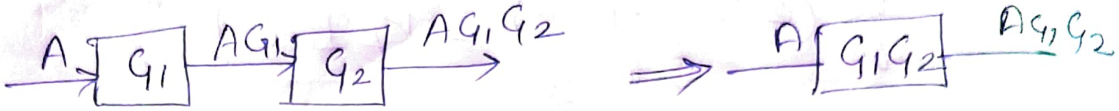
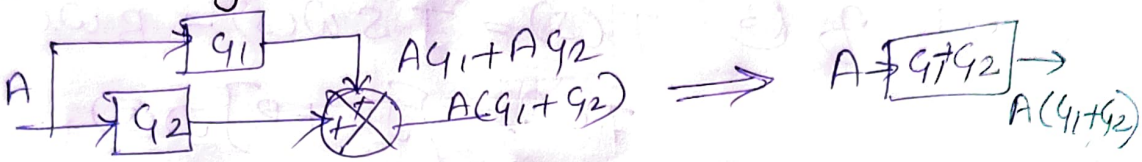
Block diagram reduction

Rules of Block diagram reduction

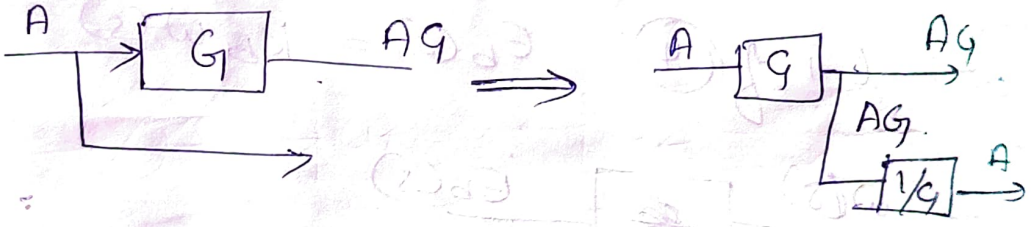
(1) Combining the blocks in cascade



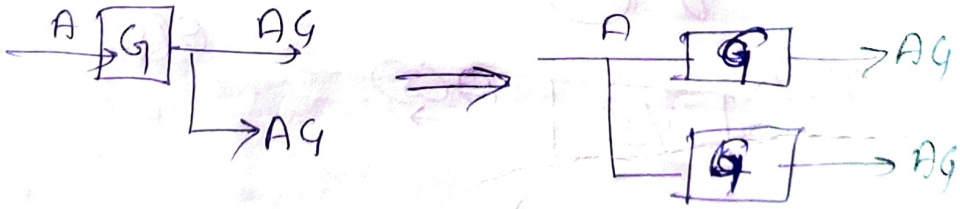
(2) Combining parallel blocks



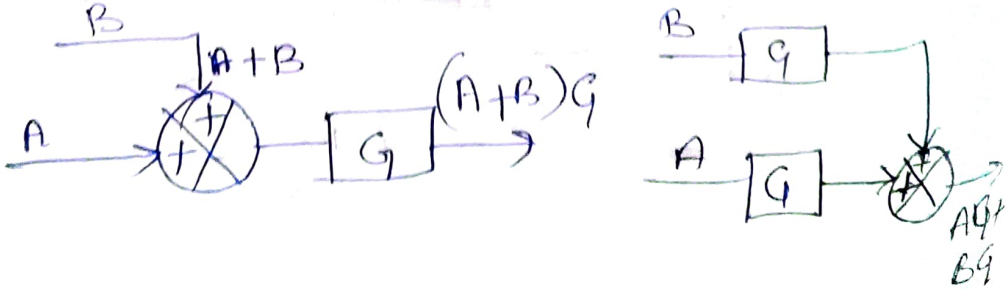
(3) Moving the branch point ahead the block



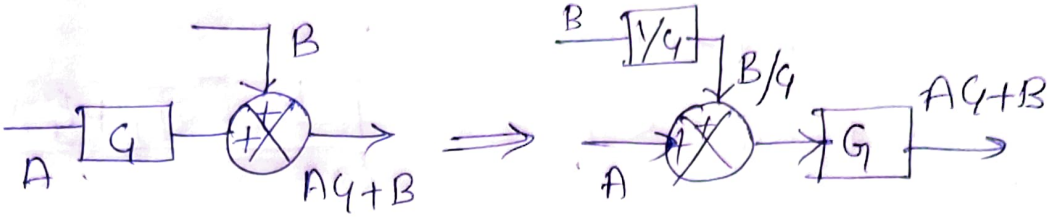
(4) Moving the branch point before the block



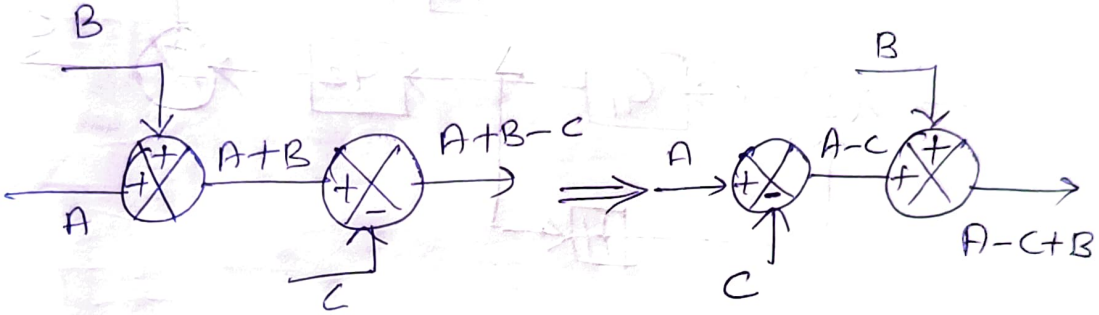
(5) Moving the summing point ahead of the block



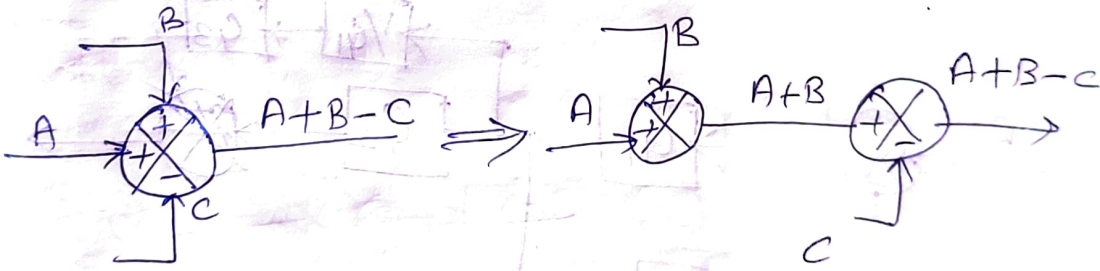
(6) Moving the summing point before the block



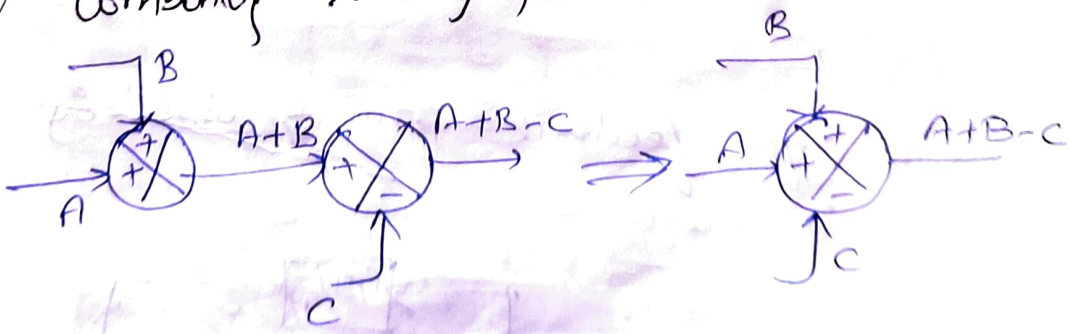
(7) Interchanging summing point



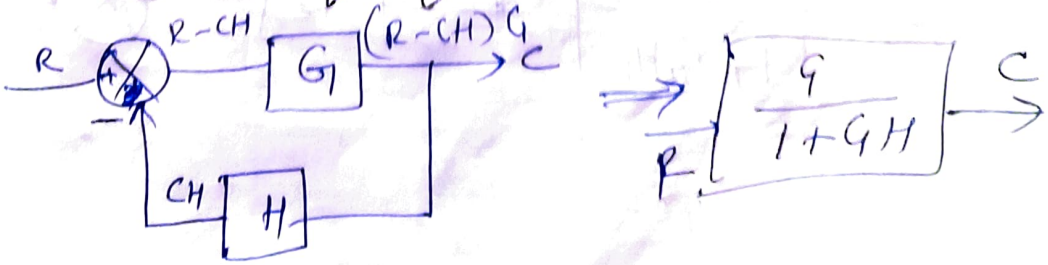
(8) Splitting summing points



(9) Combining summing points



(11) Elimination of feedback loop



$C = (R - CH)G$

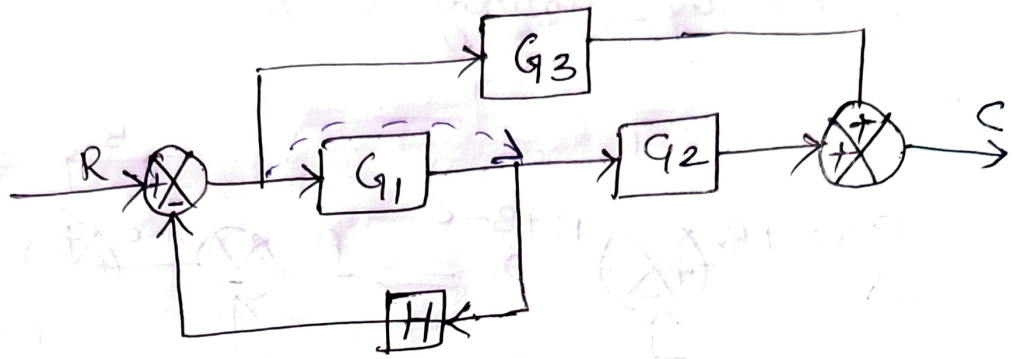
$C = RG - CHG$

$C + CHG = RG$

$C(1 + HG) = RG$

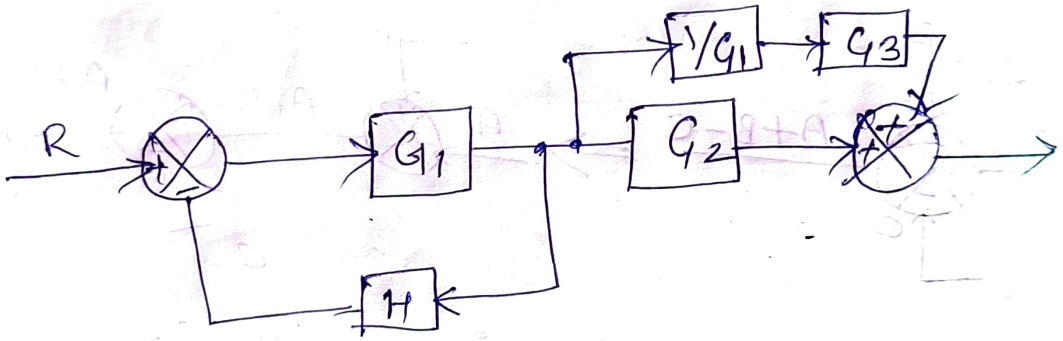
$$\boxed{\frac{C}{R} = \frac{G}{1 + HG}}$$

Problem ①



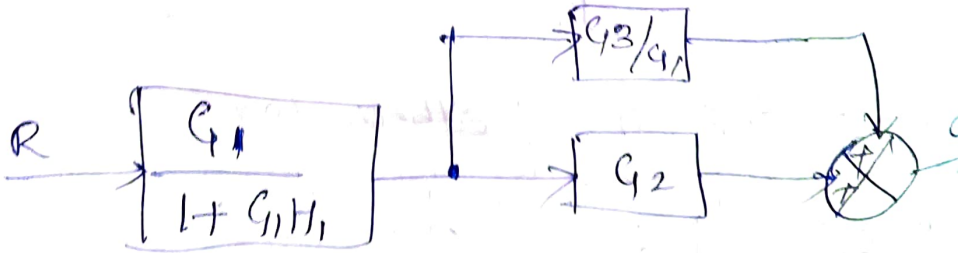
Solution

Step 1 : Move the branch after the block



Step 2.

Eliminate the feedback path & Combining blocks in cascade



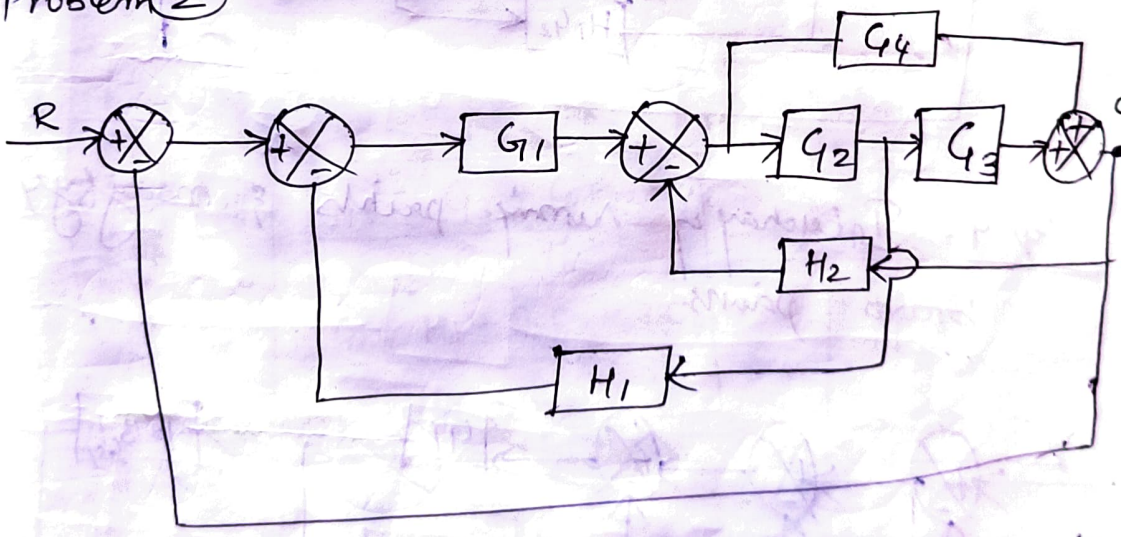
Step 3 : Combining parallel blocks

$$\frac{C}{R} = \left(\frac{G_1}{1+G_1H_1}\right)\left(G_2+\frac{G_3}{G_1}\right)$$

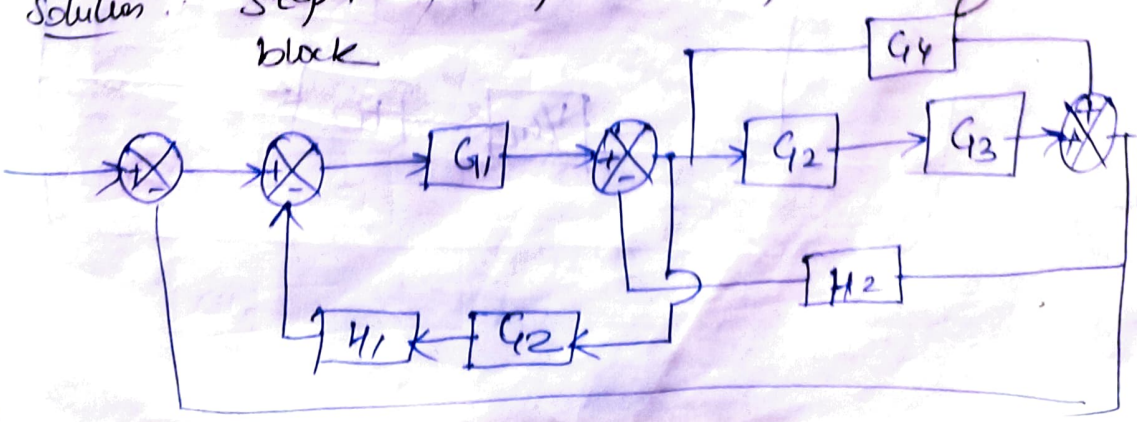
$$= \frac{G_1}{(1+G_1H_1)}\left[\frac{G_2G_1+G_3}{G_1}\right)$$

$$\boxed{\frac{C}{R} = \frac{G_2G_1+G_3}{1+G_1H_1}}$$

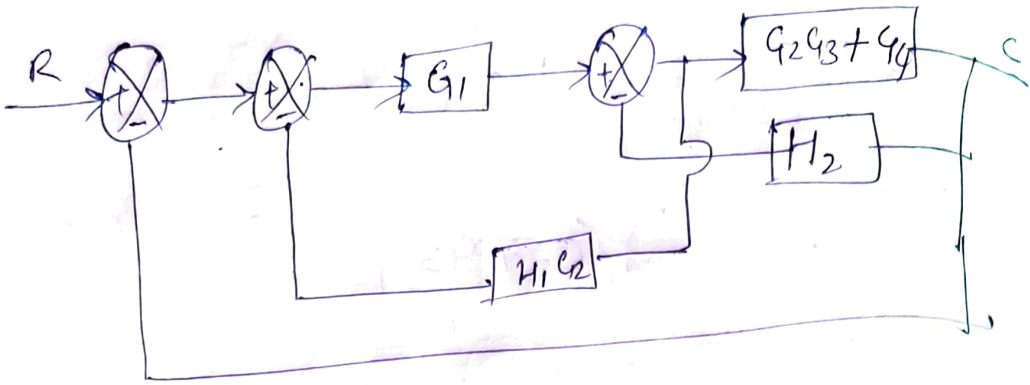
Problem (2)



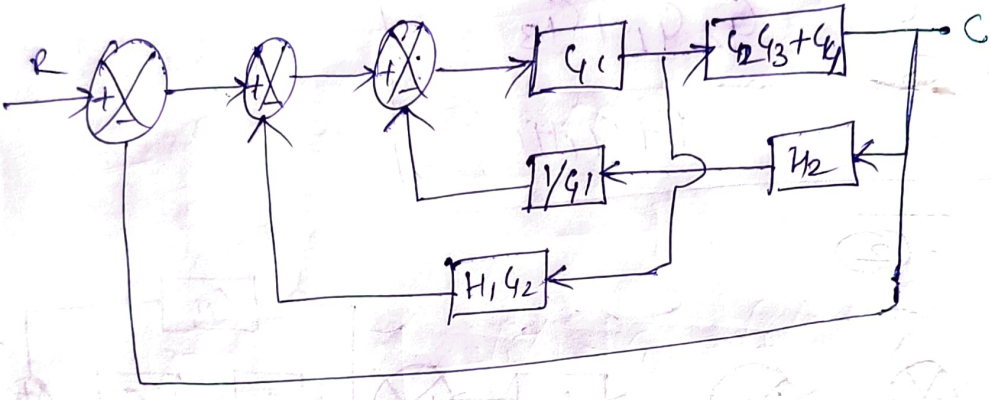
Solution : step 1 Moving branch point before the block



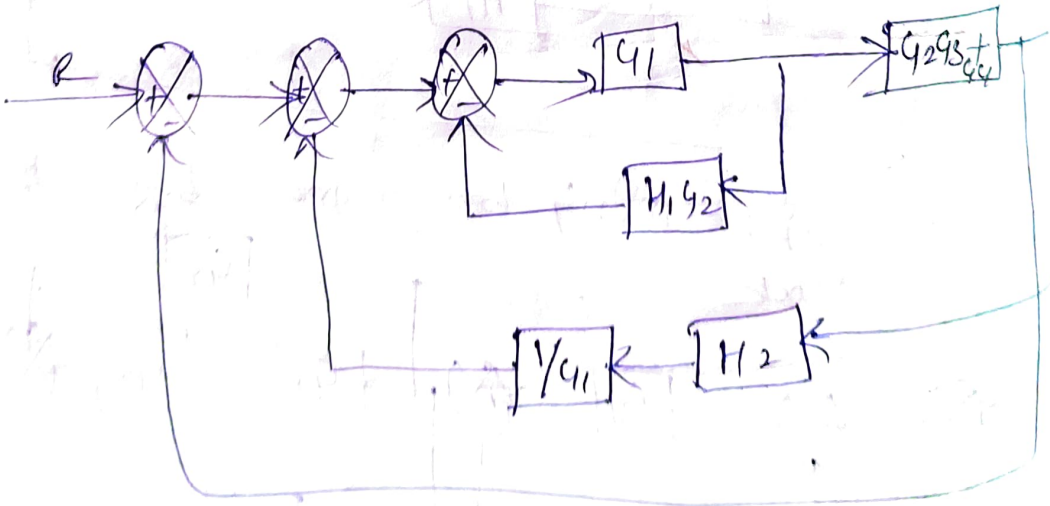
Step 2 Combining cascade & parallel blocks



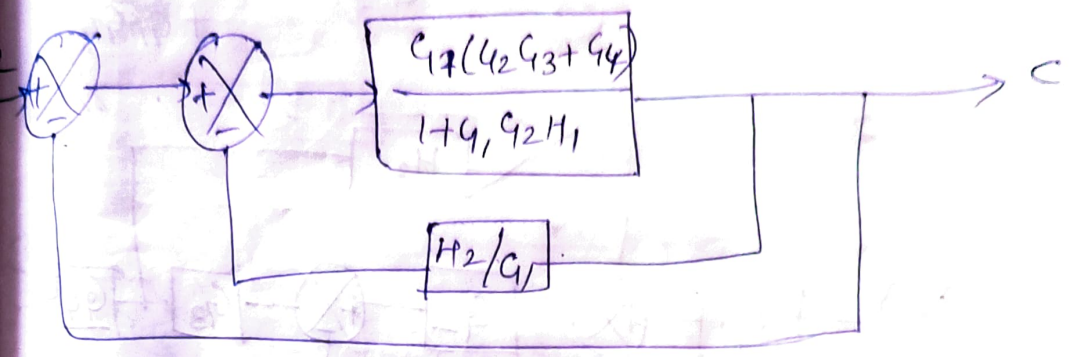
Step 3. Moving summing points before the block.

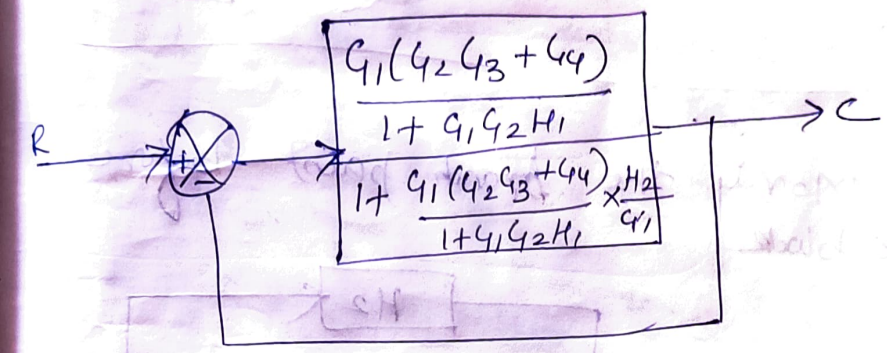


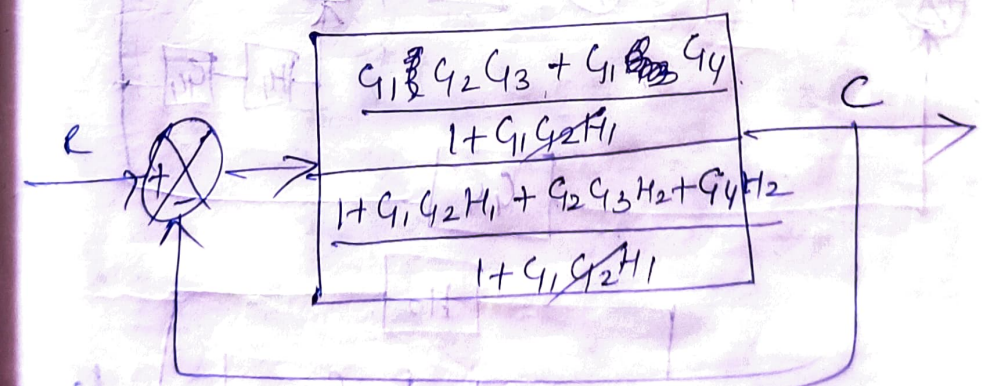
Step 4: Interchanging summing points & modifying branch points.



Step 5. Eliminating the feedback path & combing blocks in cascade





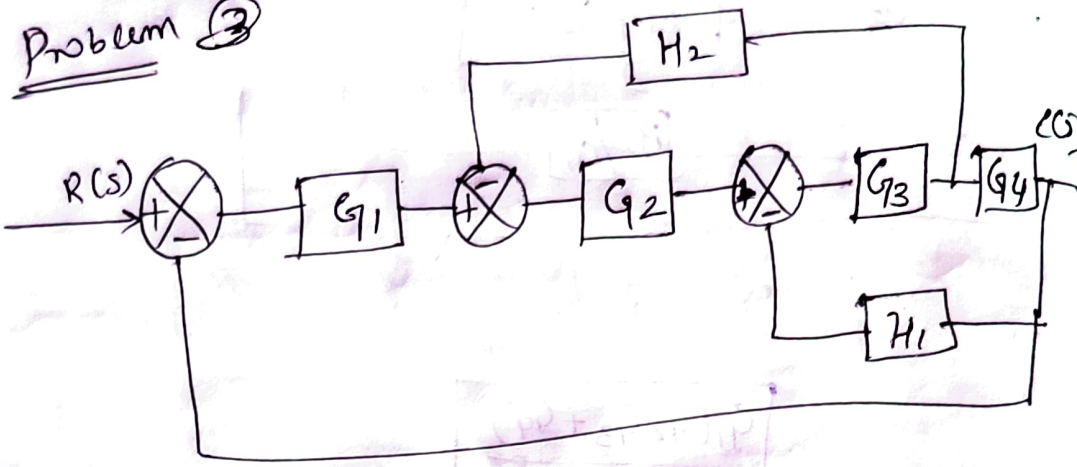


Step 6 Eliminating feedback path

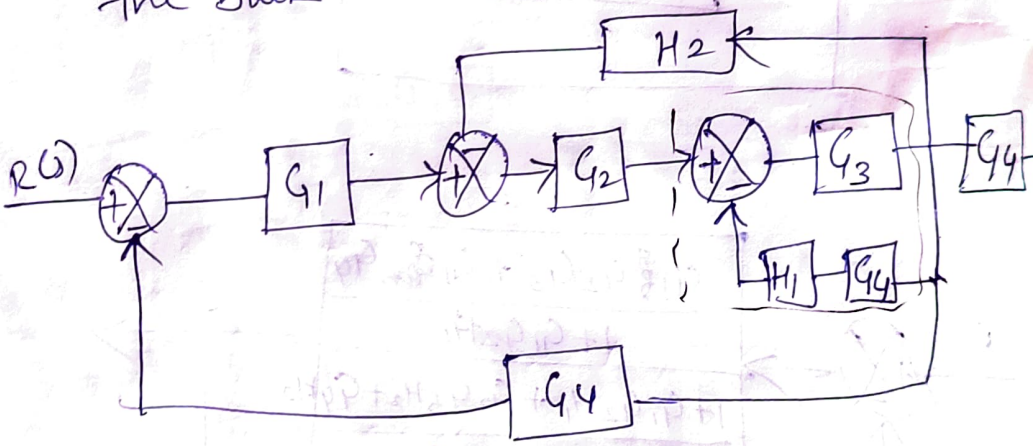
$$\frac{C}{R} = \frac{\frac{G_1G_2G_3+G_1G_4}{1+G_1G_2H_1+G_2G_3H_2+G_4H_2}}{1+\frac{G_1G_2G_3+G_1G_4}{1+G_1G_2H_1+G_2G_3H_2+G_4H_2}}$$

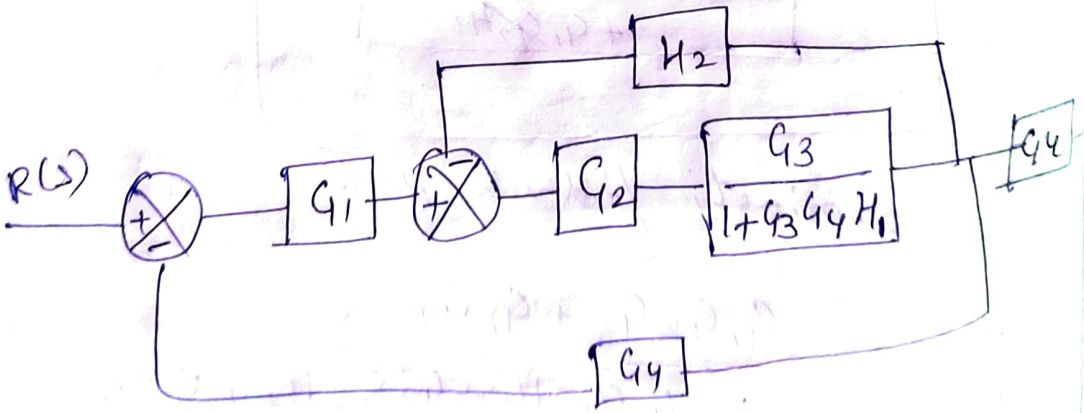
$$\frac{C}{R} = \frac{G_1 G_2 G_3 + G_1 G_4}{1 + G_1 G_2 H_1 + G_2 G_3 H_2 + G_4 H_2 + G_1 G_2 G_3 + G_1 G_4}$$

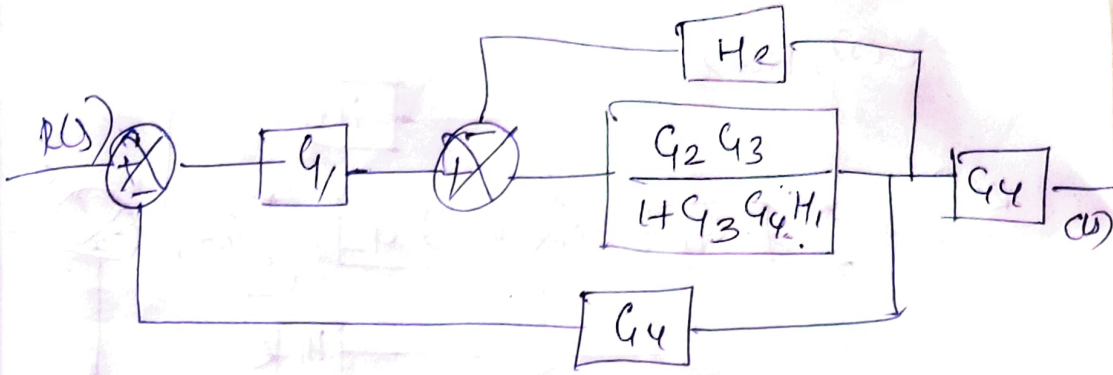
Problem (3)

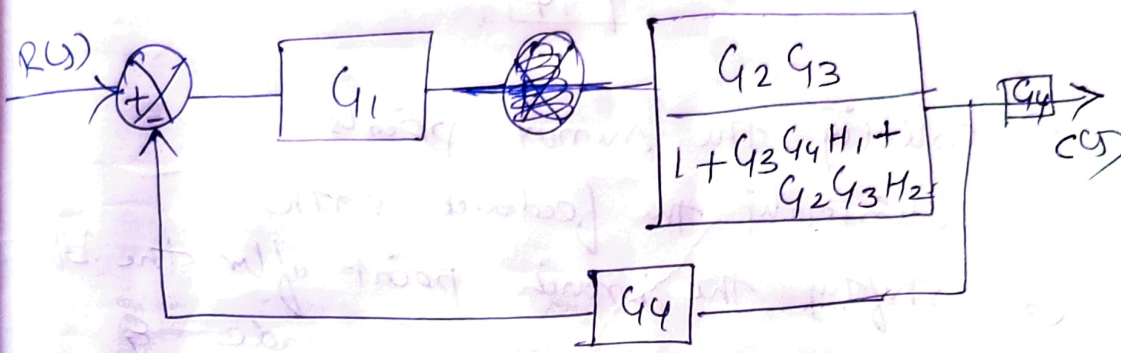


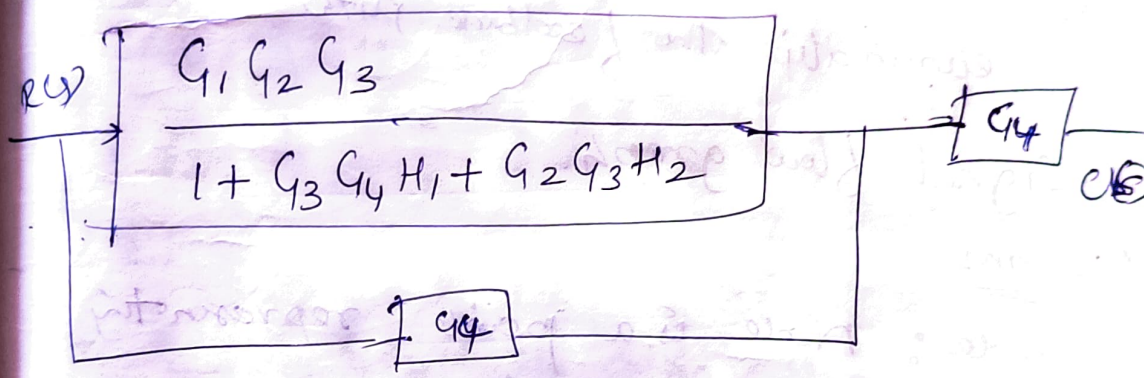
Step 1. Move the branch point before the block











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

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

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