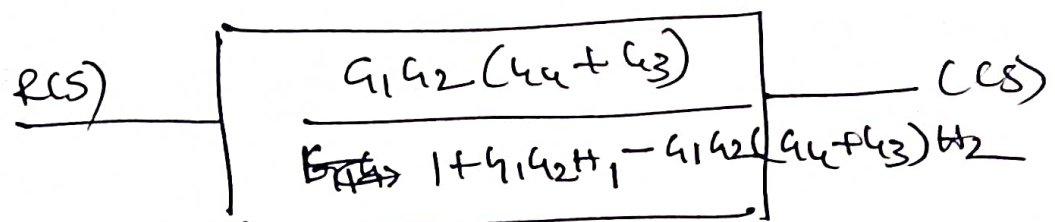
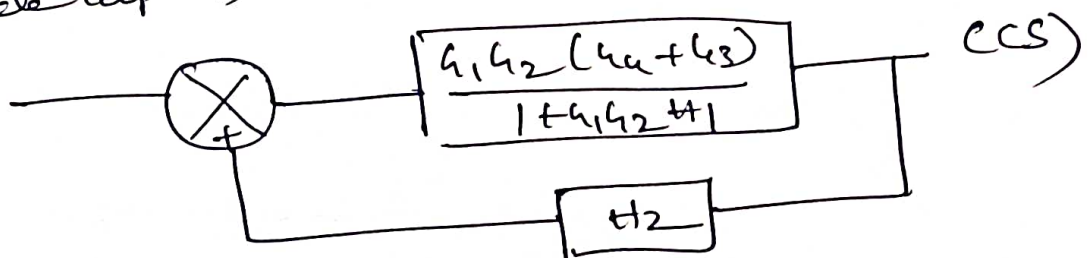
Determine $C(s)/R(s)$ using block diagram reduction technique



Eliminating feedback loop & combining blocks G_1 & G_2 .

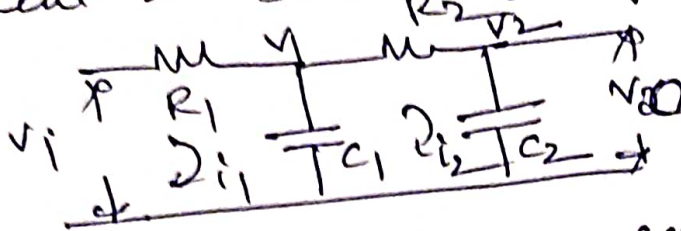


Calculating blocks & eliminating feed back loop is



$$\frac{C(s)}{R(s)} = \frac{G_1 G_2 (G_4 + G_3)}{1 + G_1 G_2 H_1 - G_1 G_2 (G_4 + G_3) H_2}$$

Represent in block diagram form & find overall transfer function

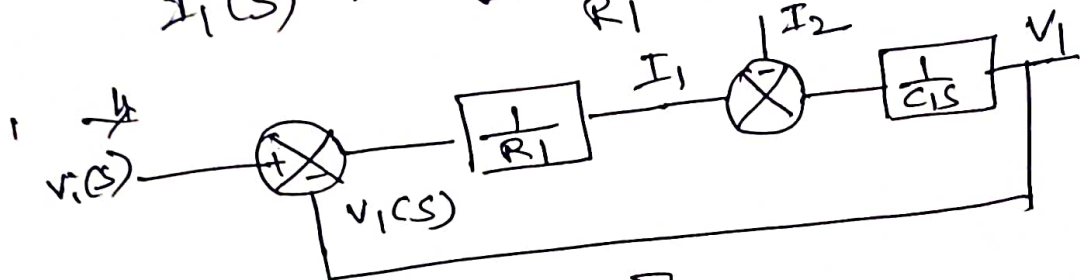


$$V_i(t) = i_1(t) R_1 + \frac{1}{C_1} \int (i_1(t) - i_2(t)) dt$$

$$V_i(s) = \left(R_1 + \frac{1}{C_1 s} \right) I_1(s) - \frac{1}{C_1 s} I_2(s)$$

$$\text{or } V_1(s) = R_1 I_1(s) + V_i(s)$$

$$I_1(s) = \frac{V_i(s) - V_1(s)}{R_1}$$



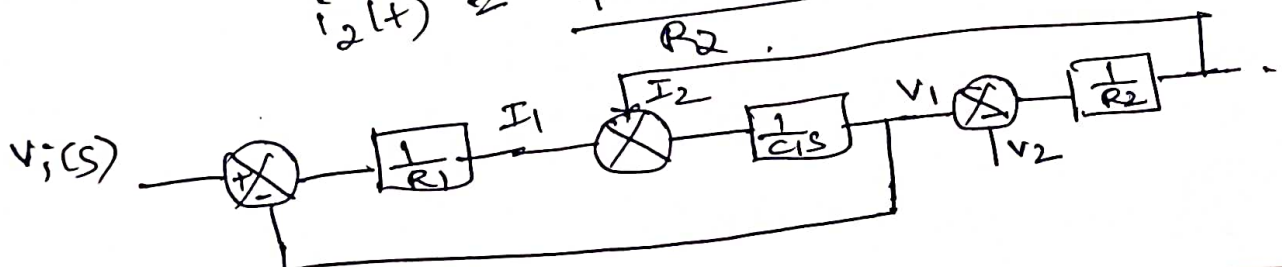
$$V_1(s) = \frac{1}{C_1 s} [I_1(s) - I_2(s)]$$

Apply KVL to loop 2

$$0 = \frac{1}{C_1} \int i_2(t) - i_1(t) dt + R_2 \dot{i}_2(t) + V_2(t)$$

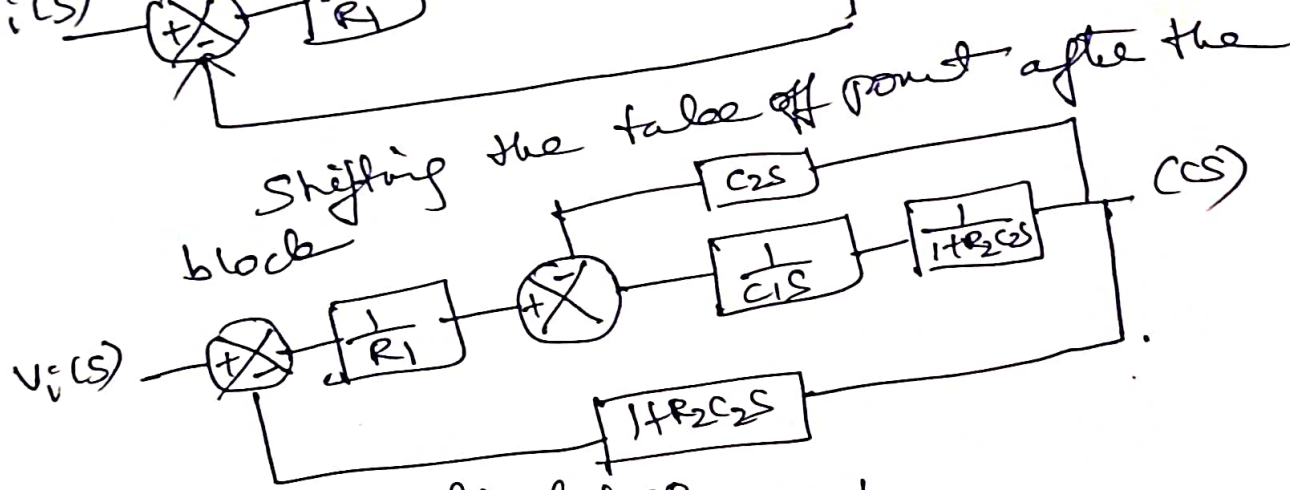
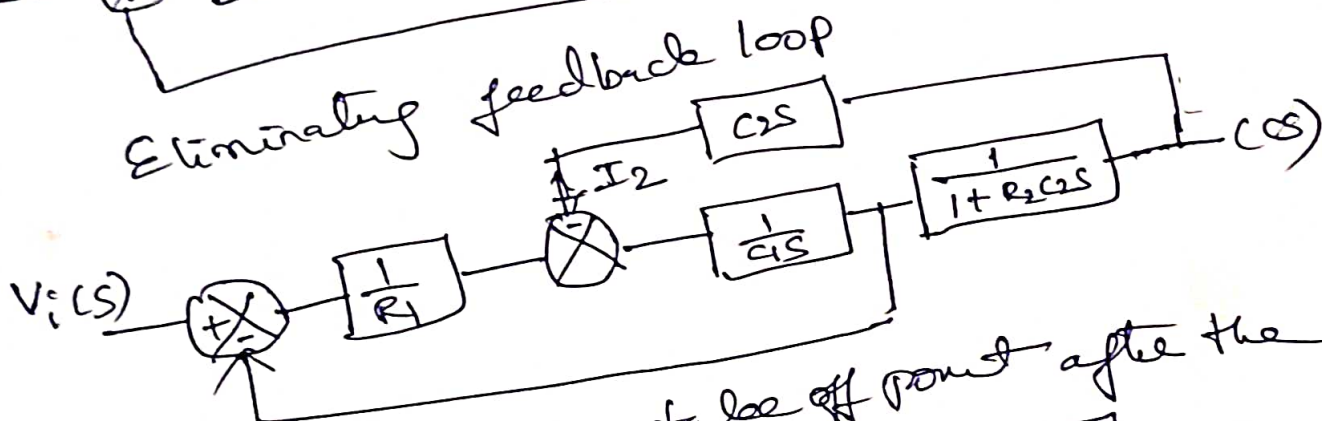
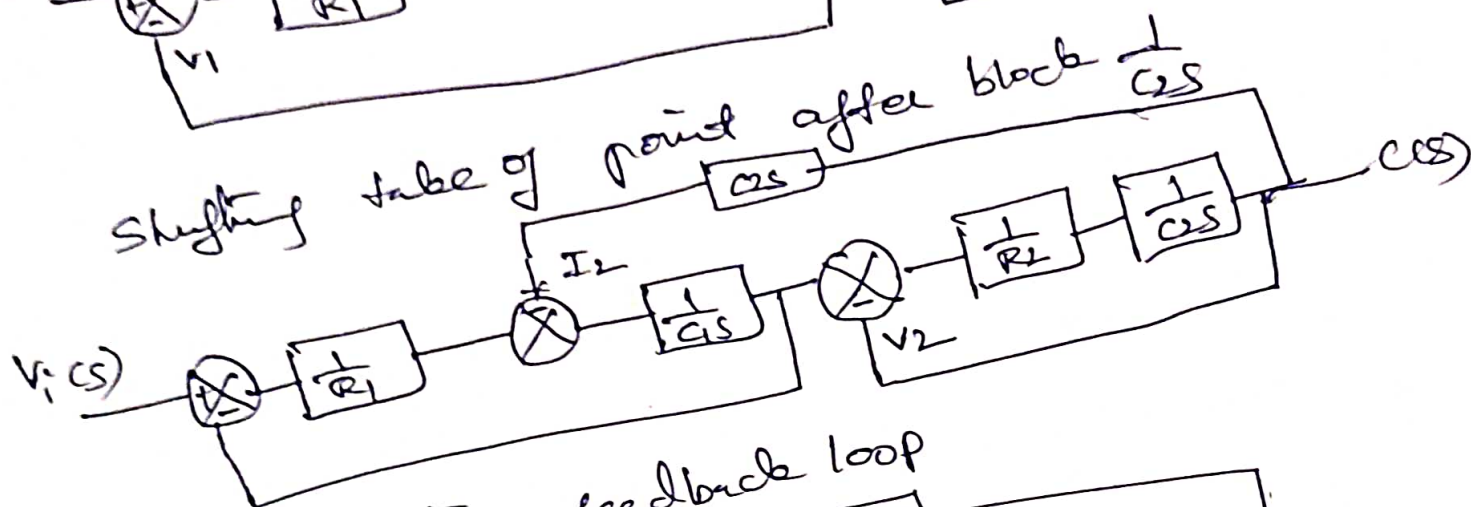
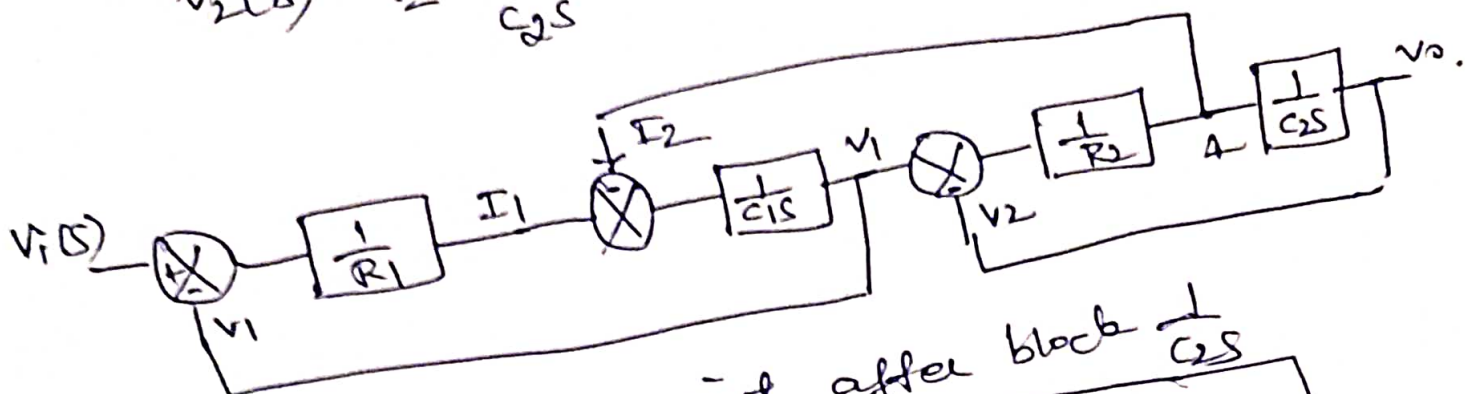
$$= -V_1(t) + R_2 \dot{i}_2(t) + V_2(t)$$

$$i_2(t) = \frac{V_1(t) - V_2(t)}{R_2}$$



$$v_2(t) = \frac{1}{C_2} \int i_2 dt$$

$$V_2(s) = \frac{1}{C_2 s} I_2(s)$$

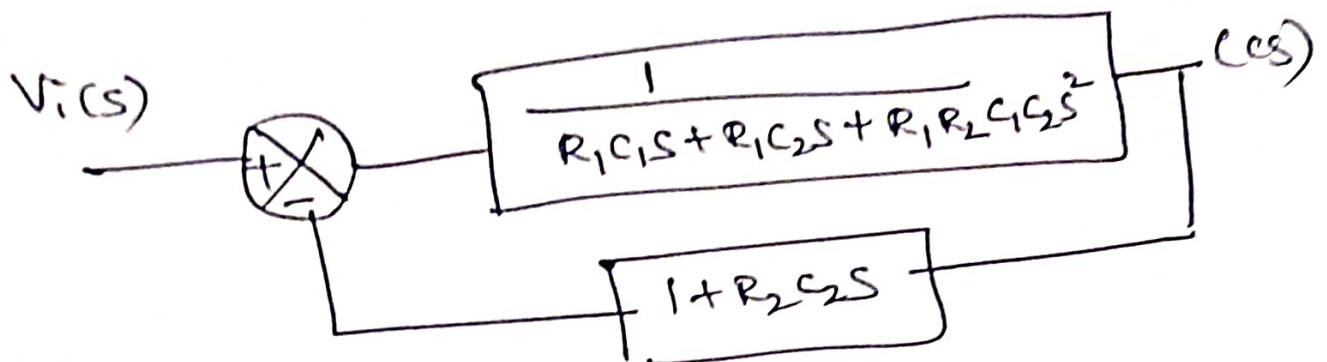
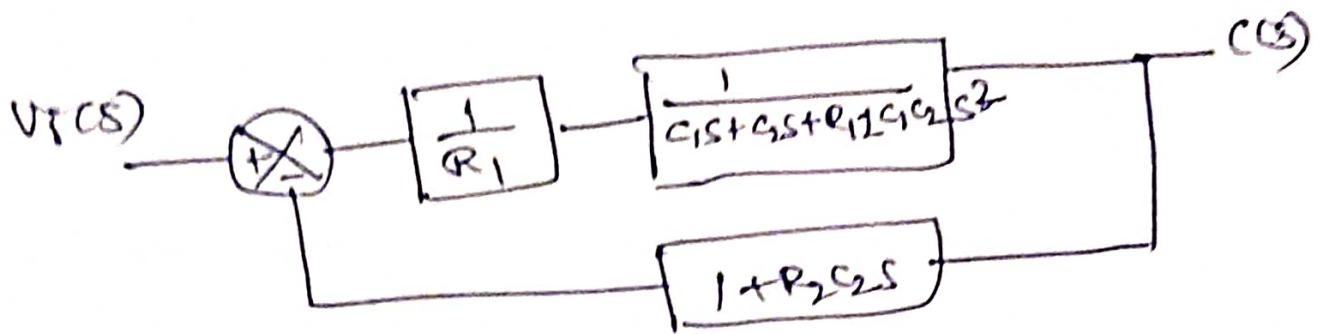


Eliminating feedback loop.

$$TF = \frac{1}{1 + 1 \cdot s} = \frac{\frac{1}{C_2 s (1 + R_2 C_2 s)}}{1 + \frac{C_2 s}{C_1 s + R_2 C_1 C_2 s^2}}$$

$$= \frac{1}{C_1 s + R_2 C_1 C_2 s^2 + C_2 s}$$

Cascading blocks



$$TF = \frac{1}{1 + 44}$$

$$= \frac{\frac{1}{R_1C_1s + R_1C_2s + R_1R_2C_1C_2s^2}}{1 + \frac{1 + R_2C_2s}{R_1C_1s + R_1C_2s + R_1R_2C_1C_2s^2}}$$

$$TF = \frac{1}{R_1C_1s + R_1C_2s + R_1R_2C_1C_2s^2 + R_2C_2s + 1}$$