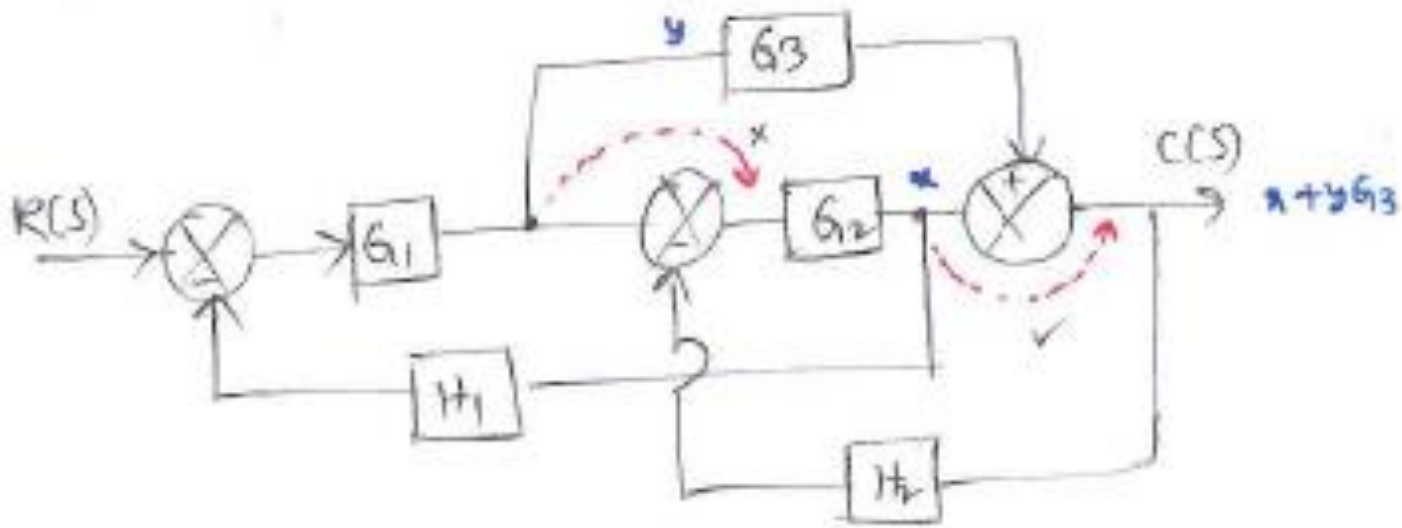
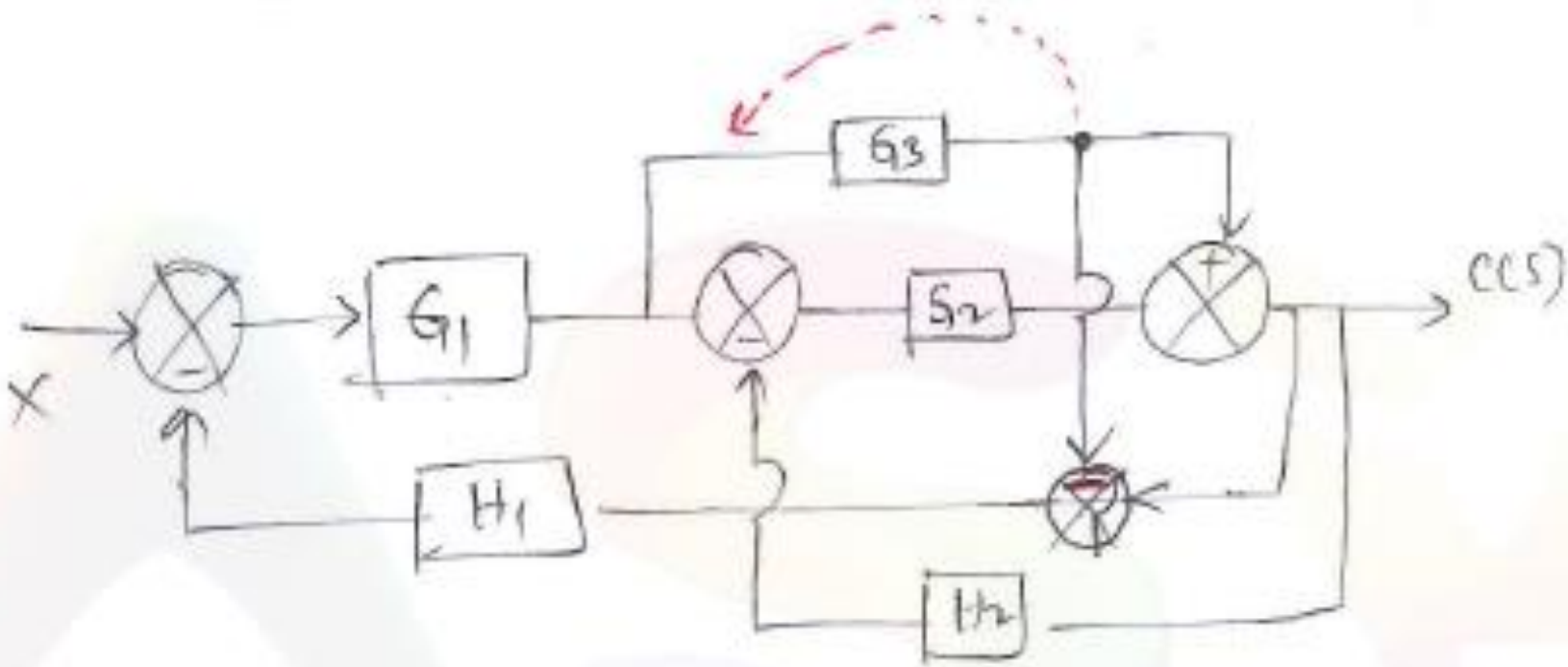
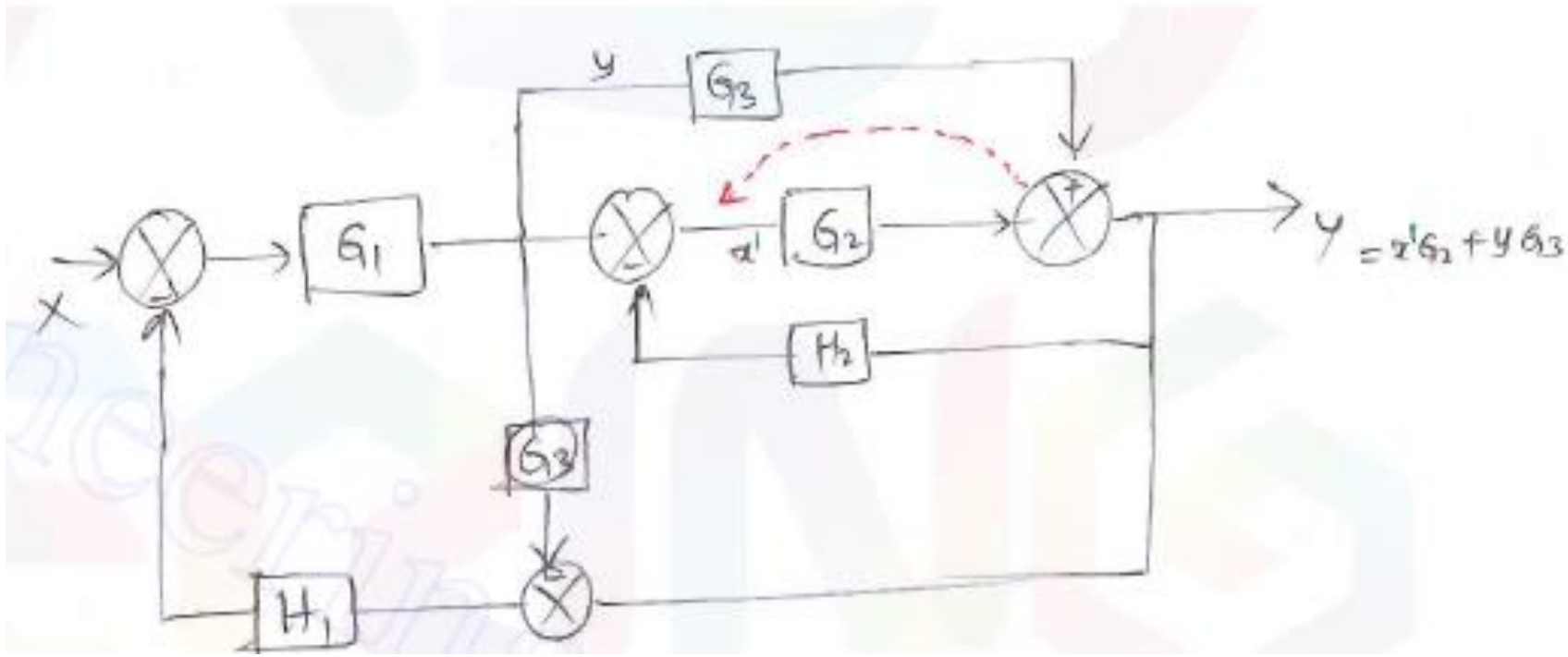
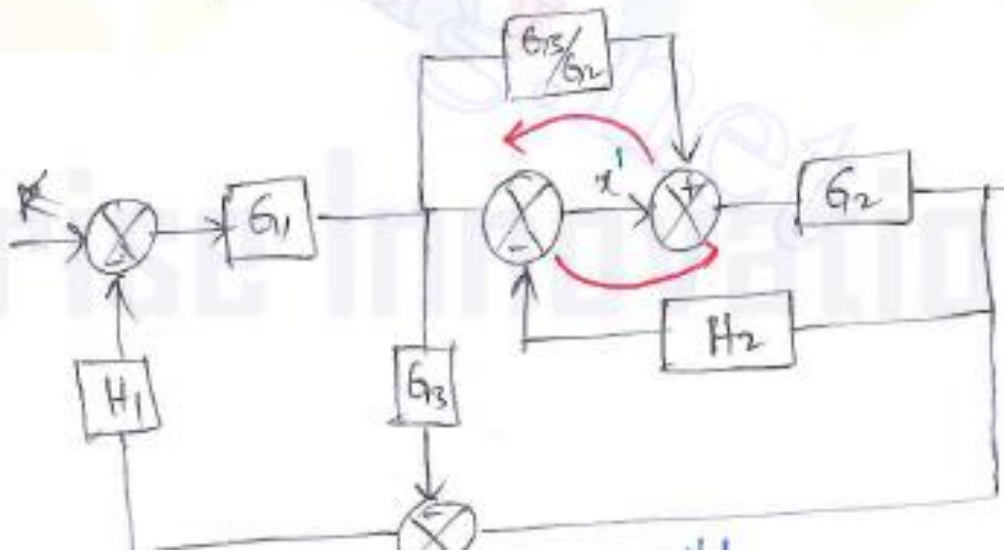

y
G3
x
C(S)
x+yG3
R(S)
G1
G2
H1
H2


G3
G1
G2
C(s)
X
H1
H2

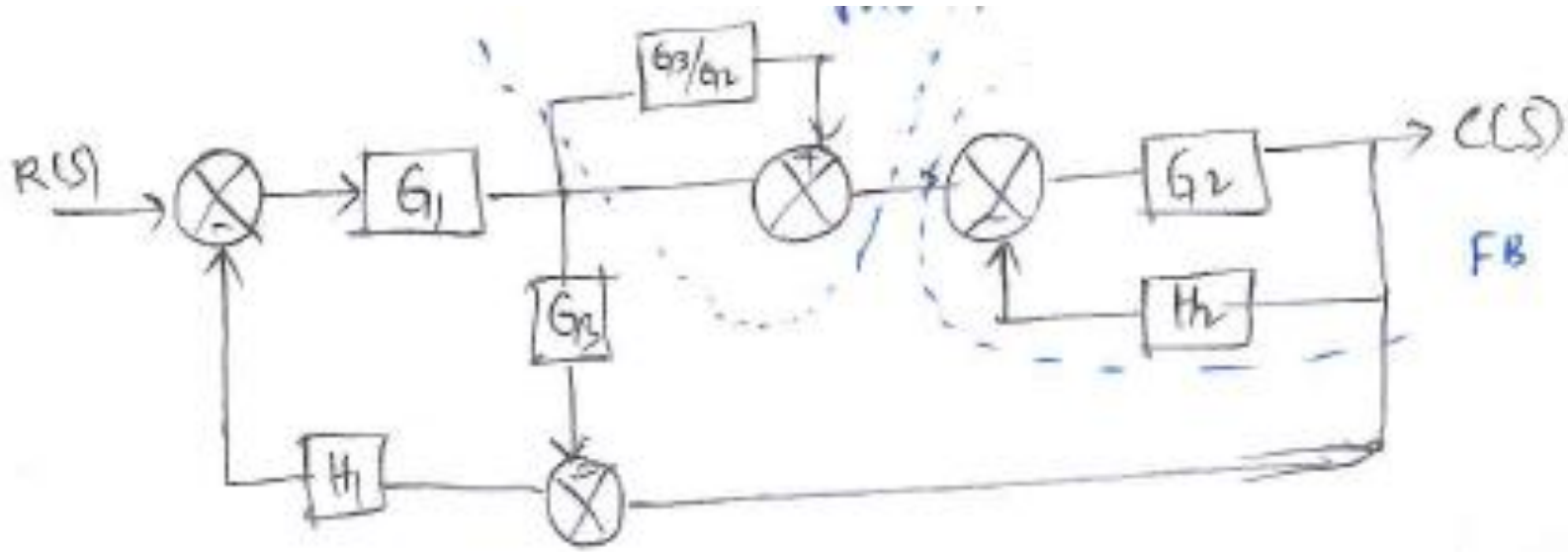

y
G3
G1
G2
x'
H2
G3
H1
X
+
-
-
+
Y = x'G2 + y G3



$$Y = x'G_2 + YG_3$$

$$= \left(x' + Y\frac{G_3}{G_2}\right)G_2$$

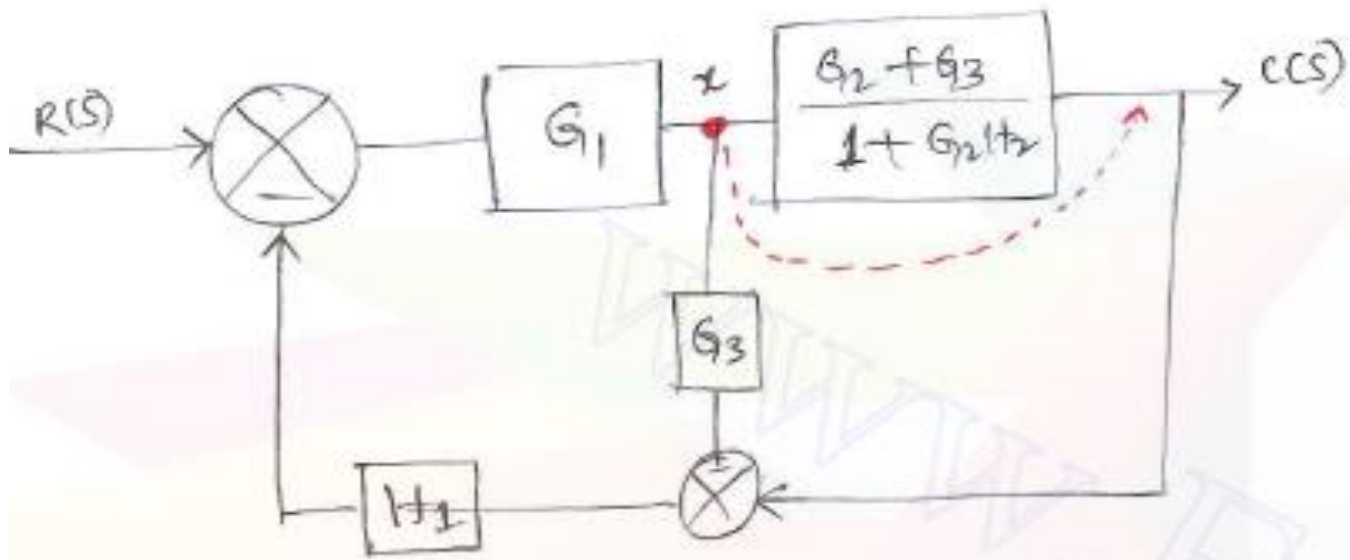
$$= x'G_2 + Y\,G_3 \times \frac{G_2}{G_2}$$

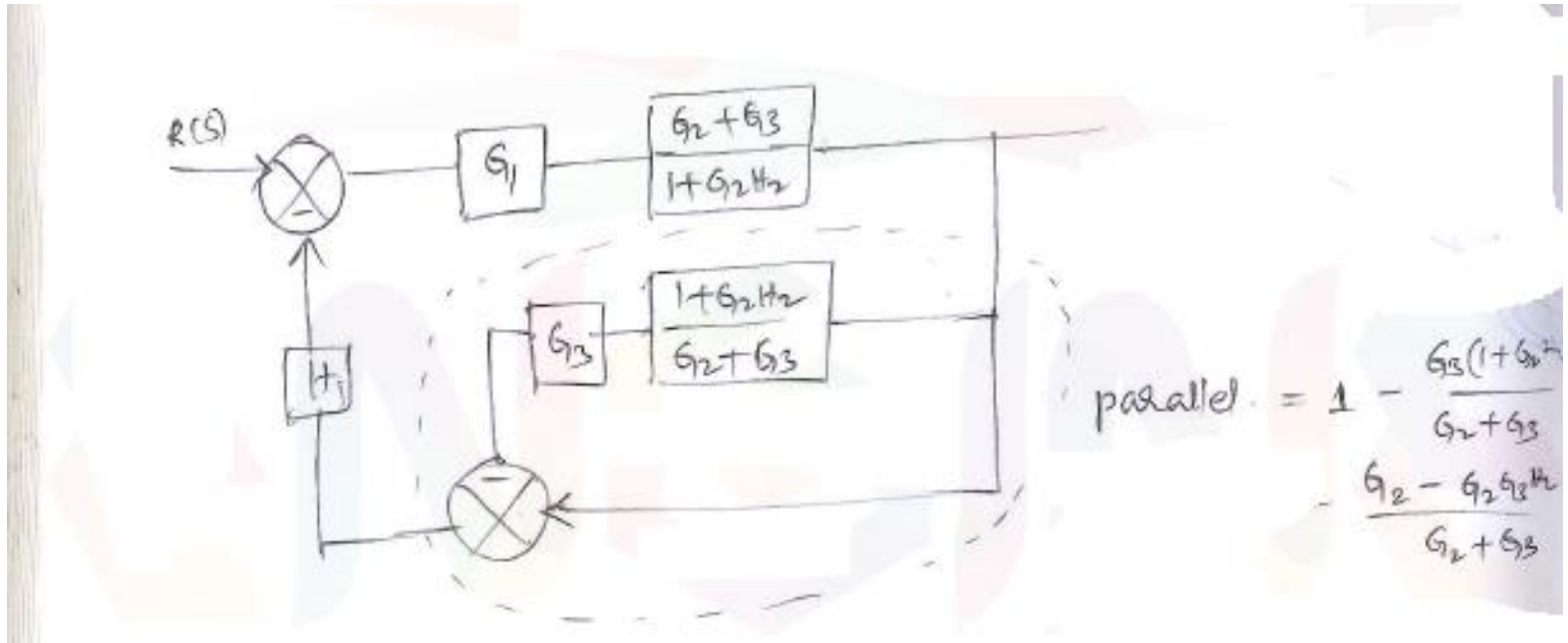

R(s)
G1
G3/G2
G3
H1
G2
H2
C(s)
FB

$$\text{parallel} = 1 + \frac{G_3}{G_2} = \frac{G_2 + G_3}{G_2}$$

$$FB = \frac{G_2}{1 + G_2 H_2}$$

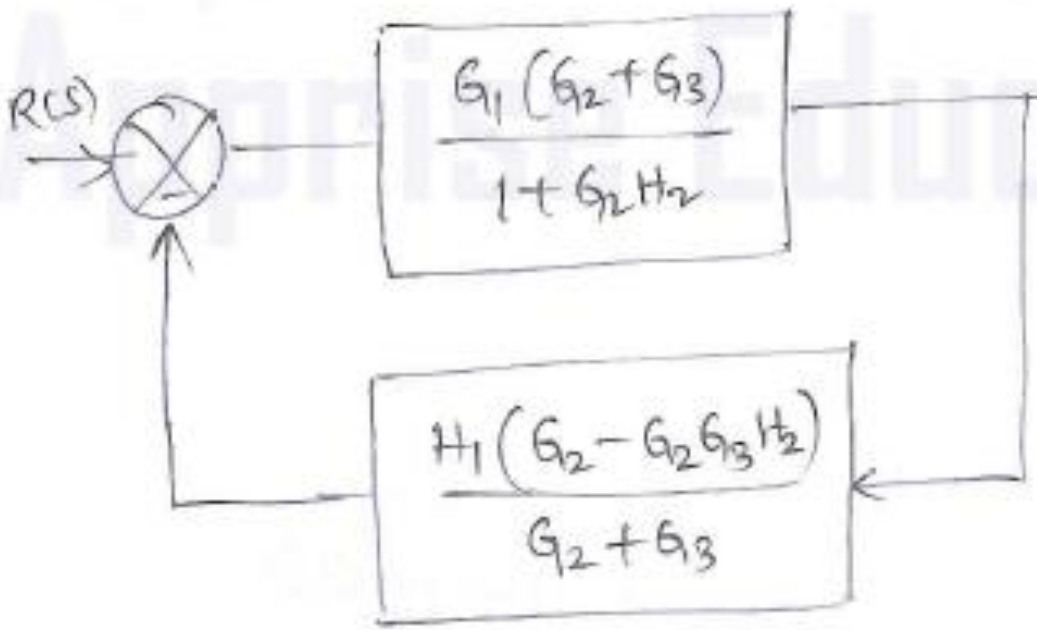
$$\text{series} = (FB) \cdot \text{parallel} = \frac{G_2 + G_3}{1 + G_2 H_2}$$





$$\text{parallel} = 1 - \frac{G_3(1+G_2H_2)}{G_2+G_3}$$

$$\frac{G_2 - G_2G_3H_2}{G_2+G_3}$$

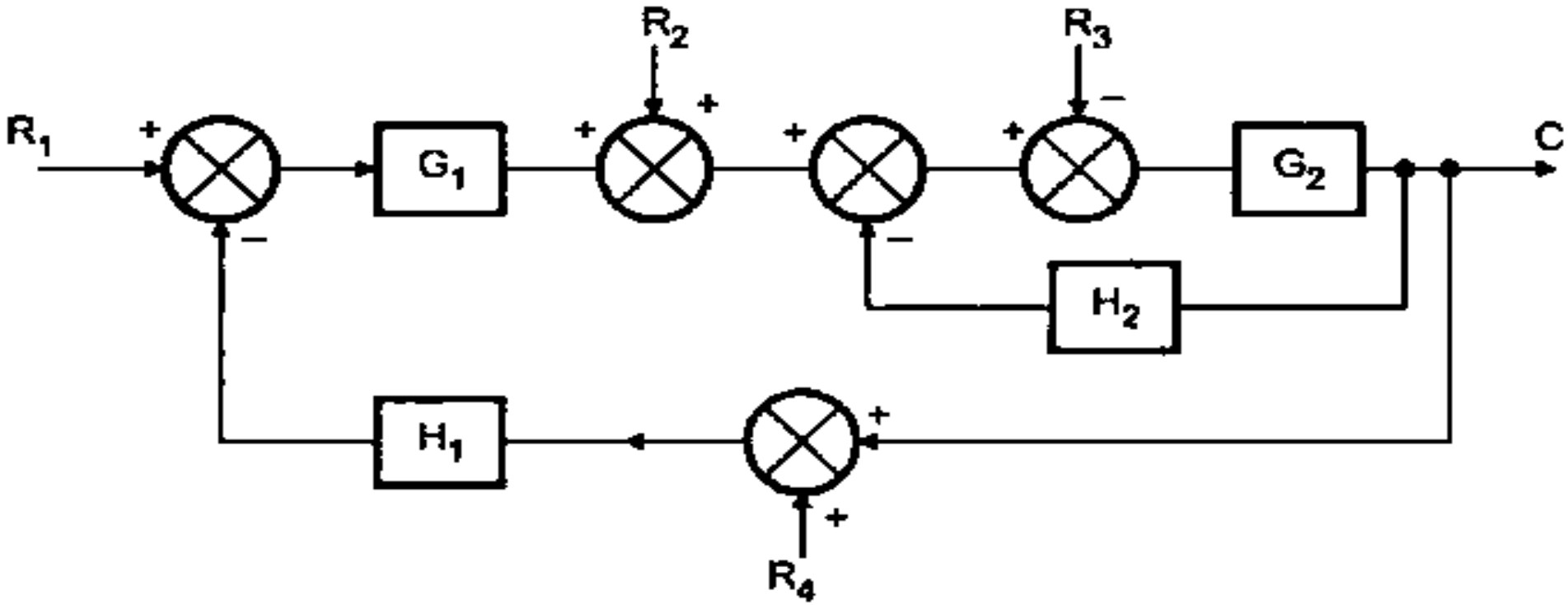


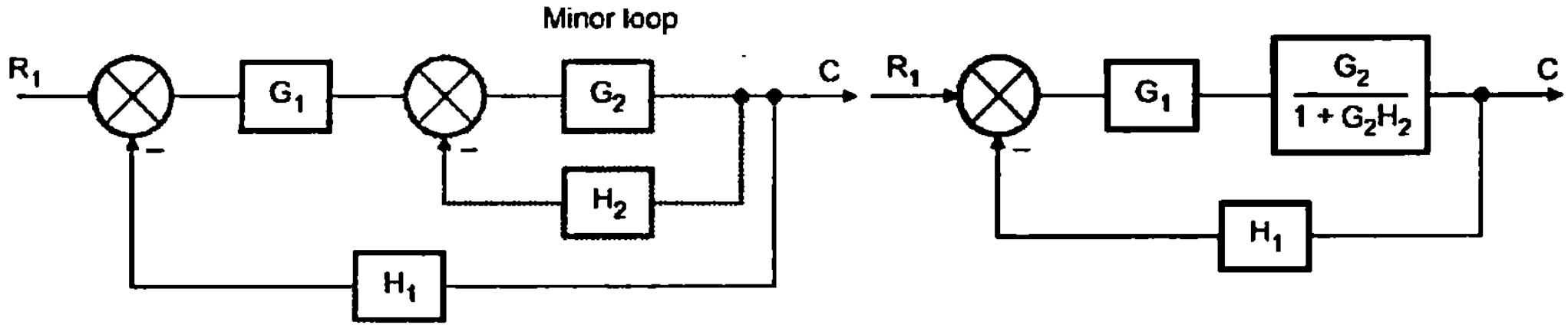
$$G(s) = \frac{G_1(G_2+G_3)}{1+G_2H_2}$$

$$H(s) = \frac{H_1G_2(1-G_3H_2)}{G_2+G_3}$$

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

Example *Find C using block diagram reduction techniques*



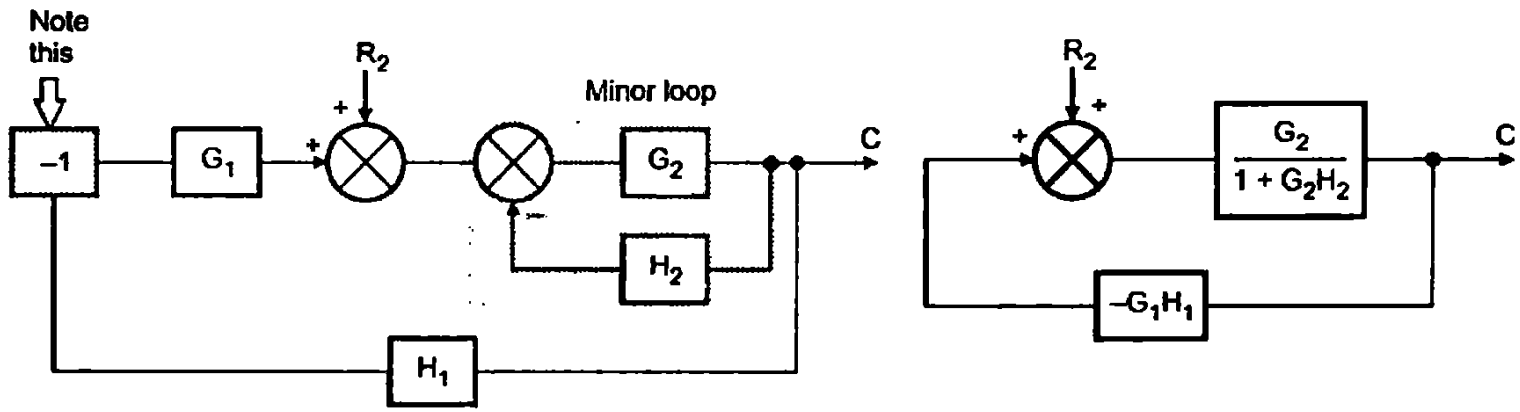


$$\therefore \quad \frac{C}{R_1} = \frac{\dfrac{G_1G_2}{1+G_2H_2}}{1+\dfrac{G_1G_2H_1}{1+G_2H_2}} = \frac{G_1G_2}{1+G_2H_2+G_1G_2H_1}$$

$$\therefore \quad \boxed{C = \frac{G_1G_2R_1}{1+G_2H_2+G_1G_2H_1}}$$

... due to R_1

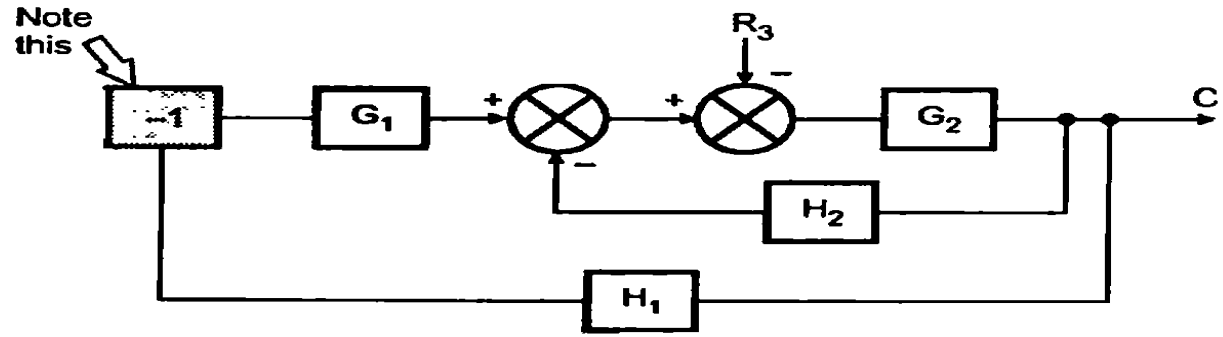
Consider R_2 alone, with $R_3 = R_1 = R_4 = 0$



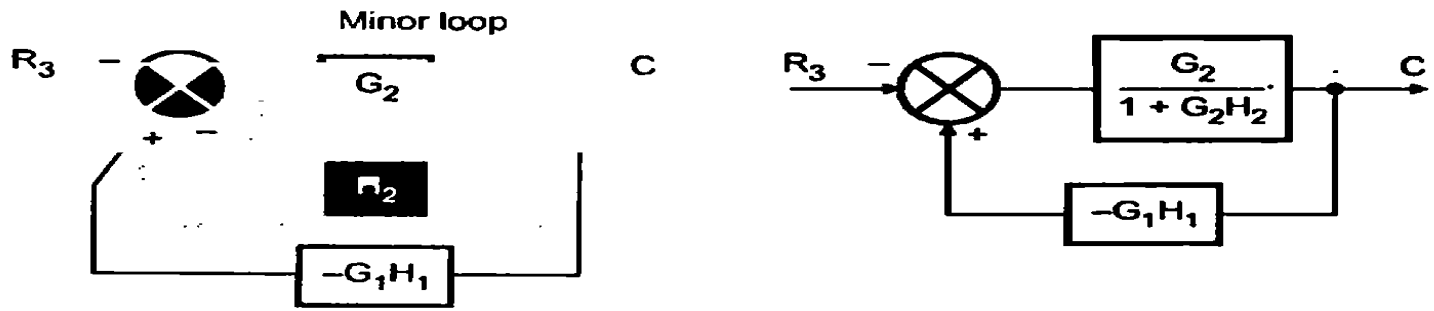
$$\therefore \quad \frac{C}{R_2} = \frac{\dfrac{G_2}{1+G_2H_2}}{1-\left(\dfrac{G_2}{1+G_2H_2}\right)(-G_1H_1)}$$

$$\therefore \quad \boxed{C = \frac{G_2R_2}{1+G_2H_2+G_1G_2H_1}}$$

Consider R_3 alone, $R_1 = R_2 = R_4 = 0$



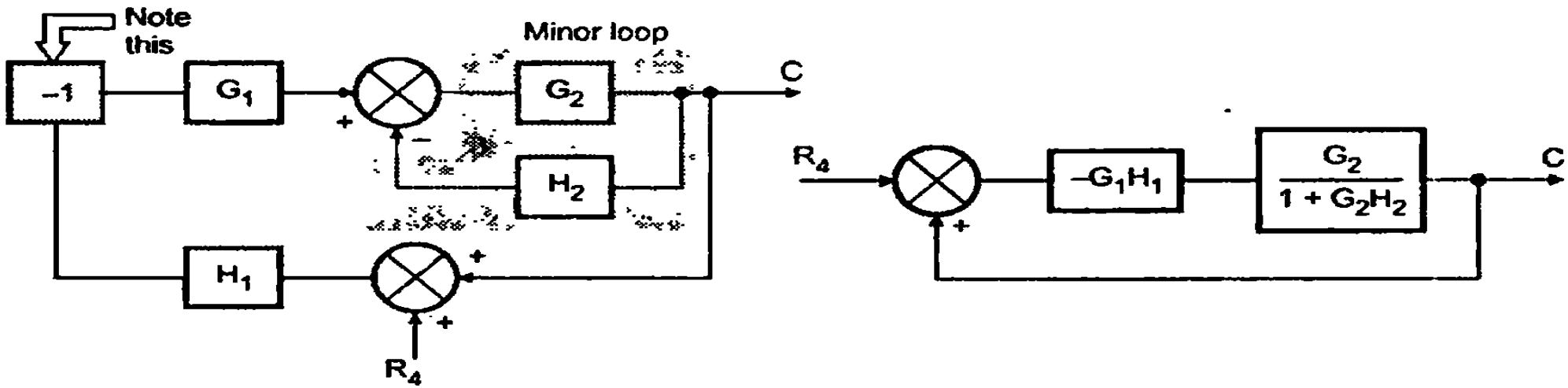
Combining two summing points we get,



$$\therefore \quad \frac{C}{-R_3} = \frac{\dfrac{G_2}{1+G_2H_2}}{1-\left(\dfrac{G_2}{1+G_2H_2}\right)(-G_1H_1)} = \frac{G_2}{1+G_2H_2+G_1G_2H_1}$$

$$\therefore \quad \boxed{C = \frac{-R_3G_2}{1+G_2H_2+G_1G_2H_1}}$$

Consider R_1 alone, with $R_1 = R_2 = R_3 = 0$.



$$\therefore \quad \frac{C}{R_4} = \frac{\dfrac{-G_1G_2H_1}{1+G_2H_2}}{1-(-G_1H_1)\left(\dfrac{G_2}{1+G_2H_2}\right)} = \frac{-G_1G_2H_1}{1+G_2H_2+G_1G_2H_1}$$

$$\therefore \quad \boxed{C = \frac{-G_1G_2H_1R_4}{1+G_2H_2+G_1G_2H_1}}$$

Combining all the values of C, we get

$$\boxed{C = \frac{G_1G_2R_1+G_2(R_2-R_3)-G_1G_2H_1R_4}{1+G_2H_2+G_1G_2H_1}}$$