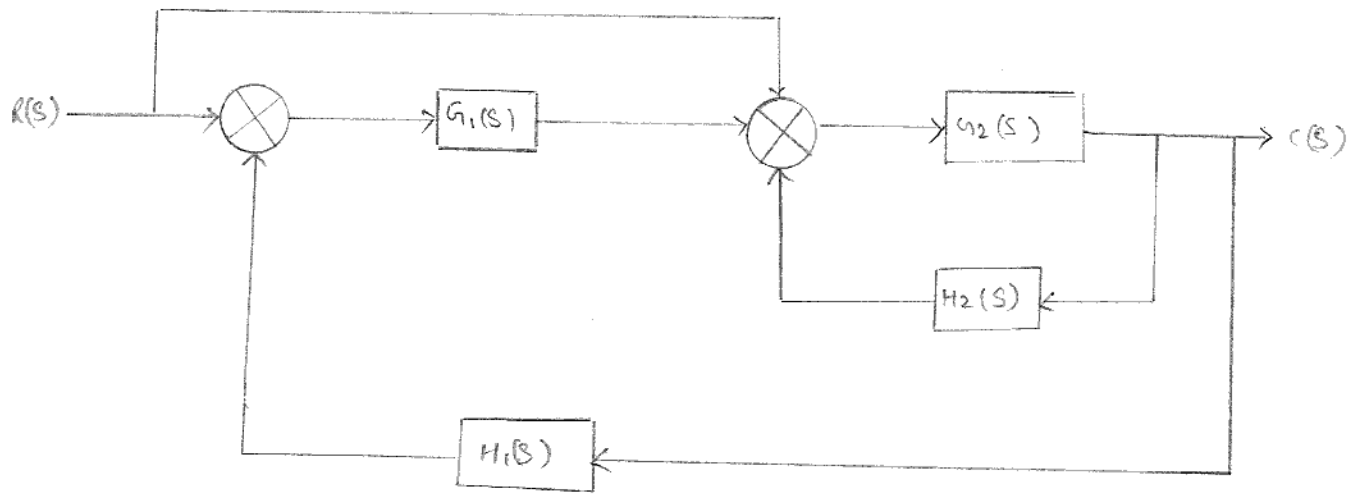
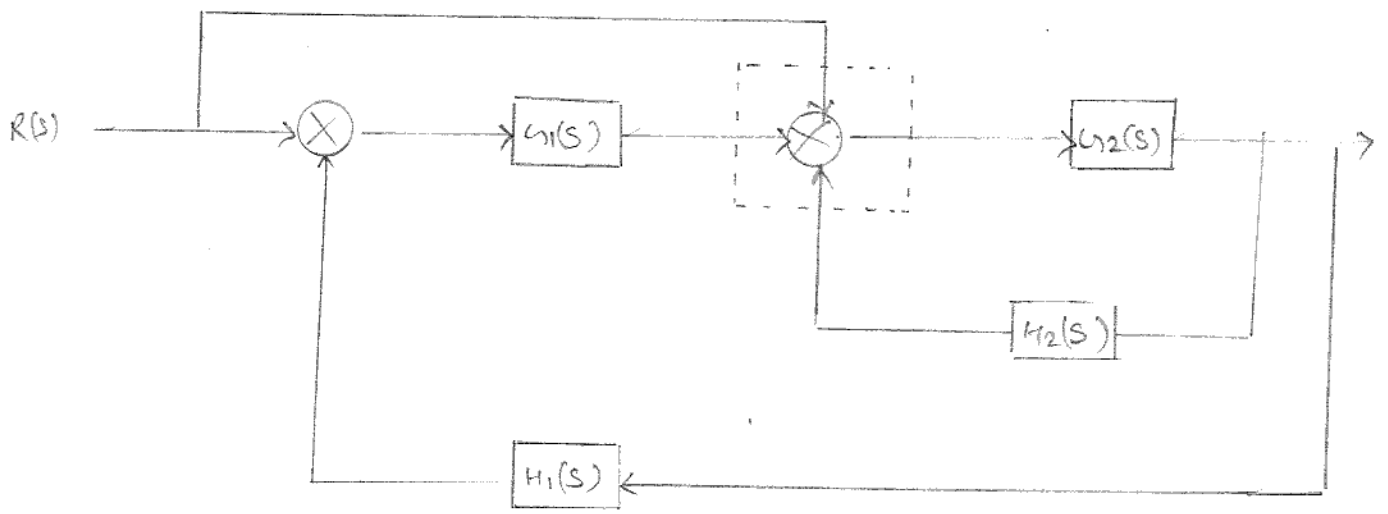
Q. Determine closed loop transfer function C(S) / R(S)

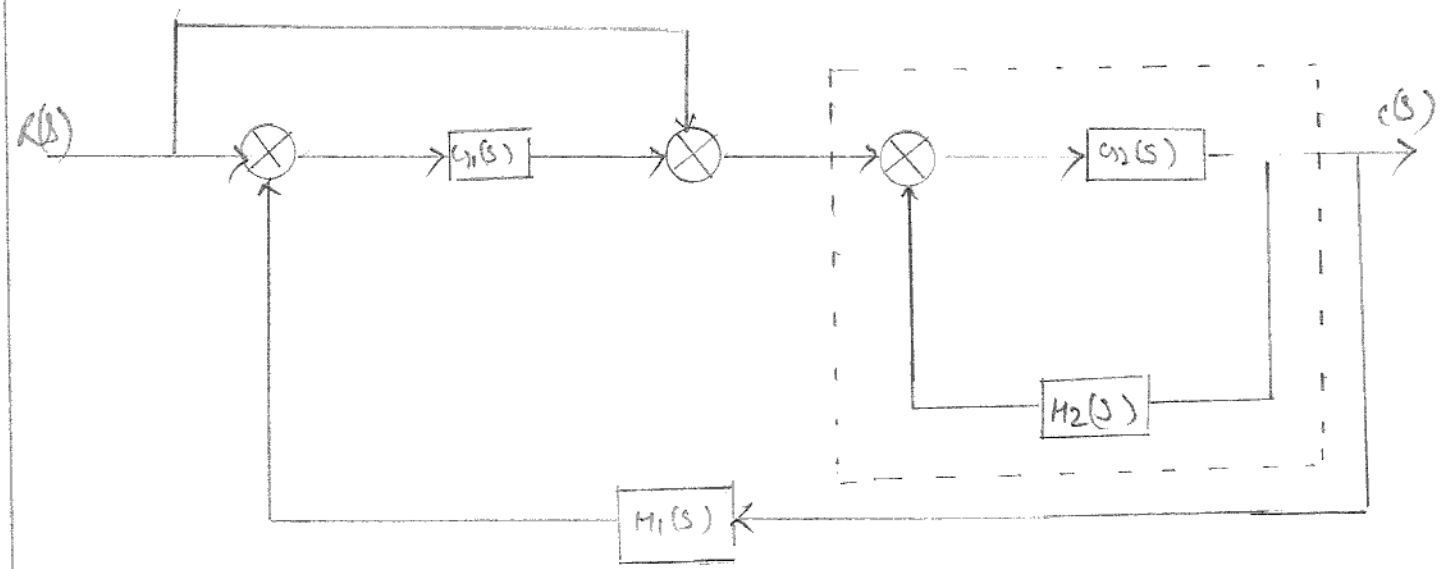


Step 1 :- Splitting the summing point



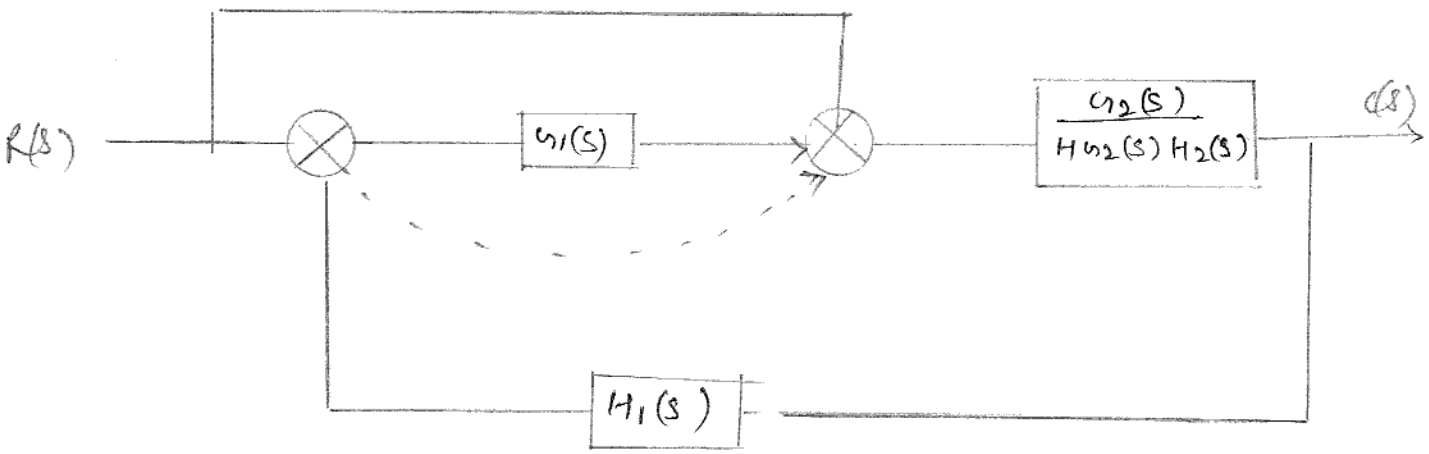
Step 2

Eliminating the feedback path



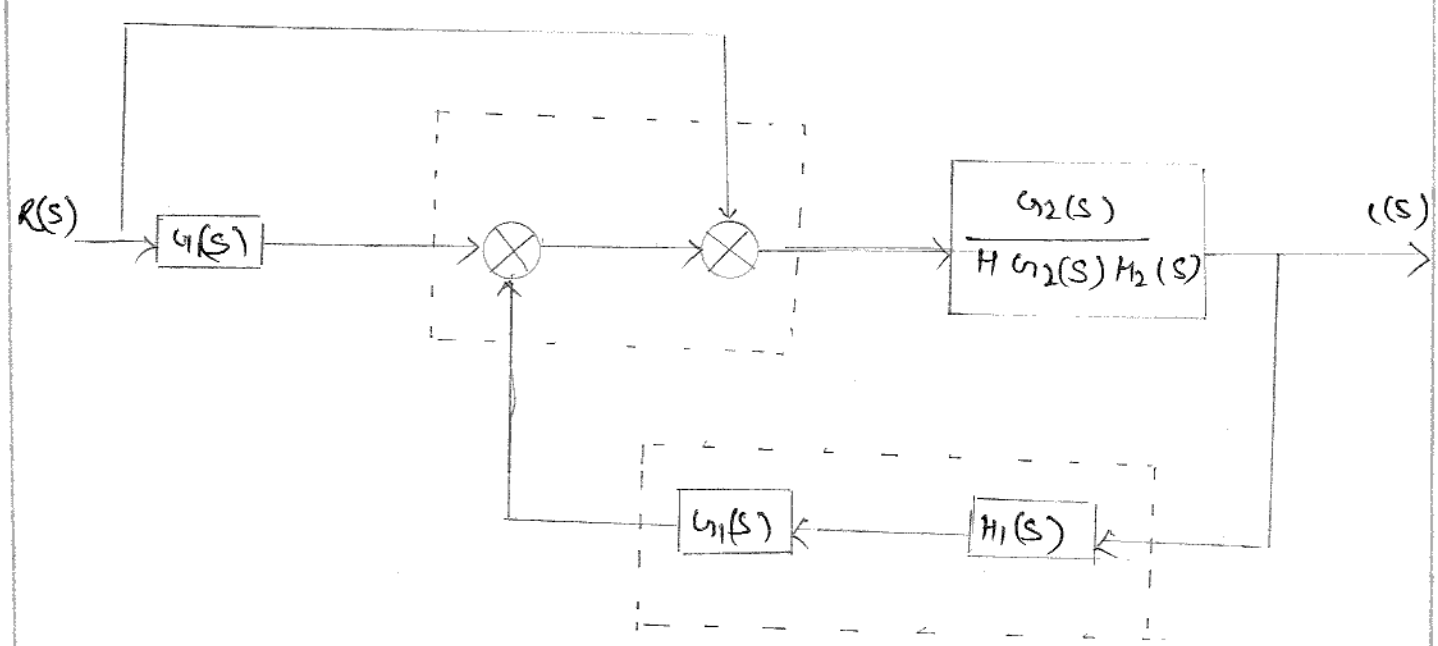
Step 3 :-

Moving the summing point after the block



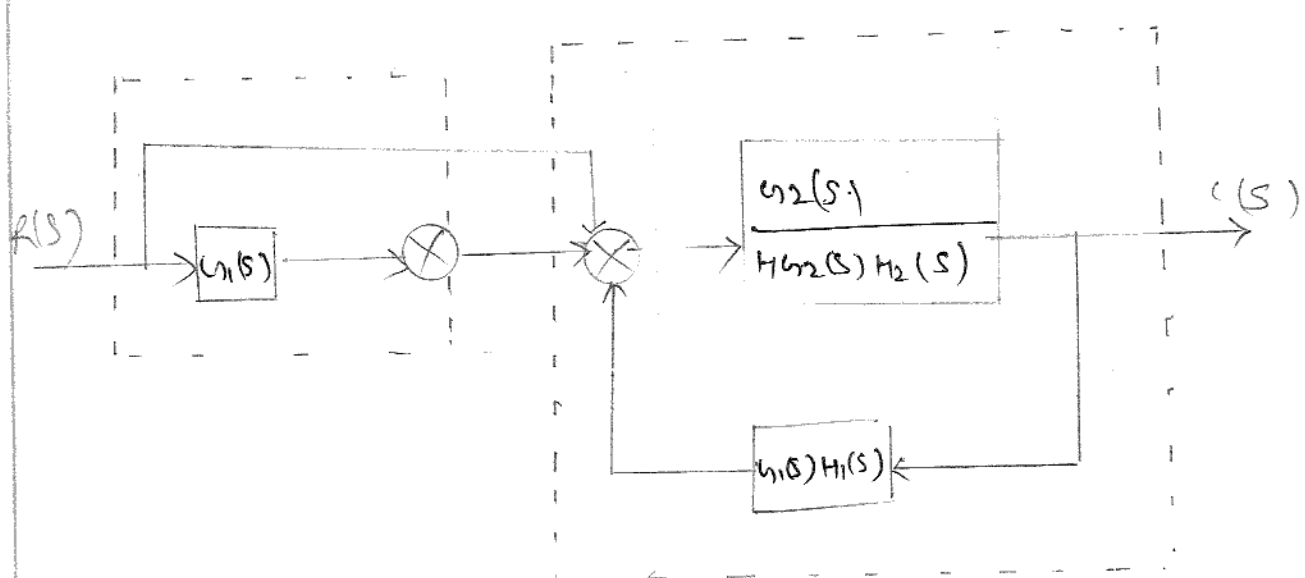
Step 4

Interchanging the summing points and combing the blocks in cascode



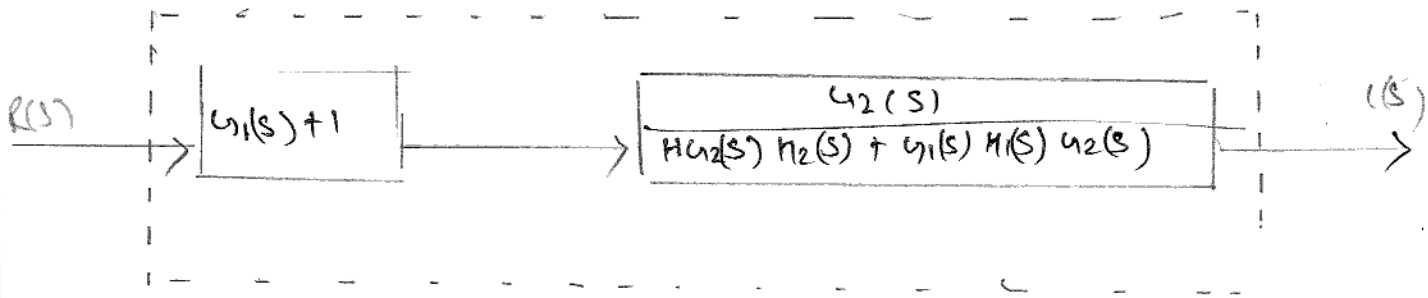
Step 5

Eleminating feedback path & feedforward path



$$\frac{\frac{G_2(S)}{H\,G_2(S)\,H_2(S)}}{1 + \frac{G_2(S)}{H\,G_2(S)\,H_2(S)} \cdot G_1(S)\,H_1(S)}$$

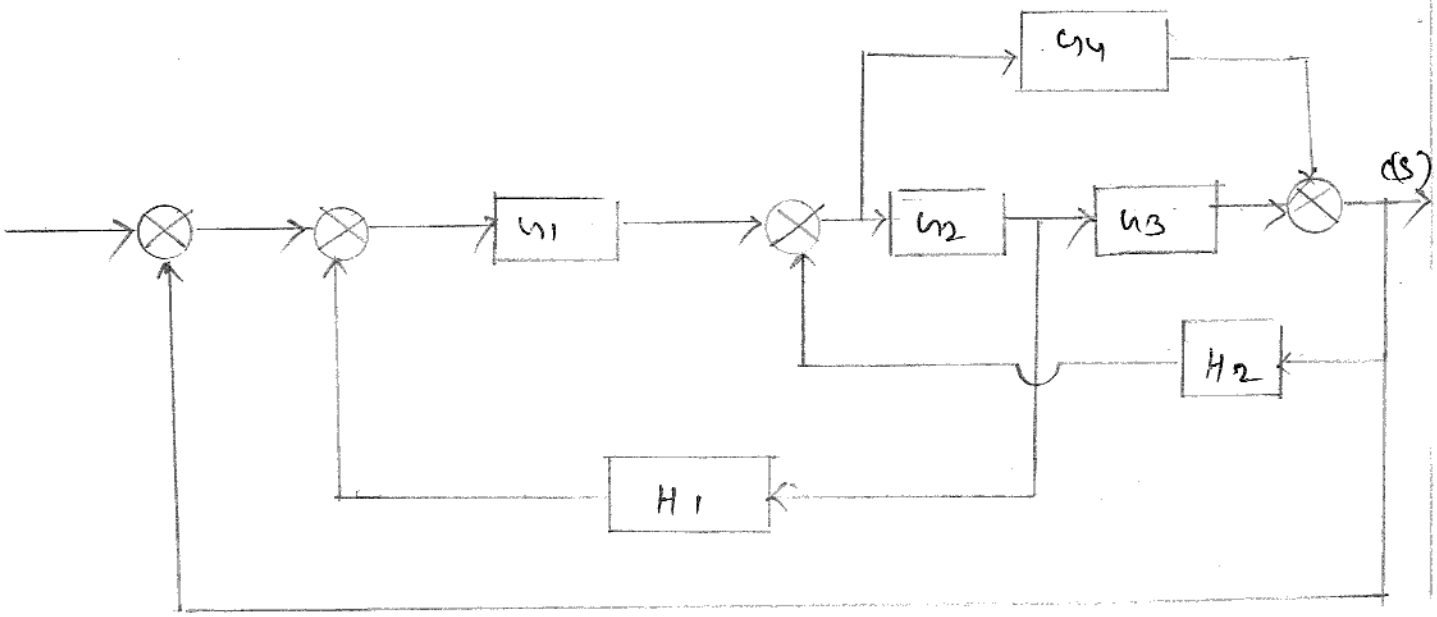
Step 6 Combining the block in cascade



Transfer function of the system is

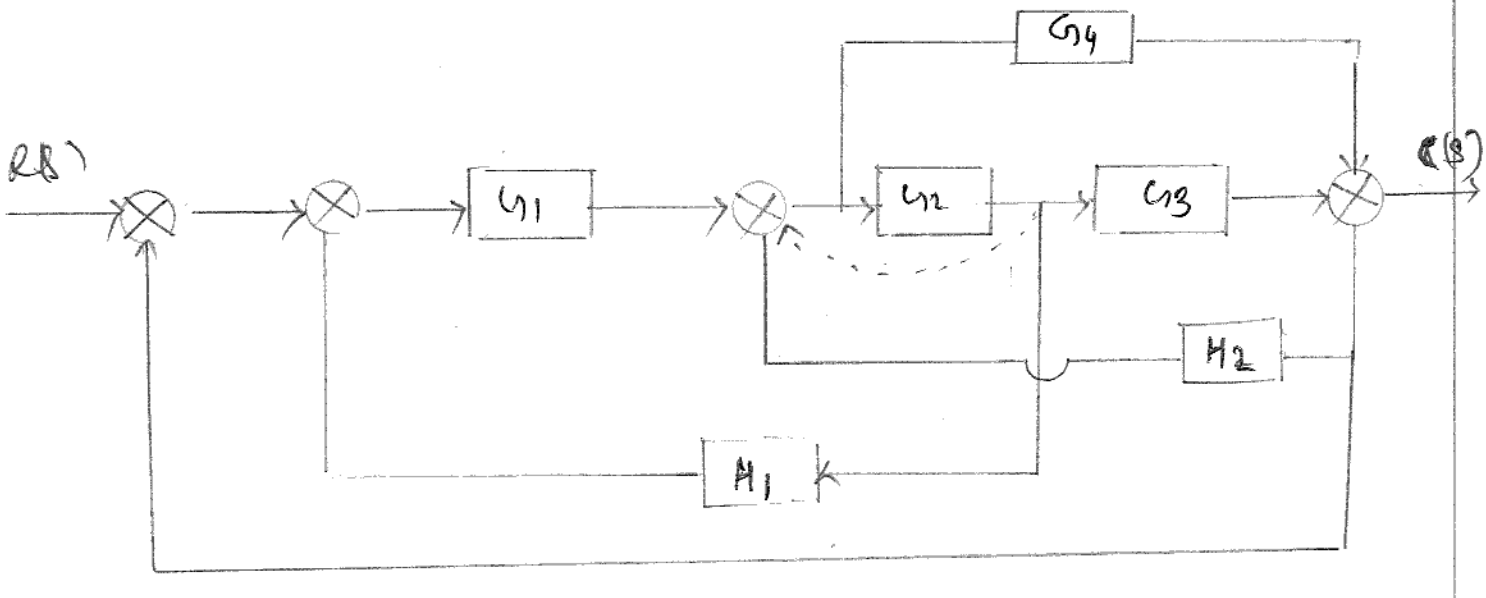
$$\frac{C(S)}{R(S)} = \frac{G_2(S)\,[G_1(S)+1]}{1+G_2(S)\,H_2(S)+G_1(S)\,G_2(S)\,H_1(S)}$$

Q. Determine closed loop transfer function C(S)/R(S)



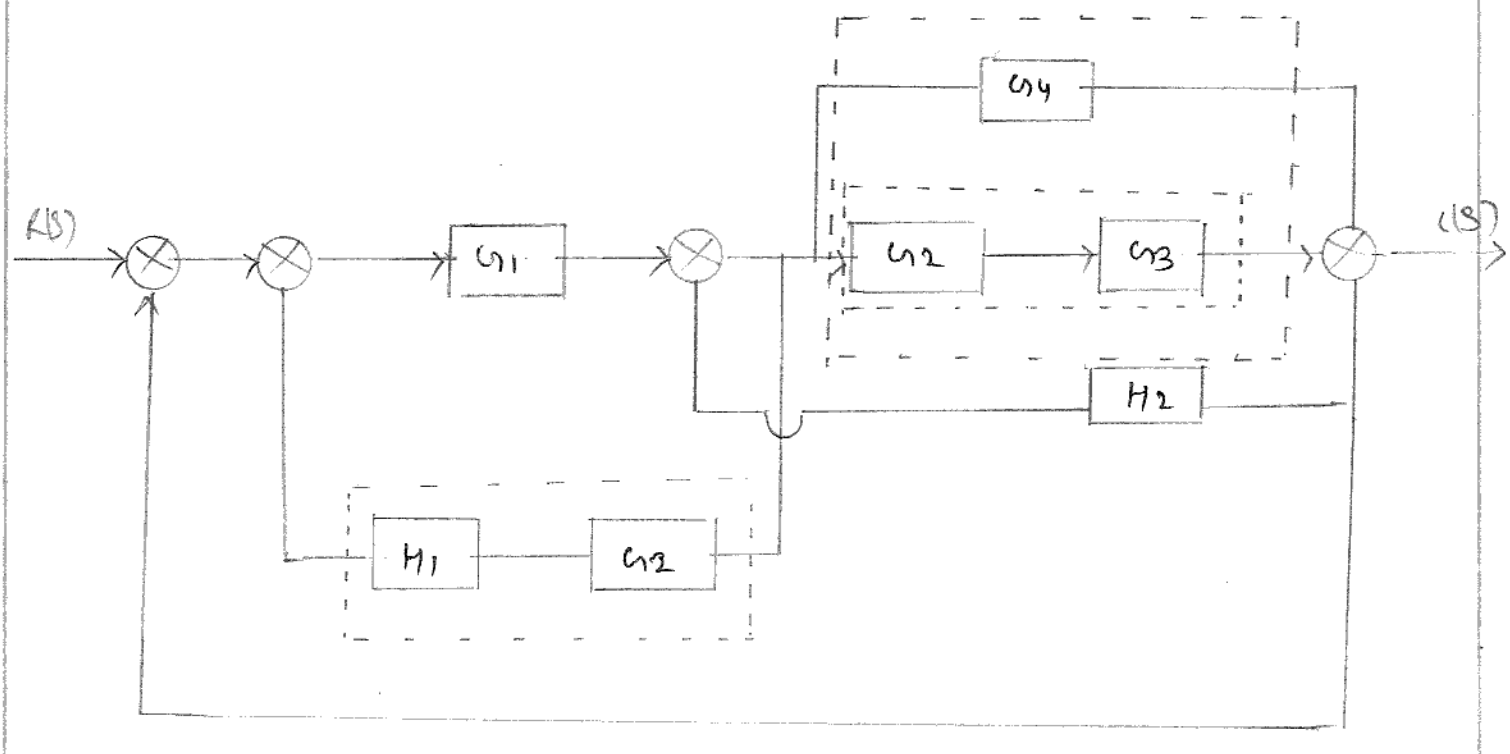
Step 1 :-

Having the branch point before the block

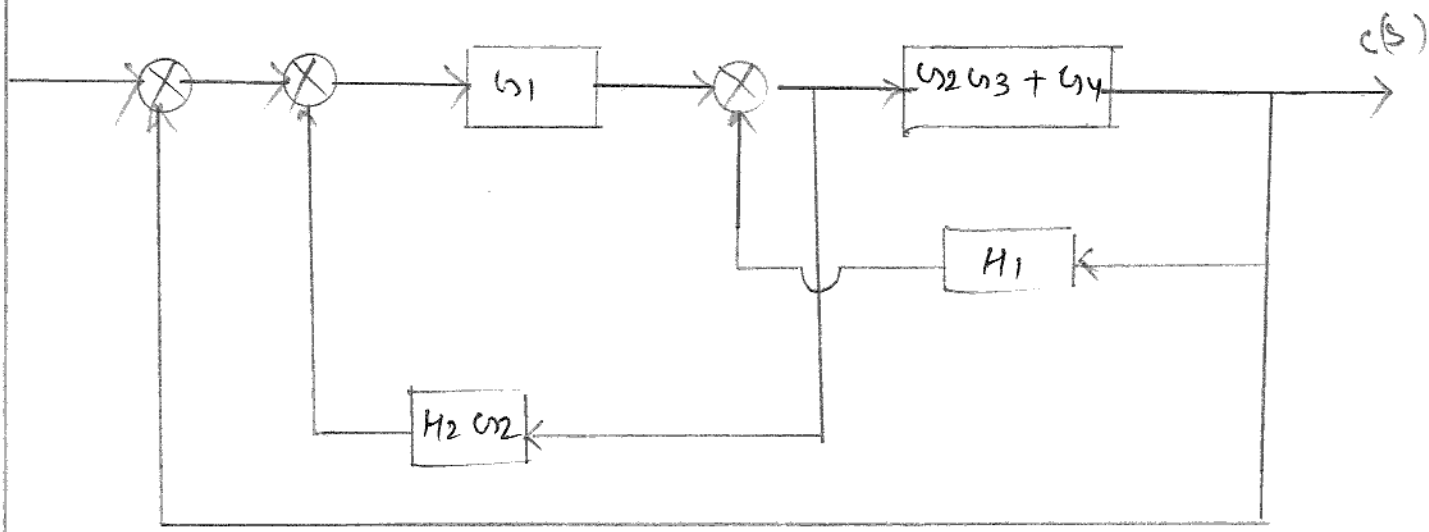


Step 2

combining the block in cascade & eliminating parallel block

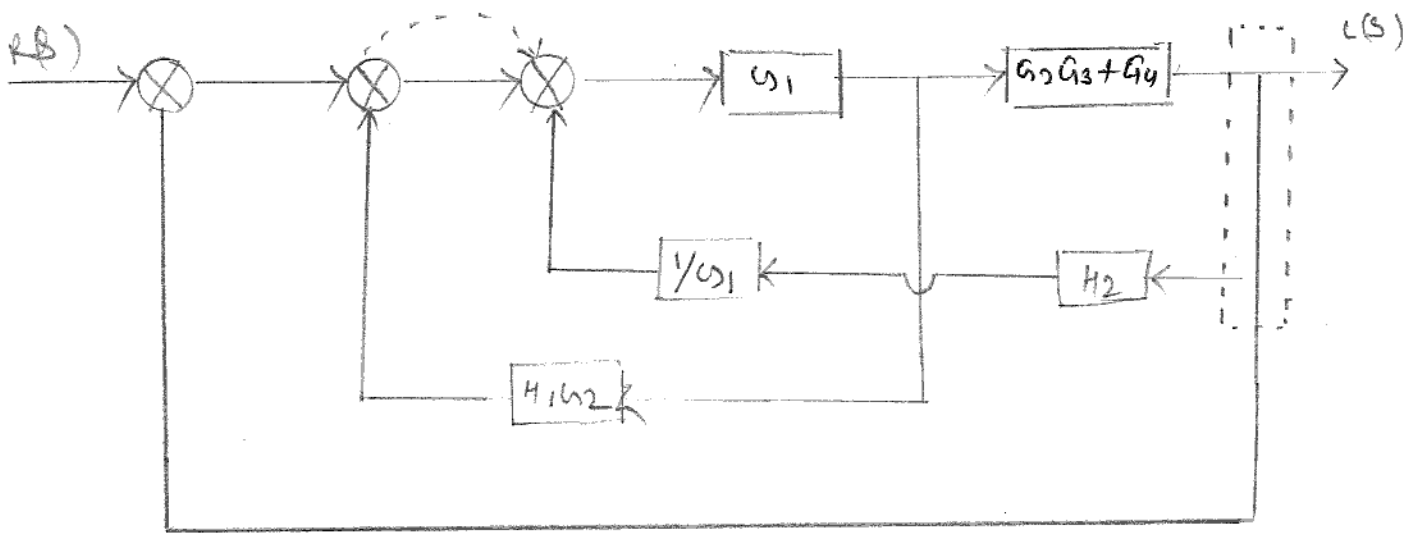


Step 3 :- Moving the summing point before the block



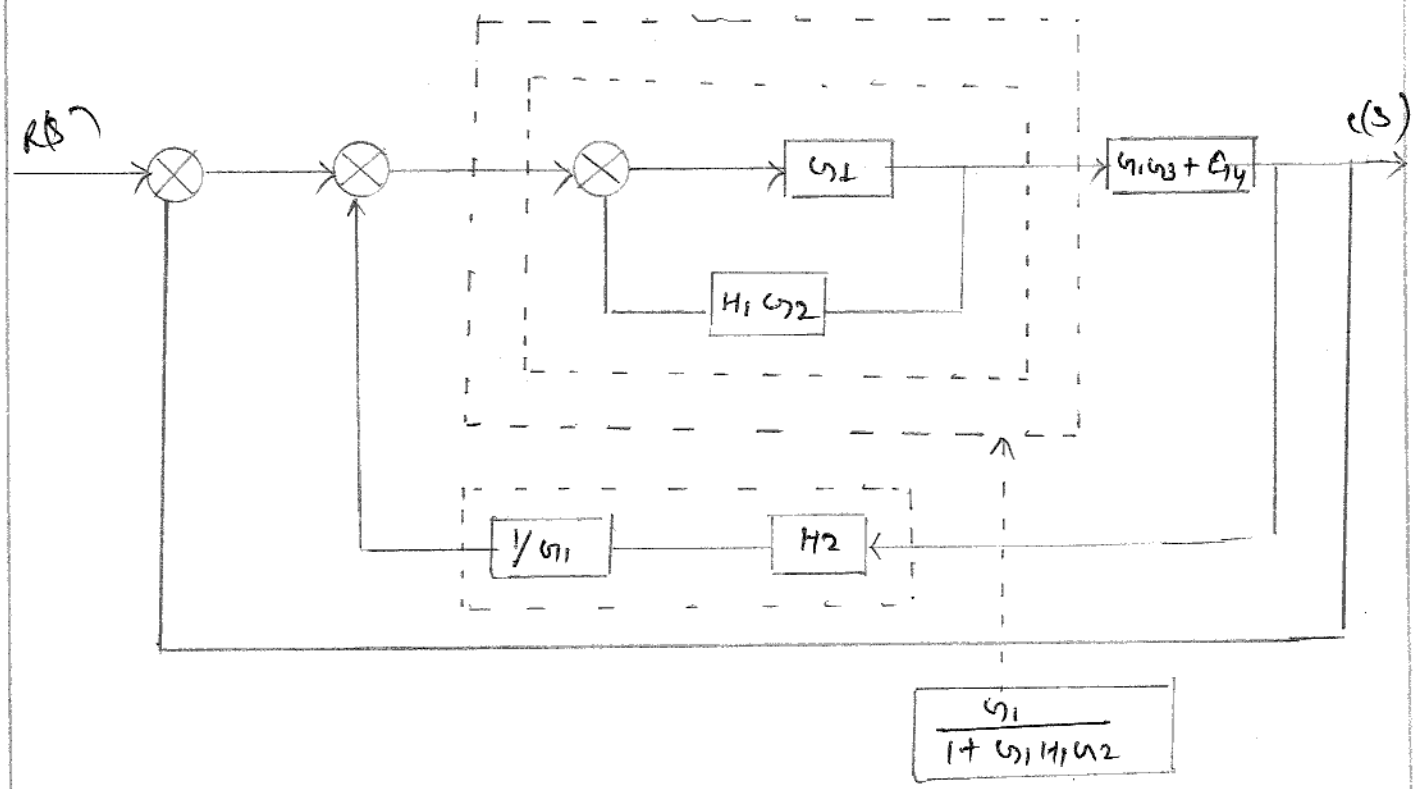
Step 4 :-

Interchanging summing point & modifying branch point



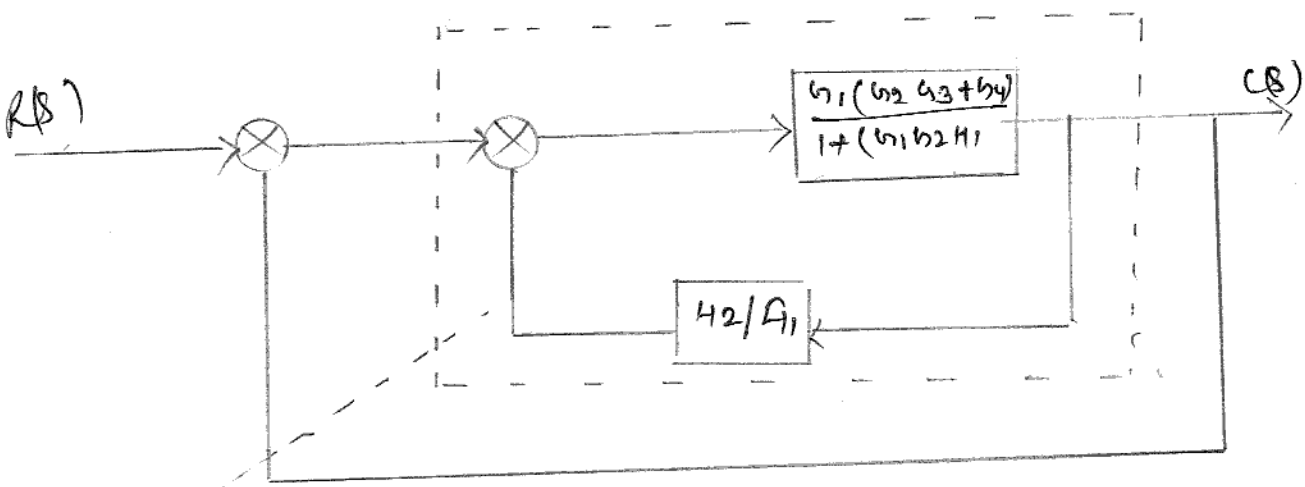
Step 5 :-

Eliminating the feedback path and combining blocks in cascade.



Step 6 :-

Eliminating the feedback path

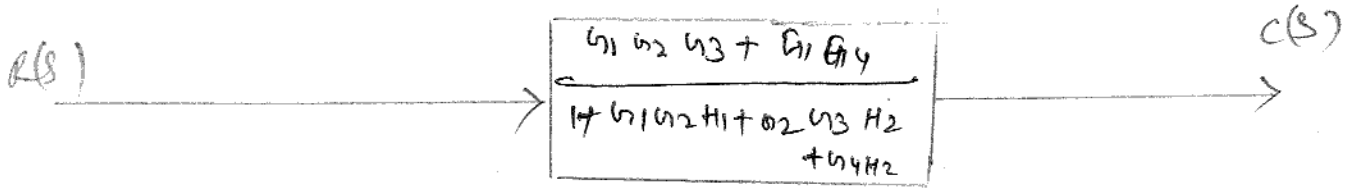


$$\frac{\frac{G_1(G_2G_3+G_4)}{1+G_1G_2H_1}}{1+\frac{G_1(G_2G_3+G_4)}{1+G_1G_2H_1}\cdot\frac{H_2}{H_1}} \Rightarrow \frac{\frac{R.G_1G_2G_3 + G_1G_4}{1+G_1G_2H_1}}{\frac{1+G_1G_2H_1+G_2G_3H_1+G_4H_2}{1+G_1G_2H_1}}$$

$$\Rightarrow \frac{G_1G_2G_3 + G_1G_4}{1+G_1G_2H_1+G_2G_3H_2+G_4H_2}$$

Step 7 :-

Eliminating the feedback path



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

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

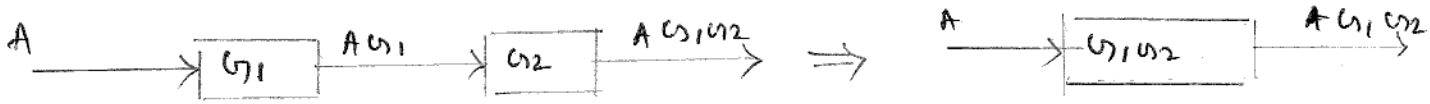
the overall transfer function is given by

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

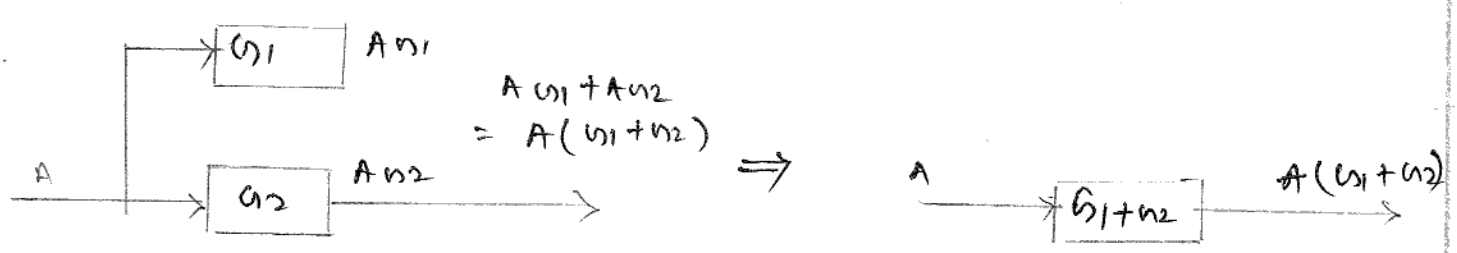
Q. Write rules for block diagram reduction technique.

Soln Rules for block diagram reduction techniques are as follows.

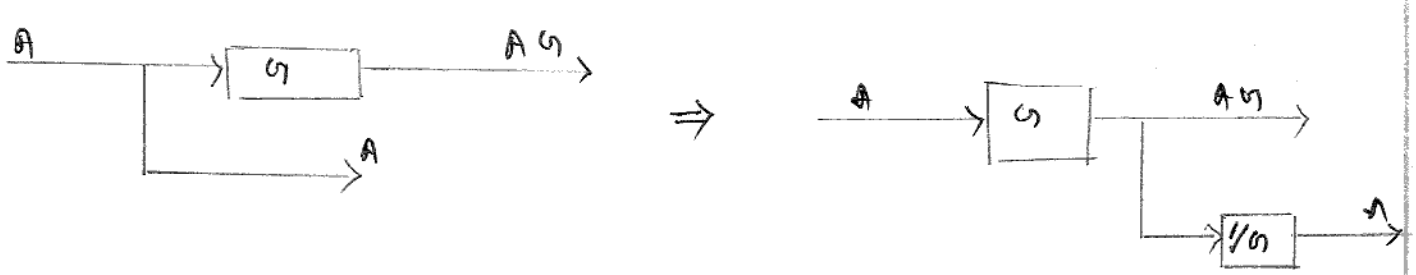
→ Rule:- 1 Combining the blocks in cascade.



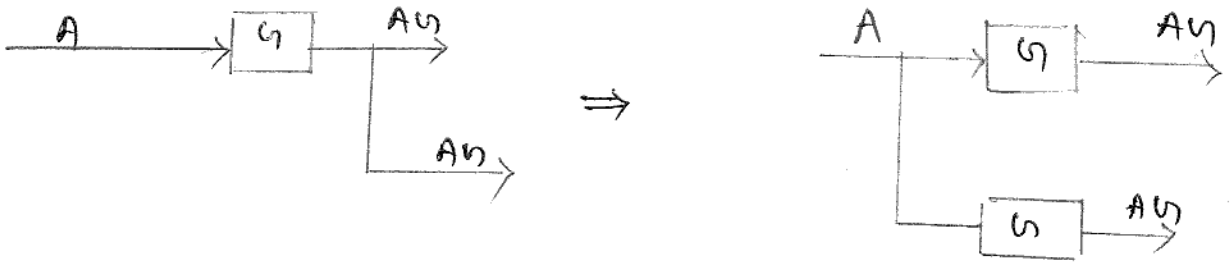
→ Rule 2 Combining parallel blocks.



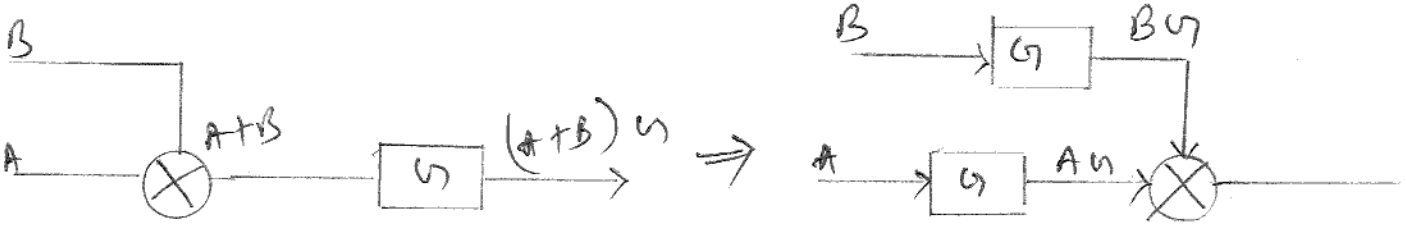
→ Rule 3 : Moving the branch point ahead of the block.



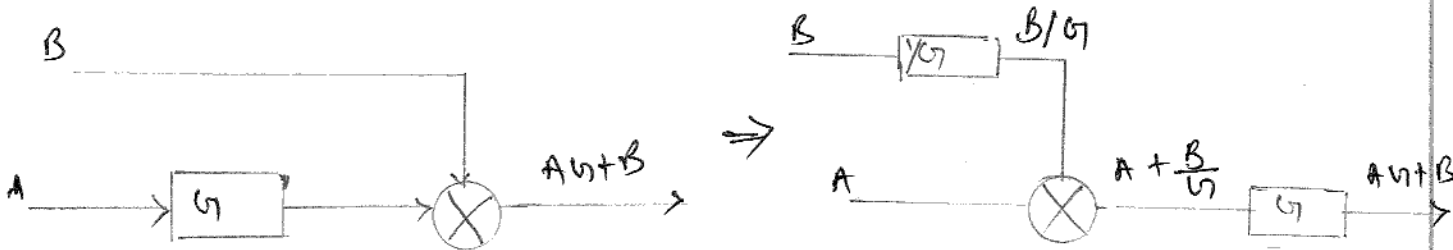
Rule 4 : Moving the branch point before the block



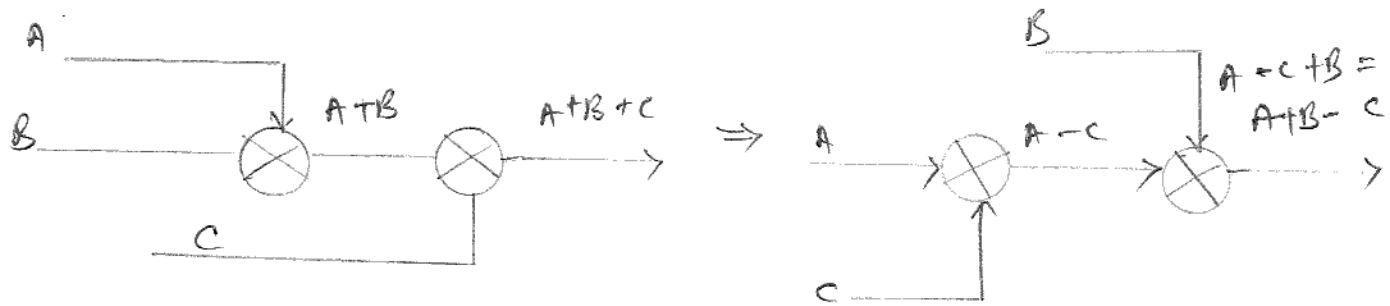
Rule 5 : Moving the summing point ahead of the block.



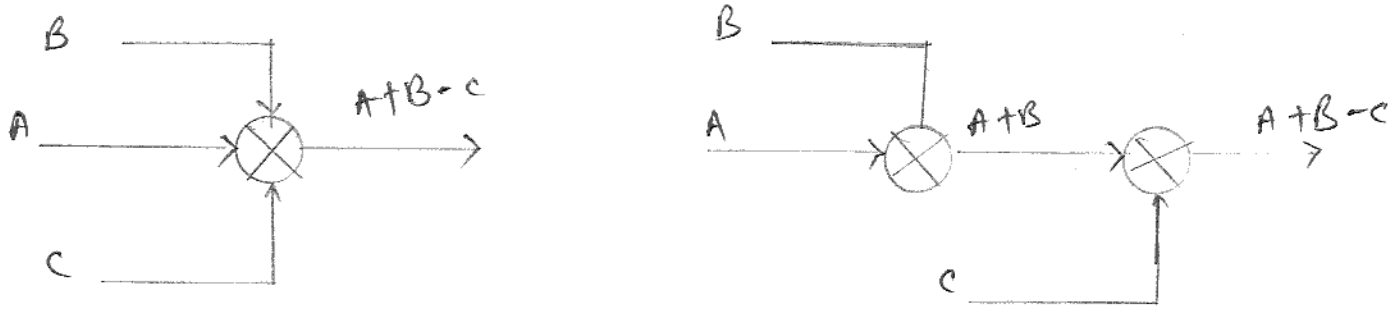
Rule 6: Moving the summing point before the block.



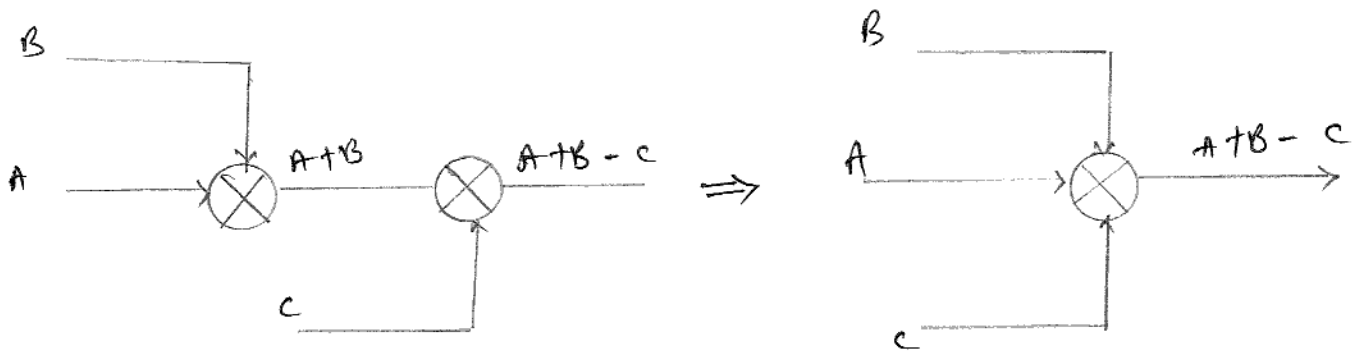
Rule 7 : Interchanging Summing point



Rule 8 : Splitting Summing point.

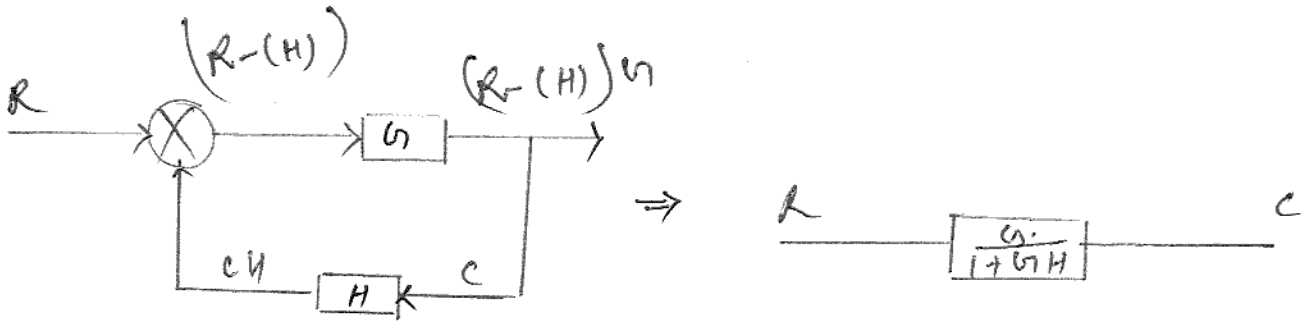


Rule 9 :- Combining Summing point



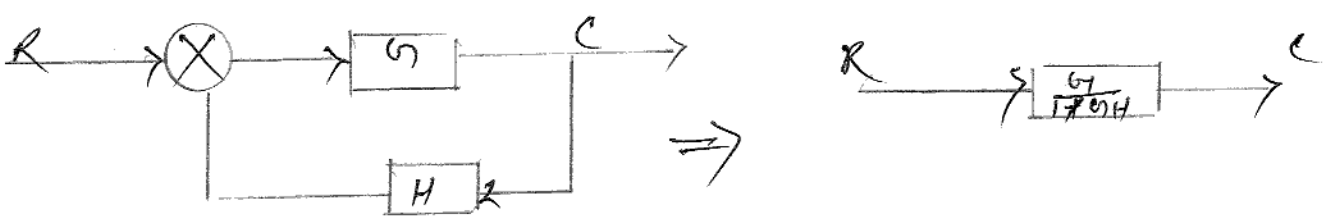
Rule 10 :-

Elimination of (negative) feedback loop

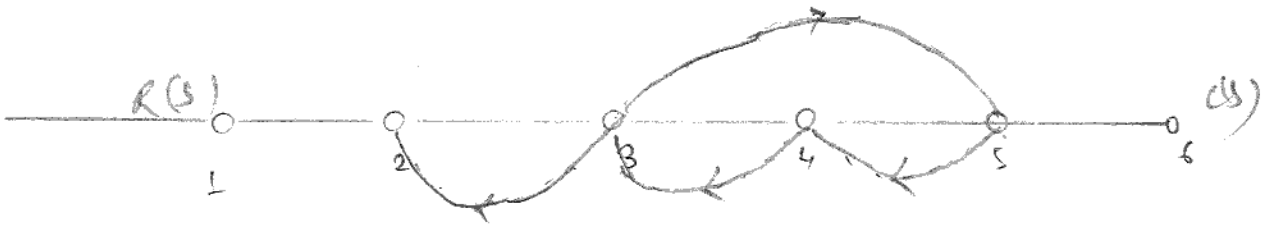


Rule 11 :-

Elimination of (positive) feedback loop



Q. Determine closed loop transfer function $C(s)/R(s)$

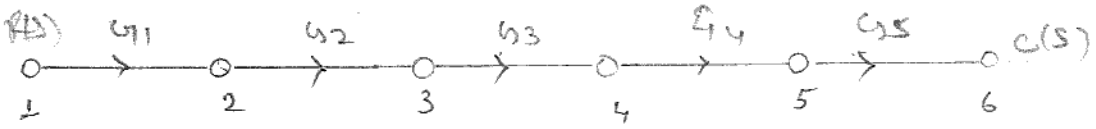


Soln

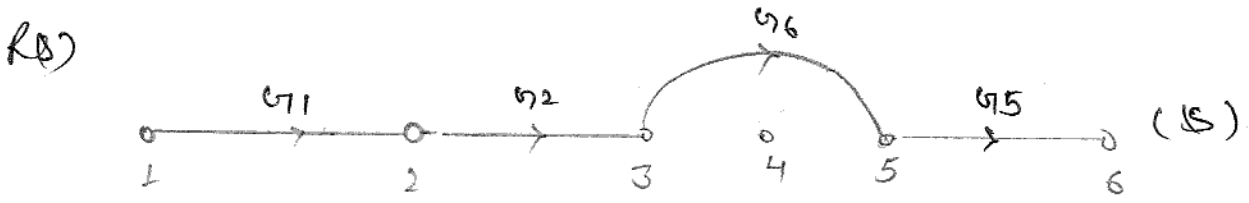
1) forward path Gains :-

There are two forward path $\therefore n = 2$

Let forward path gains be P_1 & P_2



forward part 1

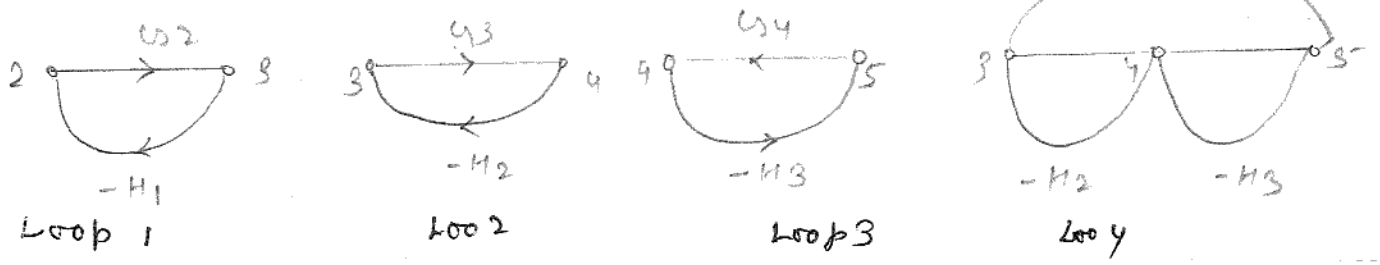


forward path 2

Gain of forward path 1, $P_1 = G_1 G_2 G_3 G_4 G_5$

Gain of forward path 1, $P_2 = G_1 G_2 G_6 G_5$

2) Individual loops :-



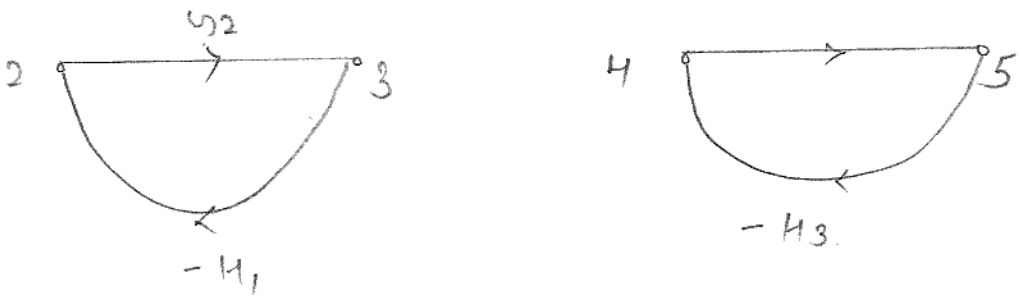
Loop gain of individual loop 1, $P_{11} = -G_2H_1$

Loop gain of individual loop 2, $P_{21} = -G_3H_2$

Loop gain of individual loop 3, $P_{31} = -G_4H_3$

Loop gain of individual loop 4, $P_{41} = -G_5H_2H_3$

3) Gain product of two non touching loops



first Combination of two non touching loops

There is only one combination of two non touching to loops. Let gain product of two non touching loops be P_{12}

Gain product of first combination of two non touching loops $= P_{12} = (-G_2H_1)(-G_4H_3)$

$= G_2G_4H_1H_3$

4) Calculation of Δ and Δ_k :

$\Delta = 1-(P_{11}+P_{21}+P_{31}+P_{41})+P_{12}$

$\Rightarrow \Delta = 1-(-G_2H_1-G_3H_2-G_4H_3+G_5H_2H_3)+G_2G_4H_1H_3$

$\Rightarrow \Delta = 1+G_2H_1+G_3H_2+G_4H_3-G_5H_2H_3+G_2G_4H_1H_3$

There is no part of graph which is non touching with forward path -1 & 2,

$$\Delta_1 = \Delta_2 = 1$$

5) Transfer function :-

By Mason's gain formula transfer function 'T' is given by

$$T = \frac{1}{\Delta} \sum_k P_k \Delta_k = \frac{1}{\Delta}(P_1\Delta_1 + P_2\Delta_2)$$ (Non forward path is 2, $\therefore k = 2$)

$$\therefore T = \frac{G_1 G_2 G_3 G_4 G_5 + G_1 G_2 G_5 G_6}{1 + G_2 H_1 + G_3 H_2 + G_4 H_3 - G_6 H_2 H_3 + G_2 G_4 H_1 H_3}$$