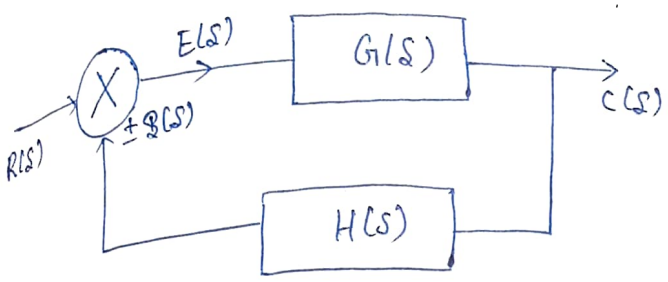
Block Diagram :—



$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 \pm G(s)H(s)}$$

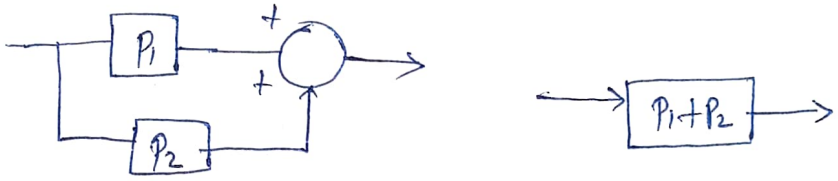
$$\frac{E(s)}{R(s)} = \frac{1}{1 \pm G(s)H(s)}$$

$$\frac{B(s)}{R(s)} = \frac{G(s)H(s)}{1 \pm G(s)H(s)}$$

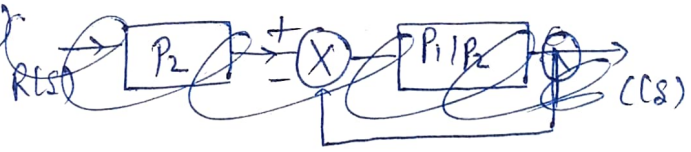
Method of Reduction :—

1.

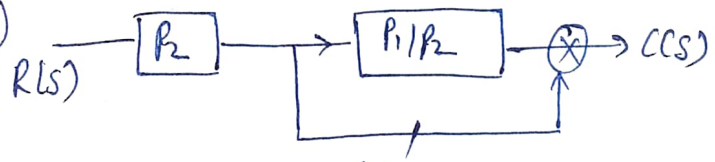
2.



3)



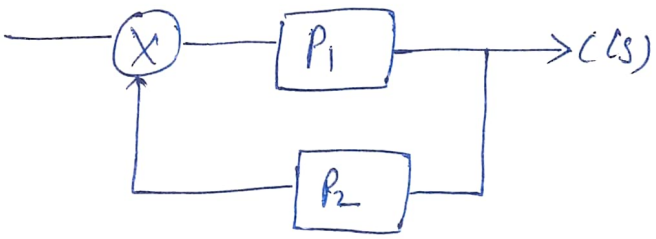
3)

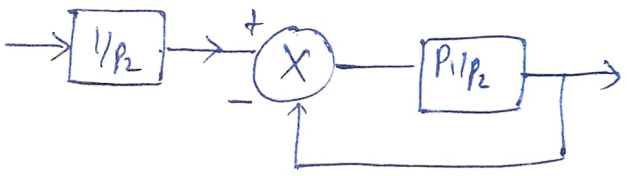


$$(P_1/P_2 + 1)P_2$$

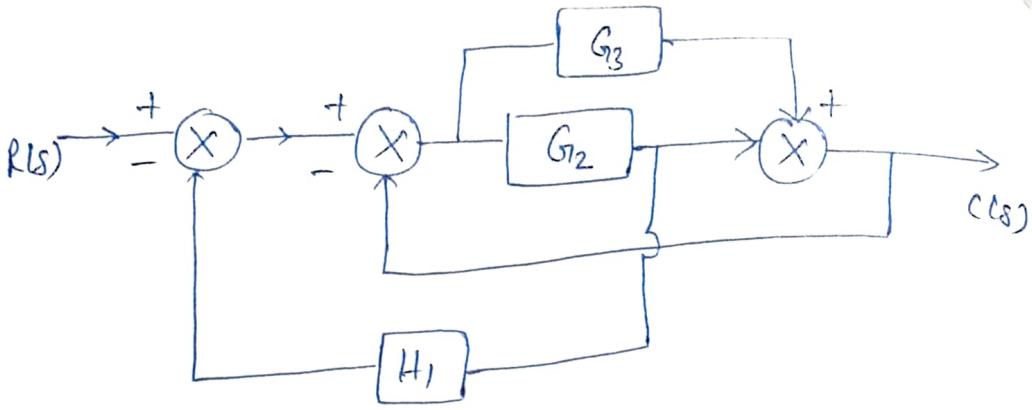
$$= (P_1 + P_2)$$

4)

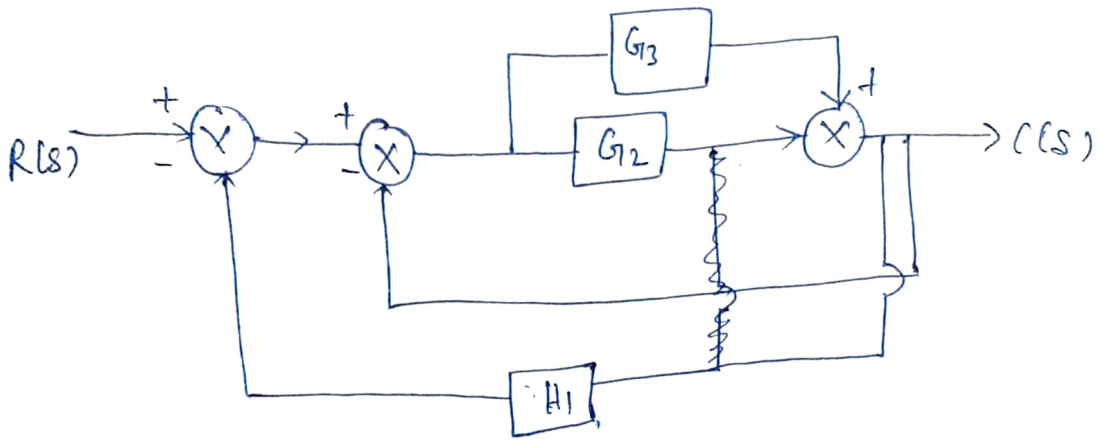


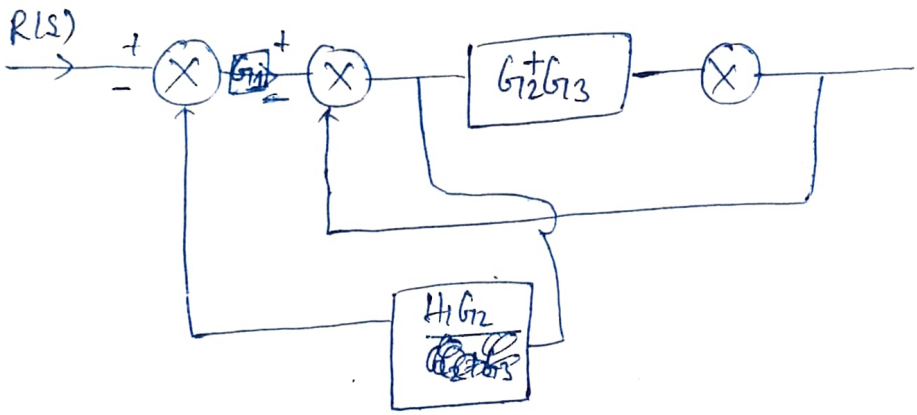


Q.



Sol^n



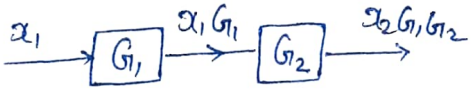


Rule

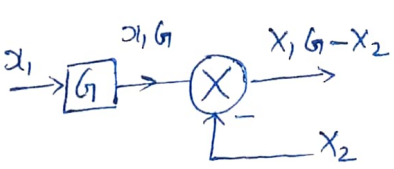
original diagram

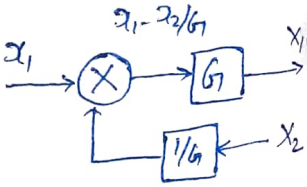
Equivalent diagram

1) Blocks in cascade

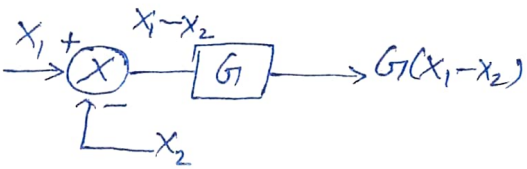


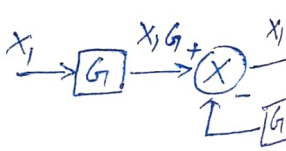
2) Moving a summing pt. ahead of a block





3) Moving a summing pt. beyond a block



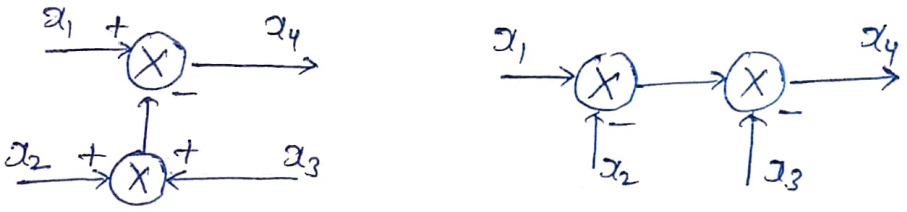


3) Moving a take off pt. beyond a block

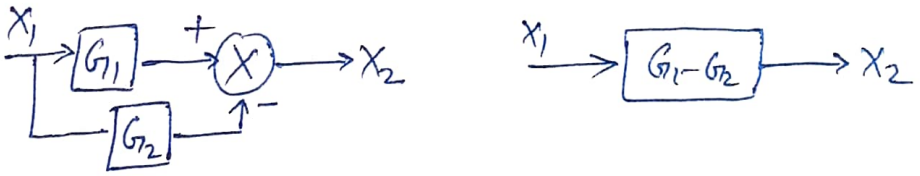
4) Moving a take off pt. ahead of a block

5) Moving a take off pt. ~~beyond~~ the block

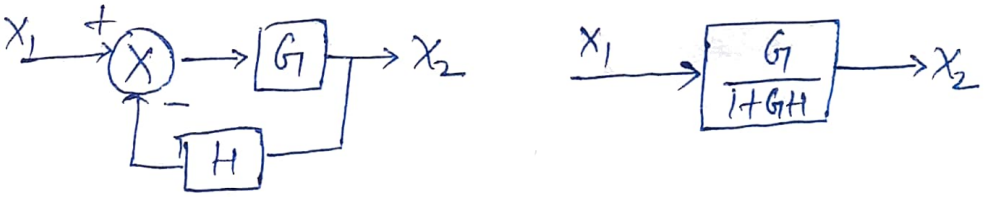
6) Rearrangement of Summing point



7) Eliminating a forward loop

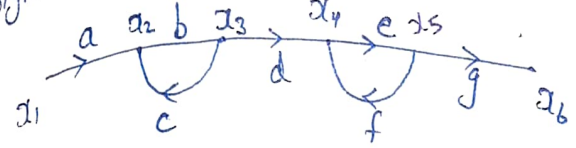


8) Eliminating feedback loop



Signal flow graph :-

Q.



(1)

Soln

$$x_2 = a x_1 + c x_3 \quad - (1)$$

$$x_3 = b x_2 \rightarrow (2)$$

$$x_4 = d x_3 + f x_5 - (4)$$

$$x_5 = e x_4 \quad - (5)$$

$$x_6 = g x_5 - (6)$$

$$\frac{x_6}{x_1} = ??$$

Mason's Gain formula :-

$$\frac{C}{R} = \frac{P_1 \Delta_1 + P_2 \Delta_2}{\Delta}$$

$P_1 \rightarrow$ forward path

$\Delta_1 \rightarrow$ ~~$= 1 - (L_1 + L_2)$~~

$P_2 \rightarrow$ Forward IInd path

$\Delta_2 \rightarrow$

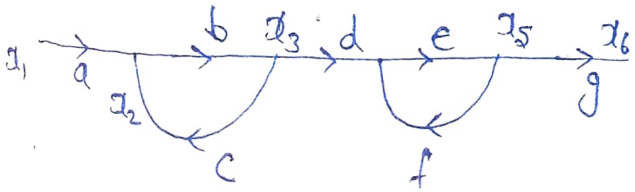
$\rightarrow$ Individual loops

$$\Delta = 1 - (L_1 + L_2 + L_3) + \underbrace{L_1 L_2 + L_2 L_3}_{\text{two non touching loops.}} + L_1 L_3 - \underbrace{L_1 L_2 L_3}_{\text{three non touching loops}}$$

L_1, L_2, L_3 are feedback loops.

$\Delta_1 \rightarrow$ Same as Δ but for P_1

$\Delta_2 \rightarrow$ Same as Δ, but for P_2.



, $\frac{x_8}{x_1} = ??$

$P = abdeg$

$L_1 = bc$

$L_2 = ef$

$\Delta_1 = 1$

$\Delta = 1 - (L_1 + L_2) + L_1 L_2$ — if both loops are not touching.

$= 1 - (bc + ef) + bcef.$

$$\frac{C}{R} = \frac{abdeg}{1-(bc+ef)+bcef}$$

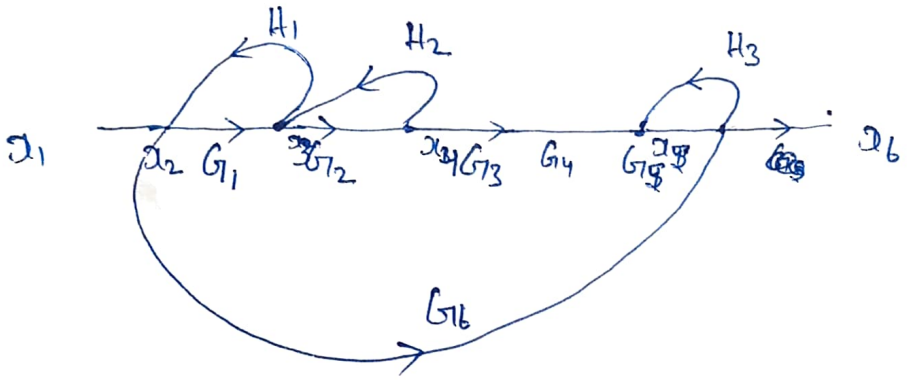
$\frac{x_8}{x_1} = ??$

$P = abdegij$ $\quad L_1 = bc$ $\quad \Delta = 1 - (bc+ef+ih) + bcef + efih + bcih - bcefih.$

$\Delta_1 = 1$ $\quad L_2 = ef$

$L_3 = ih$

Q.

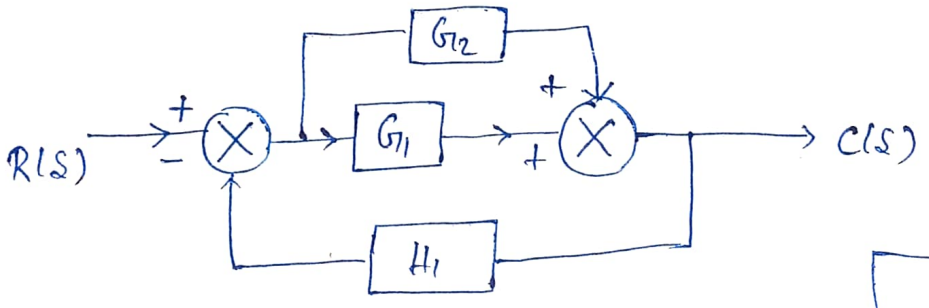


$P_1 = G_1 G_2 G_3 G_4 G_5$, $\Delta_1 = 1$

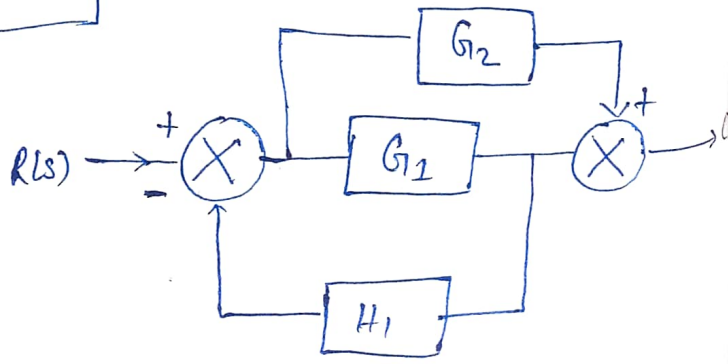
$P_2 = G_1 G_6$ $\quad \Delta_2 = (1 - G_2 H_2)$

$\Delta = 1 - (L_1 + L_2 + L_3) + (L_1 L_3 + L_2 L_3)$

Q.

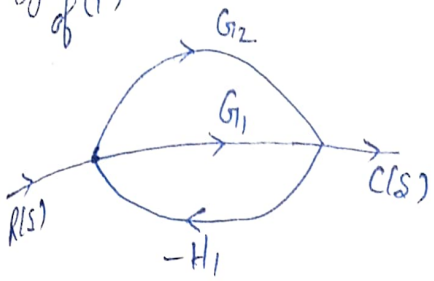


(i)



(ii)

Signal flow graph of (i)



(i) $\Delta_1 = 1$

$P_1 = G_1$, $P_2 = G_2$

$L_1 = -G_1H_1$ $\Delta_2 = 1$

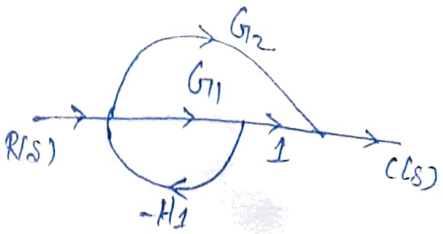
$L_2 = -G_2H_2$.

$$\frac{C}{R} = \frac{P_1\Delta_1 + P_2\Delta_2}{\Delta}$$

$\Delta = 1 - (-G_1H_1 - G_2H_1)$

$= 1 + (G_1+G_2)H_1$

S.F G_1 of (ii)



(ii)

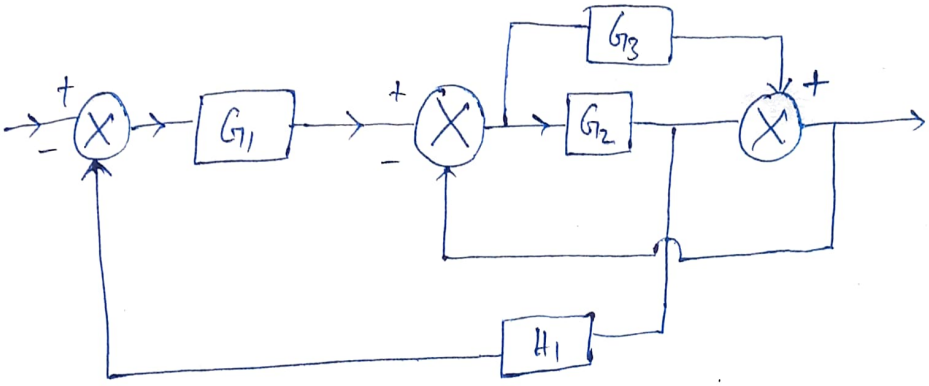
$P_1 = G_1$, $\Delta_1 = 1$

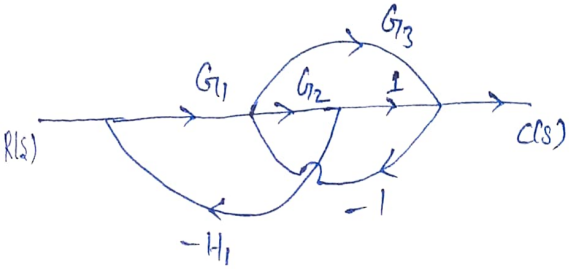
$P_2 = G_2$, $\Delta_2 = 1$

$\Delta = 1 - (-G_1H_1)$

$= 1 + G_1H_1$

$$\frac{C}{R} = \frac{G_1 + G_2}{1 + G_1H_1}$$





$P_1 = G_1G_3$, $\Delta_1 = 1$

$P_2 = G_1G_2$, $\Delta_2 = 1$

$L_1 = -G_1G_2H_1$

$L_2 = -G_2$

$L_3 = -G_3$

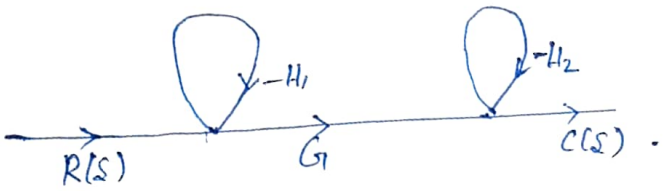
$\Delta = 1 - (L_1 + L_2 + L_3)$

$\Delta = 1 + G_1G_2H_1 + G_2 + G_3$

Q.

G-2 Marks

IES-04



A) G B) $\frac{G}{(1-H_1)(1+H_2)}$

C) $\frac{G}{1+H_1+H_2}$ d) $\frac{G}{(1+H_1)(1+H_2)}$ (✓)

Soln

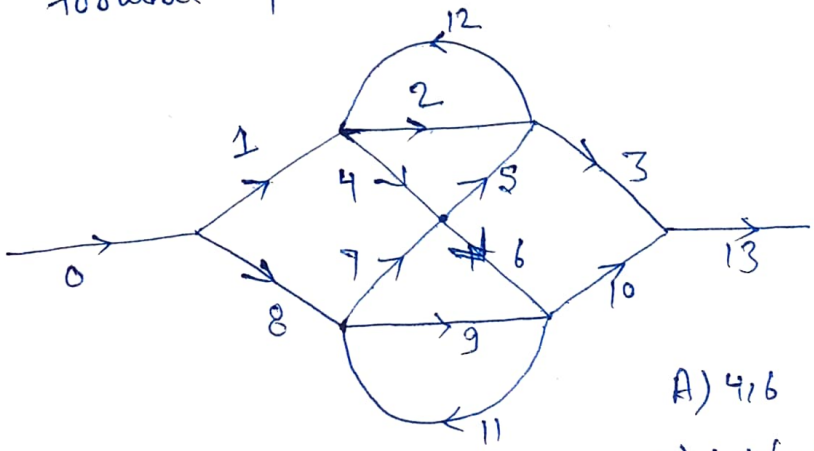
$P = G$, $\Delta_1 = 1$

$L_1 = -H_1$, $\Delta = 1+(L_1+L_2)+L_1L_2$

$L_2 = -H_2$ $= 1+H_1+H_2+H_1H_2$

$= (1+H_1)\cdot(1+H_2)$

Q. No. of forward path & loops



A) 4,6 B) 6,6

C) 6,4 (✓) d) 4,4

Soln

0, 1, 2, 3, 13 ✓

0, 8, 9, 10, 13 ✓

0, 1, 4, 6, 10, 13 ✓

0, 8, 9, 10, 13

~~0, 1, 2, 12, 4, 6, 10, 13~~

~~0, 8, 9, 11, 9, 5, 3, 13~~

0-8-7-5-3-13

0-8-7-6-10-13

2-12

9-11

4-5-12

7-6-11