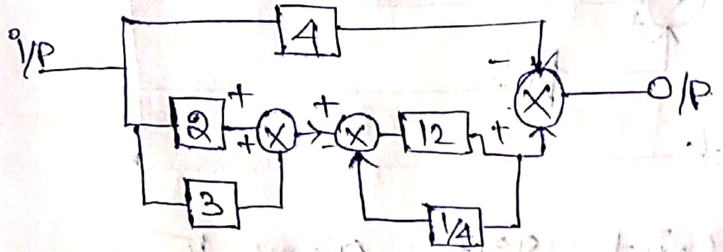
Control System Engineering

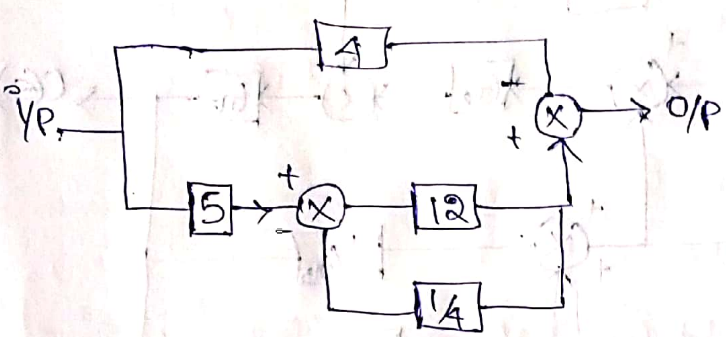
Assignment - 1

E. Nithish Kumar
2018504038

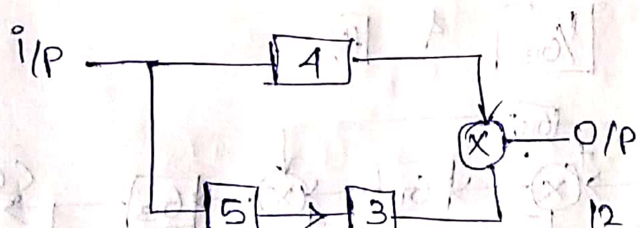
• To determine the gain



i, Reduce parallel block

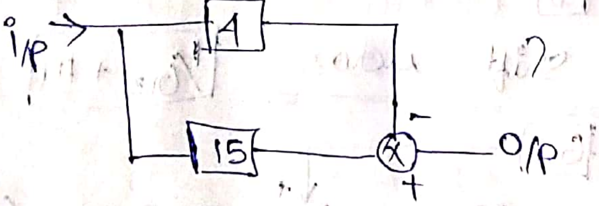


ii, Reduce Negative feedback



$$\frac{12}{1+12\left(\frac{1}{4}\right)} = 3$$

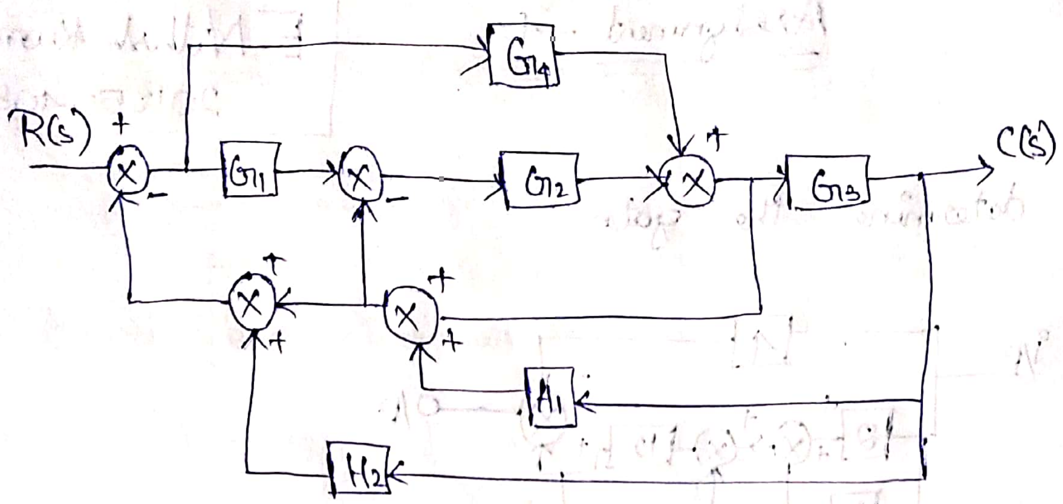
iii, Reduce series block



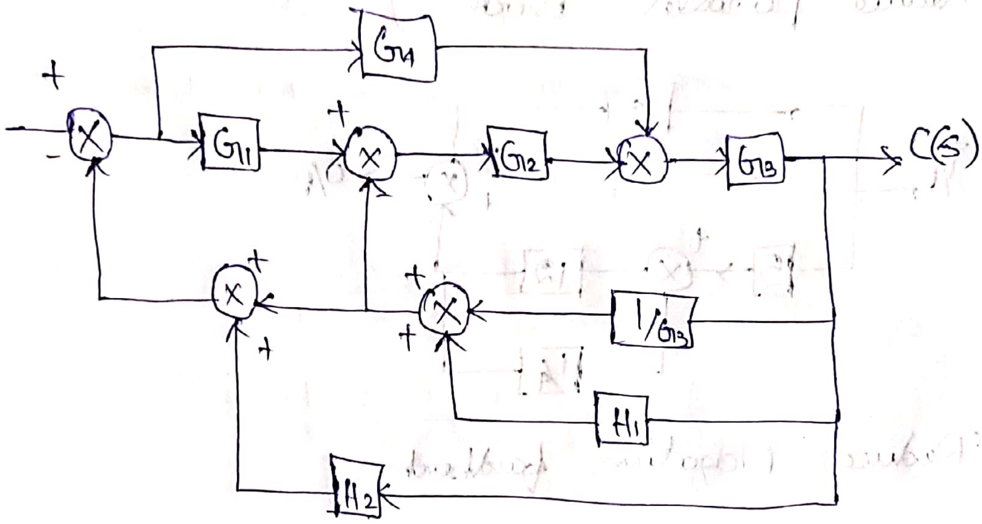
iv, Reduce Parallel block

Overall Gain of System = 11

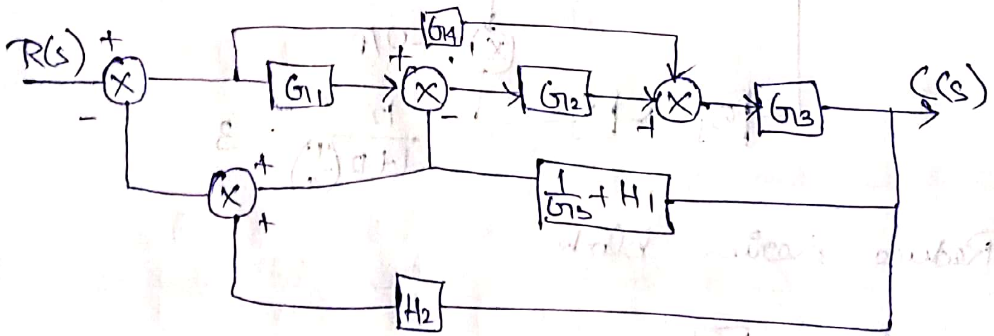
Q. To reduce block diagram



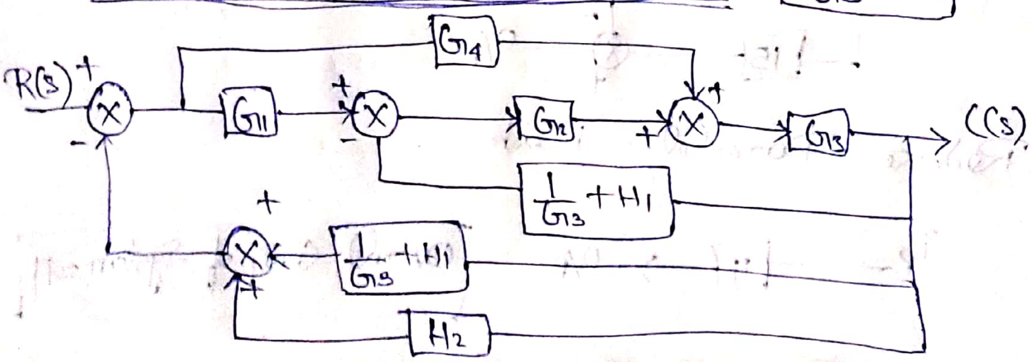
i, Take off point shift across G_3



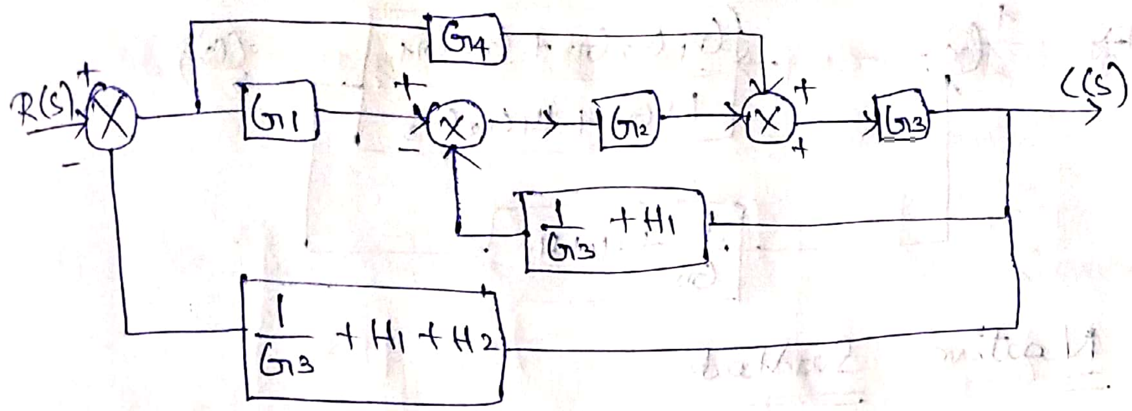
ii, parallel block $1/G_3$ & H_1.



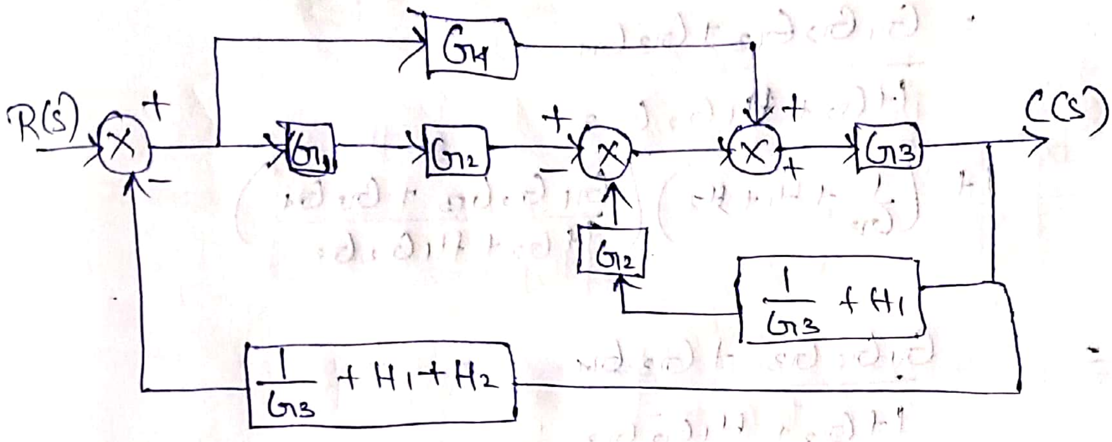
iii, Take-off point shift across $1/G_3 + H_1$



iv, Parallel block Reduction $\boxed{1/G_3 + H_1}$ + $\boxed{H_2}$

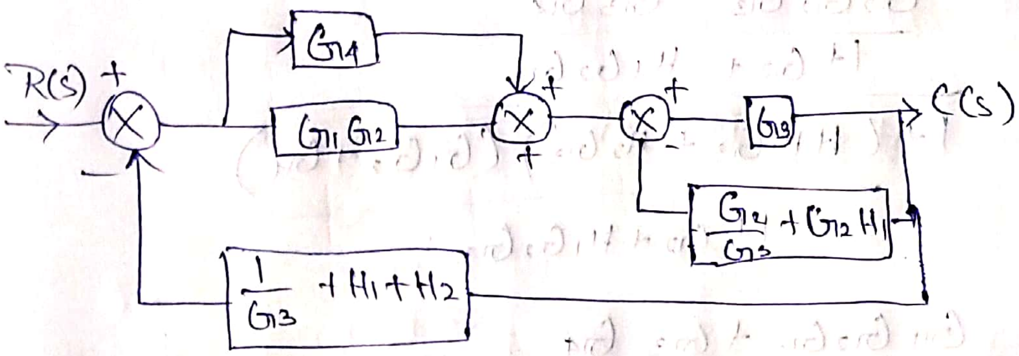


V, Summing point Shift Across $\boxed{G_2}$

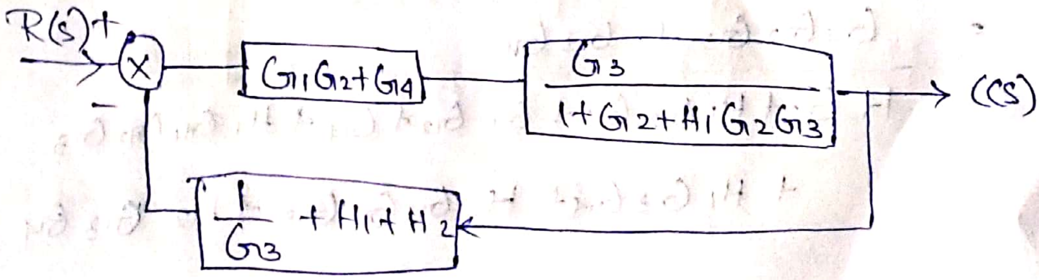


Vi, (Vii) Series $\boxed{G_2}$ and $\boxed{1/G_3 + H_1}$, $\boxed{G_1}$ and $\boxed{G_2}$

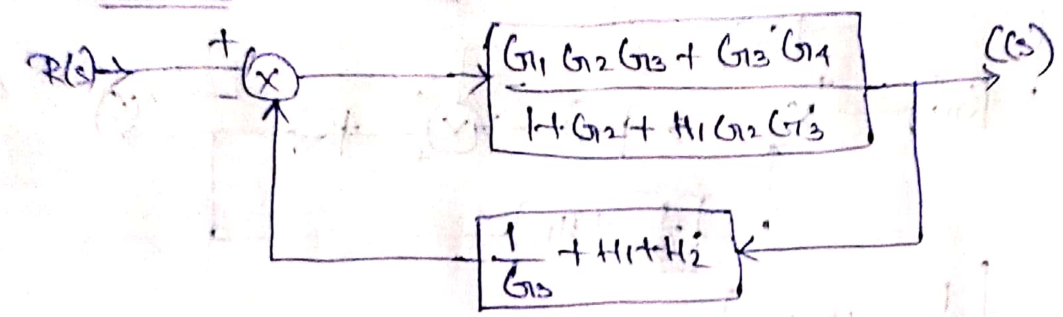
associativity of summing points



Viii, (ix) Negative feedback Parallel $\boxed{G_4}$ $\boxed{G_1 G_2}$



x, Series



xi, Negative feedback

Transfer function $= \frac{C(s)}{R(s)}$

$$= \frac{\dfrac{G_1 G_2 G_3 + G_3 G_4}{1+G_2+H_1 G_2 G_3}}{1+\left(\dfrac{1}{G_3}+H_1+H_2\right)\left(\dfrac{G_1 G_2 G_3 + G_3 G_4}{1+G_2+H_1 G_2 G_3}\right)}$$

$$= \frac{\dfrac{G_1 G_2 G_3 + G_3 G_4}{1+G_2+H_1 G_2 G_3}}{1+\left(\dfrac{1+H_1 G_3+H_2 G_3}{G_3}\right) G_3\left(\dfrac{G_1 G_2 + G_4}{1+G_2+H_1 G_2 G_3}\right)}$$

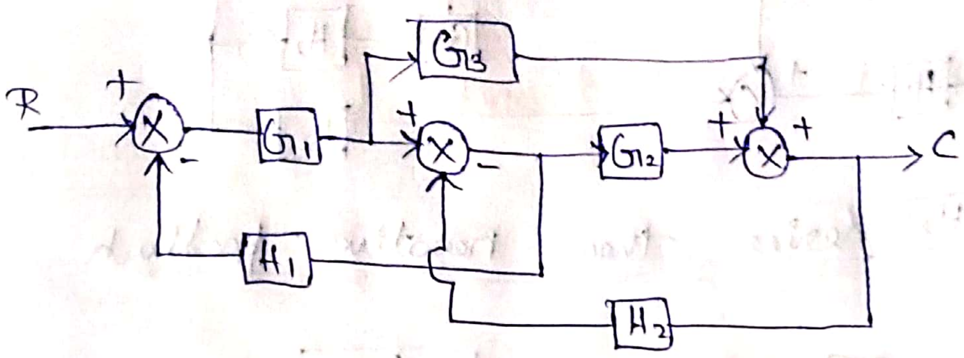
$$= \frac{\dfrac{G_1 G_2 G_3 + G_3 G_4}{1+G_2+H_1 G_2 G_3}}{1+\dfrac{(1+H_1 G_3+H_2 G_3)(G_1 G_2 + G_4)}{1+G_2+H_1 G_2 G_3}}$$

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

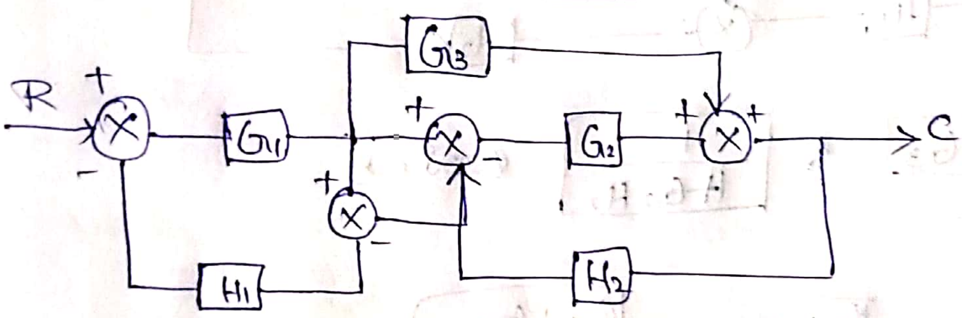
$$= \frac{G_1 G_2 G_3 + G_3 G_4}{1+G_2+H_1 G_2 G_3 + G_1 G_2 + G_4 + H_1 G_1 G_2 G_3 + H_1 G_3 G_4 + H_2 G_1 G_2 G_3 + H_2 G_3 G_4}$$

$$= \frac{G_{11} G_{12} G_{13} + G_{13} G_{14}}{1 + G_{12} + G_{14} + G_{11} G_{12} + H_1 (G_{12} G_{13} + G_{13} G_{14} + G_{11} G_{12} G_{13}) + H_2 (G_{13} G_{14} + G_{11} G_{12} G_{13})}$$

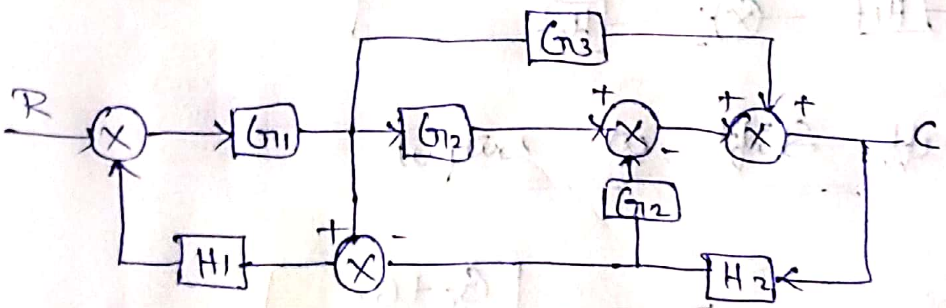
3. To reduce the given circuit block diagram



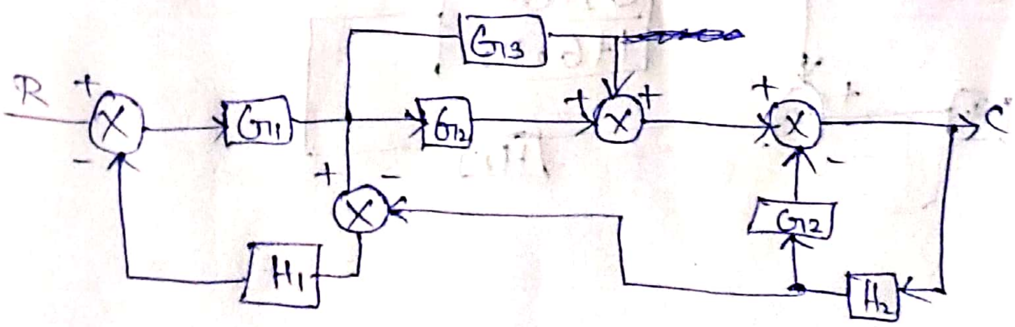
i, Take off shift before summing point



ii, Summing point shift ahead of G12

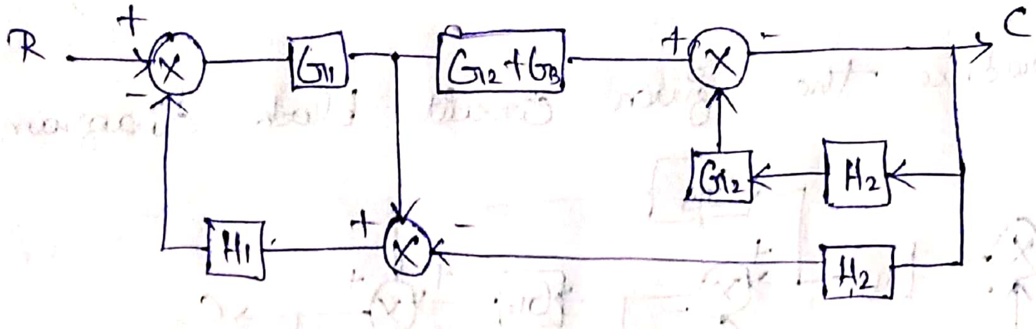


iii, Summing point Associativity

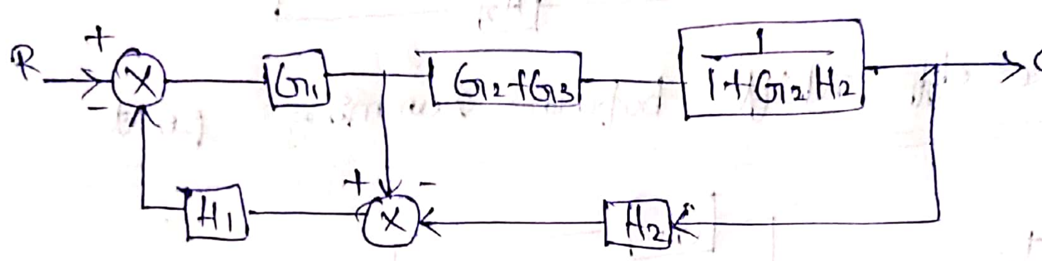


iv, $\boxed{G_2}$ and $\boxed{G_3}$ and parallel

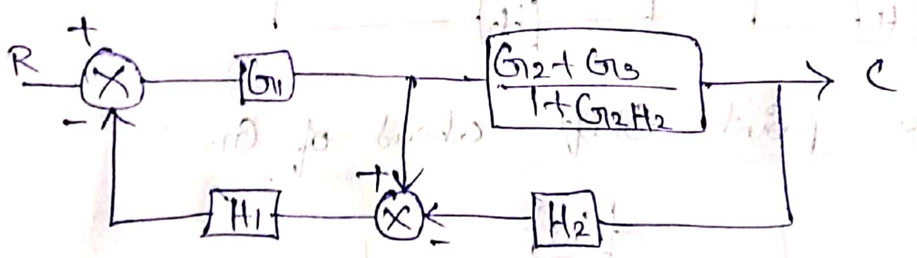
v, Take off shift before $\boxed{H_2}$ bottom right



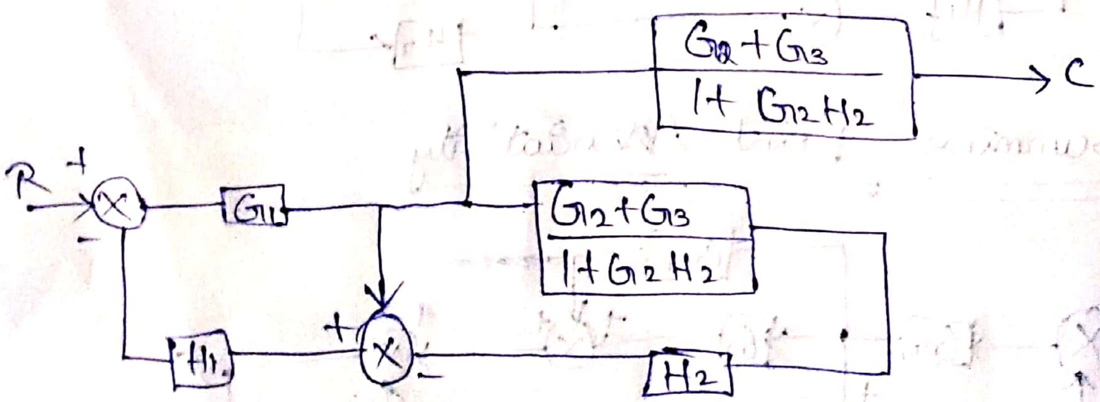
vi, $\boxed{G_2}$ & $\boxed{H_2}$ series then negative feedback



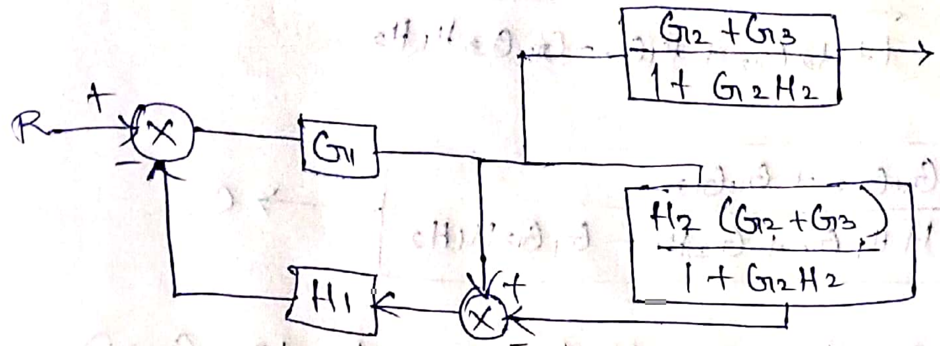
vii, $\boxed{G_2+G_3}$ & $\boxed{\frac{1}{1+G_2H_2}}$ series



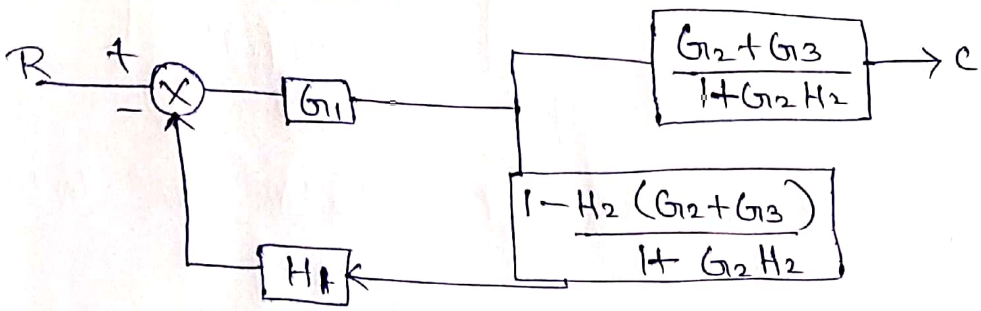
ix, Take-off shift at output



X, Series block



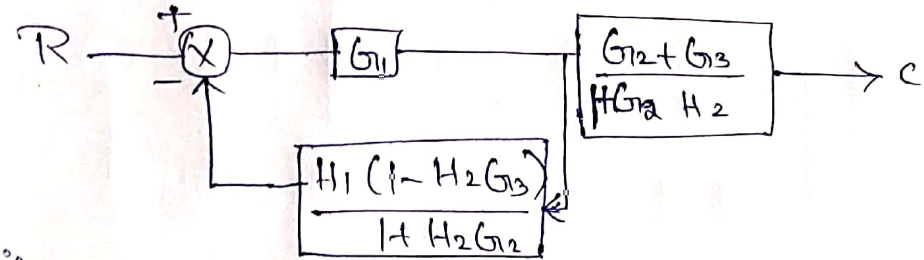
XI, Parallel block



XII, Simplication & Series block

$$1-\frac{H_2(G_2+G_3)}{1+G_2H_2} = \frac{1+G_2H_2-G_2H_2-H_2G_3}{1+G_2H_2}$$

$$= \frac{1-H_2G_3}{1+G_2H_2}$$



(XII)
XIII, Negative feed back & Series block

$$\left[\frac{G_1}{1+\frac{G_1H_1(1-H_2G_3)}{1+H_2G_2}}\right]\left[\frac{G_2+G_3}{1+H_2G_2}\right]$$

$$= \frac{G_1\cancel{(1+H_2G_2)}}{1+H_2G_2+H_1G_1-G_1G_3H_1H_2}\left[\frac{G_2+G_3}{\cancel{1+H_2G_2}}\right]$$

$$= \frac{G_1G_2 + G_1G_3}{1 + H_2G_2 + H_1G_1 - G_1.G_3H_1H_2}$$

$$R \longrightarrow \boxed{\frac{G_1G_2 + G_1G_3}{1 + H_1G_1 + G_2H_2 - G_1G_3H_1H_2}} \longrightarrow C$$

Which is the overall transfer function (Gain).