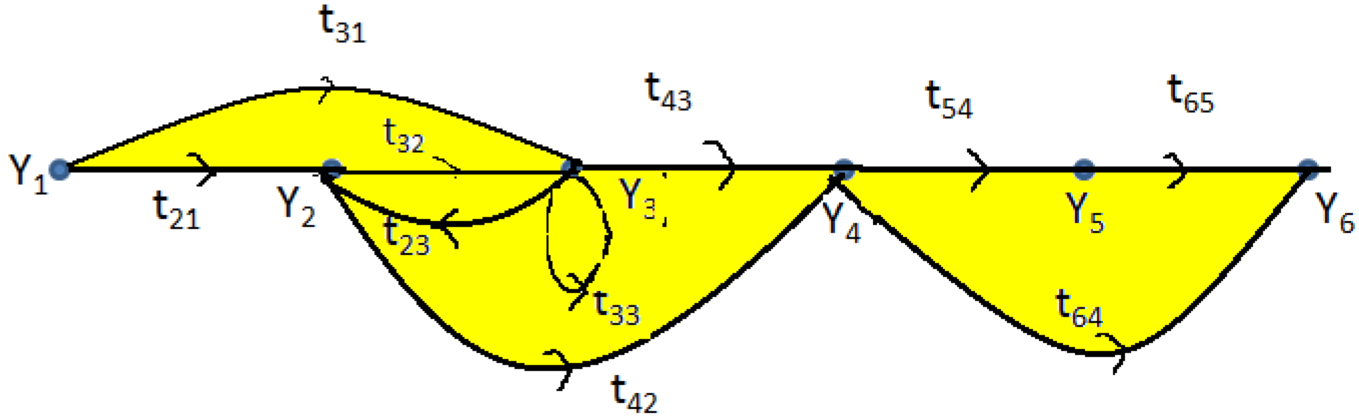
After joining all SFG



SFG from Differential equations

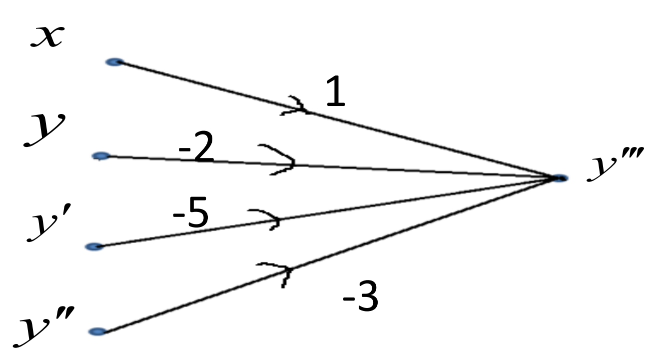
Consider the differential equation

$$y''' + 3y'' + 5y' + 2y = x$$

Step 1: Solve the above eqn for highest order

$$y''' = x - 3y'' - 5y' - 2y$$

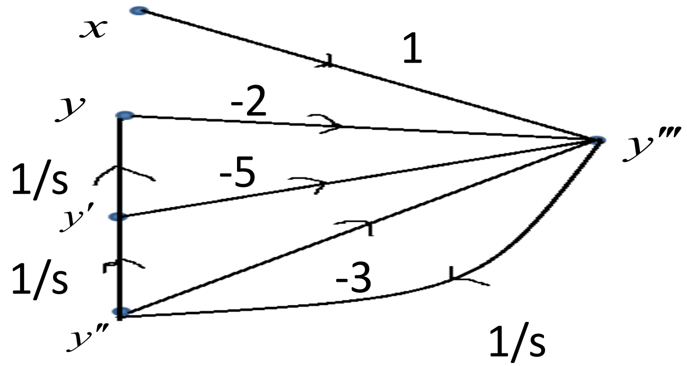
Step 2: Consider the left hand terms (highest derivative) as dependant variable and all other terms on right hand side as independent variables.
Construct the branches of signal flow graph as shown below:-



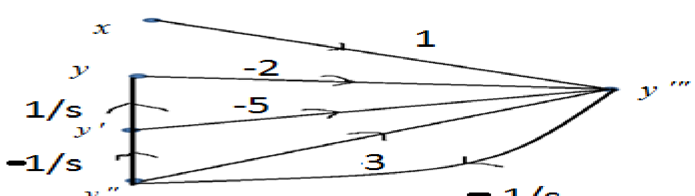
(a)

Step 3: Connect the nodes of highest order derivatives to the lowest order der.node and so on. The flow of signal will be from higher node to lower node and transmittance will be 1/s as shown in fig (b)

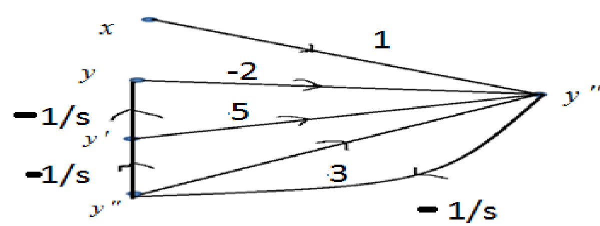
(b)



Step 4: Reverse the sign of a branch connecting y''' to y'', with condition no change in T/F fn.

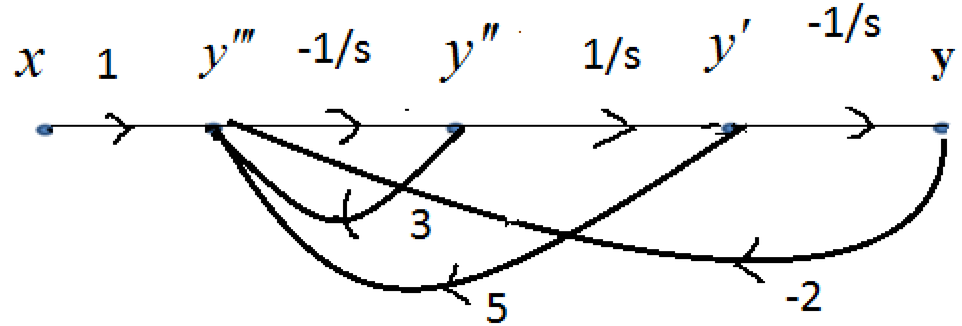


(c)

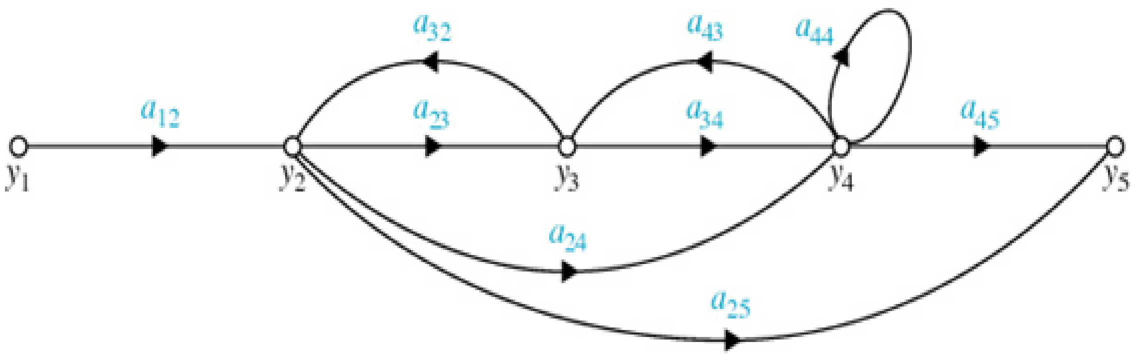


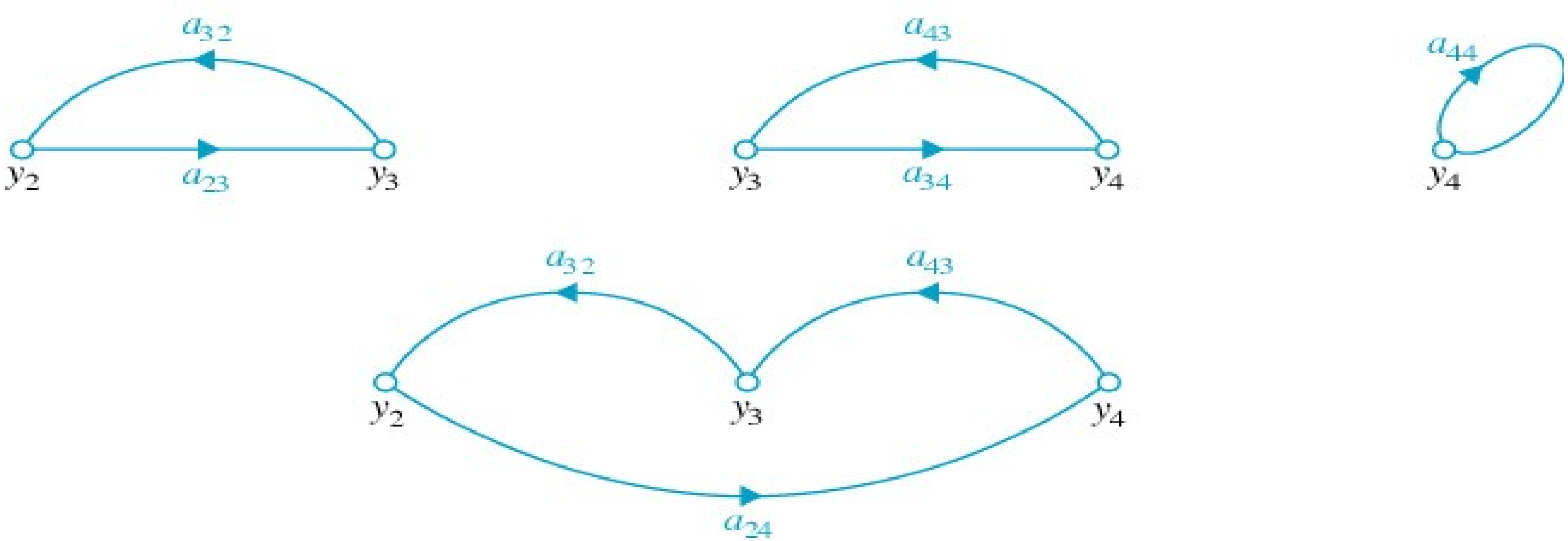
(d)

Step5: Redraw the SFG as shown.

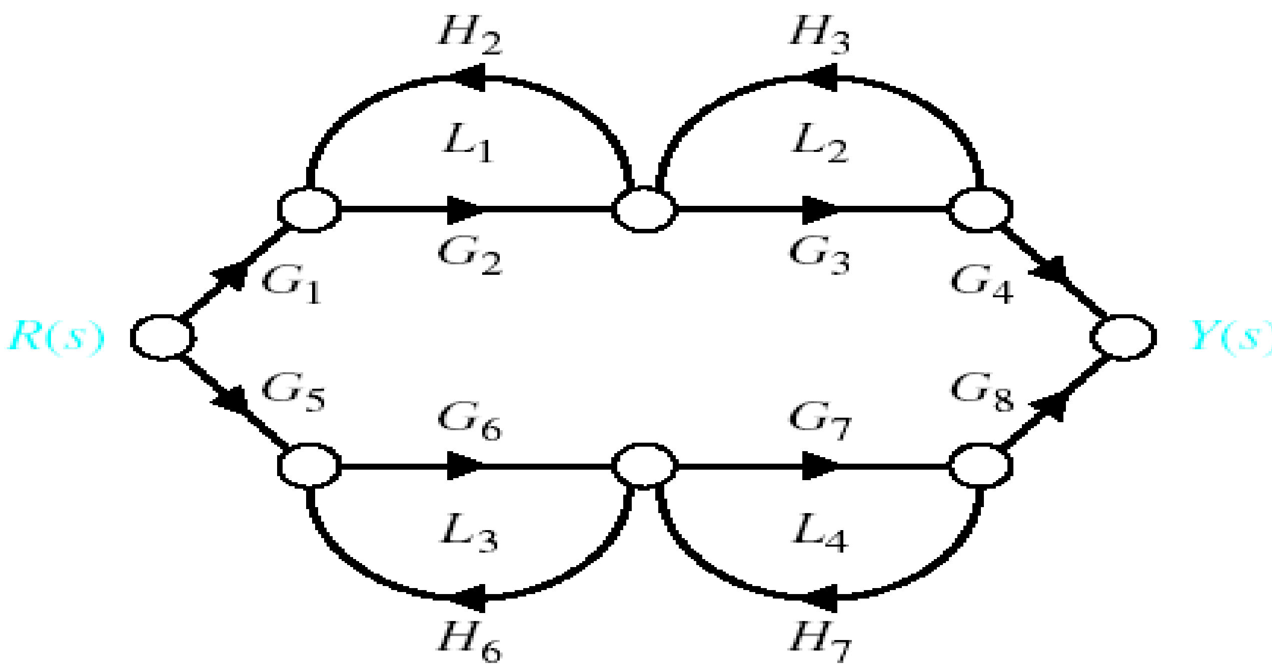


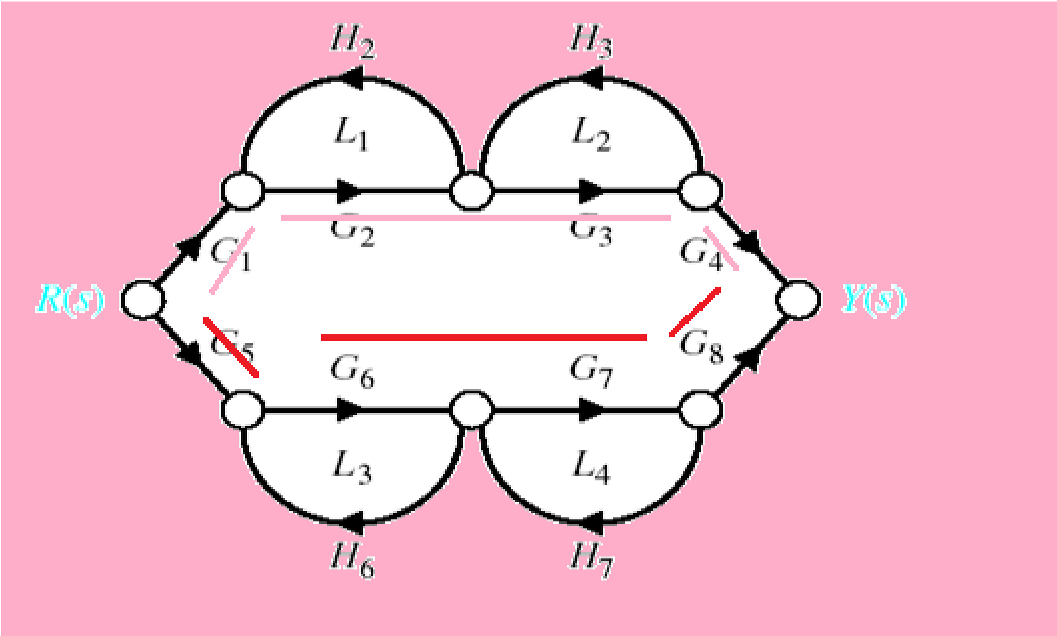
Problem: to find out loops from the given SFG





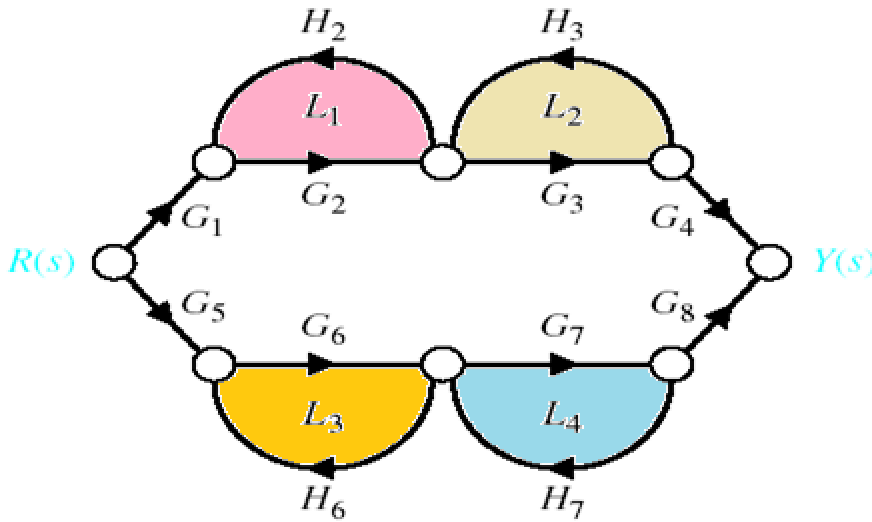
Ex: Signal-Flow Graph Models





$P_1 = G_1 \cdot G_2 \cdot G_3 \cdot G_4 \cdot$

$P_2 = G_5 \cdot G_6 \cdot G_7 \cdot G_8 \cdot$



Individual loops

$L_1 = G_2 H_2$

$L_2 = G_3 H_3$

$L_3 = G_6 H_6$

$L_4 = G_7 H_7$

Pair of Non-touching loops

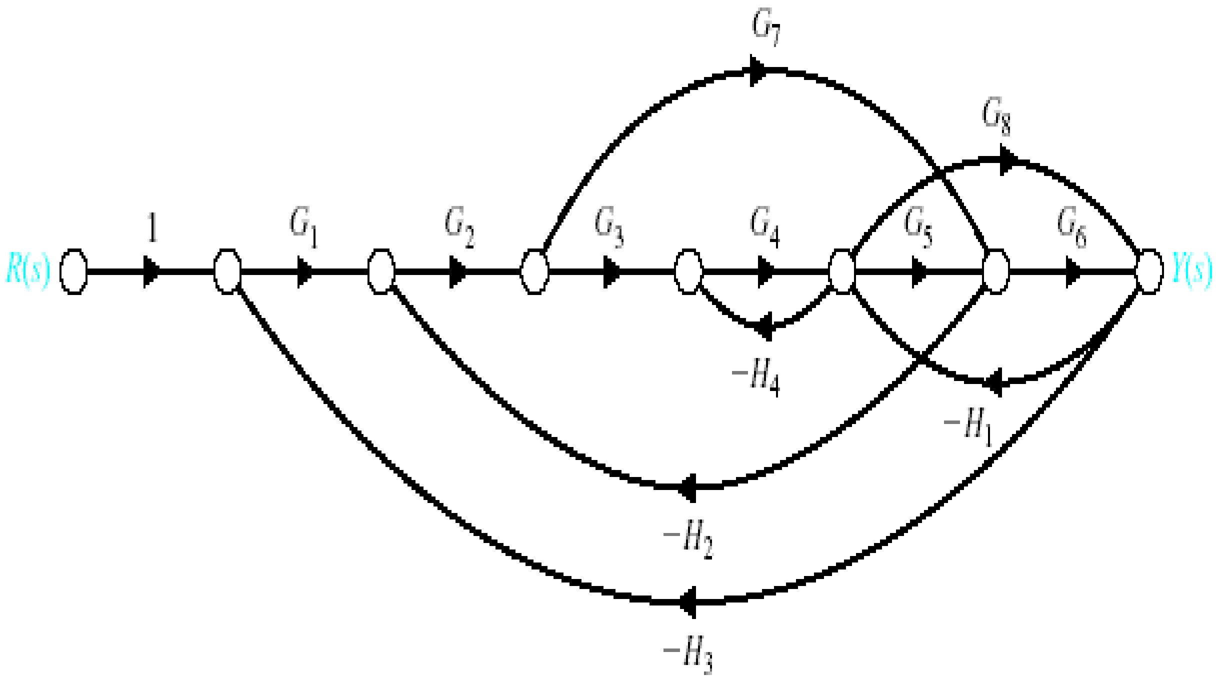
$L_1 L_3$ $L_1 L_4$

$L_2 L_3$ $L_2 L_4$

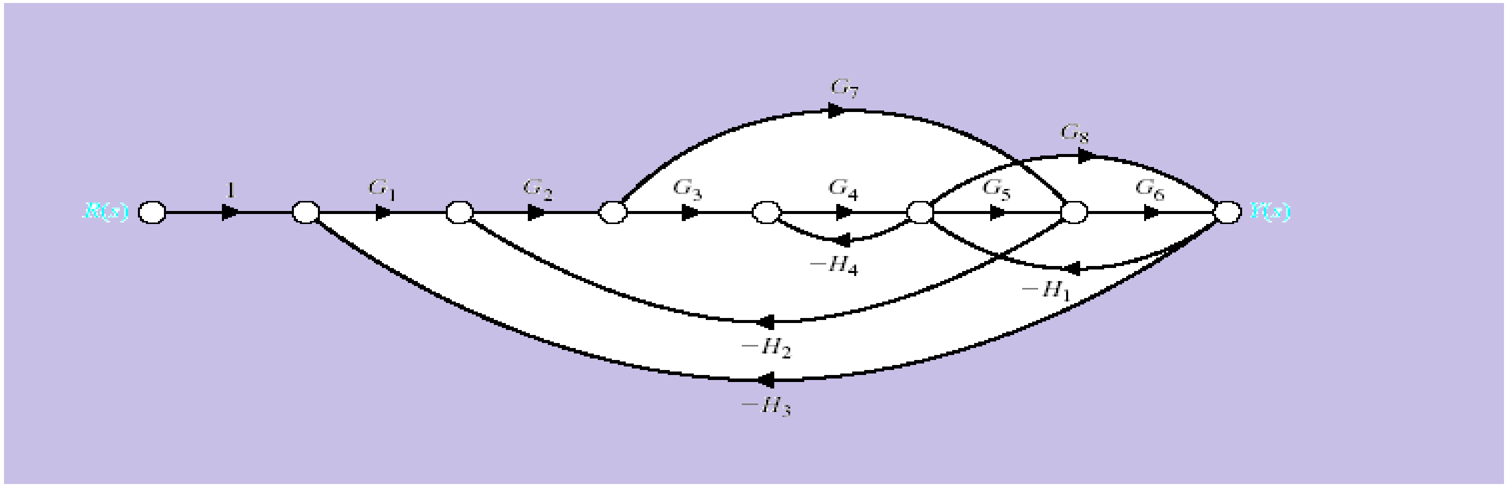
$$\frac{Y}{R} = \frac{\sum P_k \Delta_k}{(1-(L1+L2+---)+\sum LiLj-\sum LiLjLk..}$$

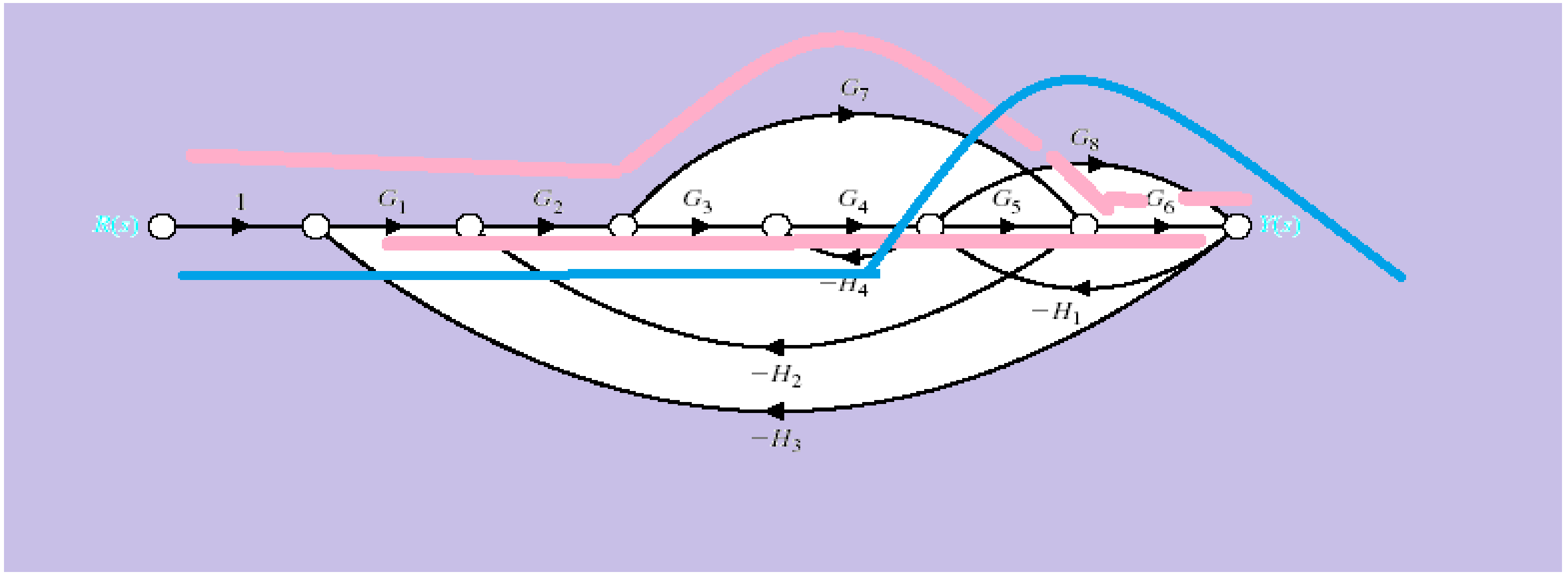
$$\frac{Y(s)}{R(s)} = \frac{\left[G_1 \cdot G_2 \cdot G_3 \cdot G_4 \cdot \left(1 - L_3 - L_4\right)\right] + \left[G_5 \cdot G_6 \cdot G_7 \cdot G_8 \cdot \left(1 - L_1 - L_2\right)\right]}{1 - L_1 - L_2 - L_3 - L_4 + L_1 \cdot L_3 + L_1 \cdot L_4 + L_2 \cdot L_3 + L_2 \cdot L_4}$$

Ex:

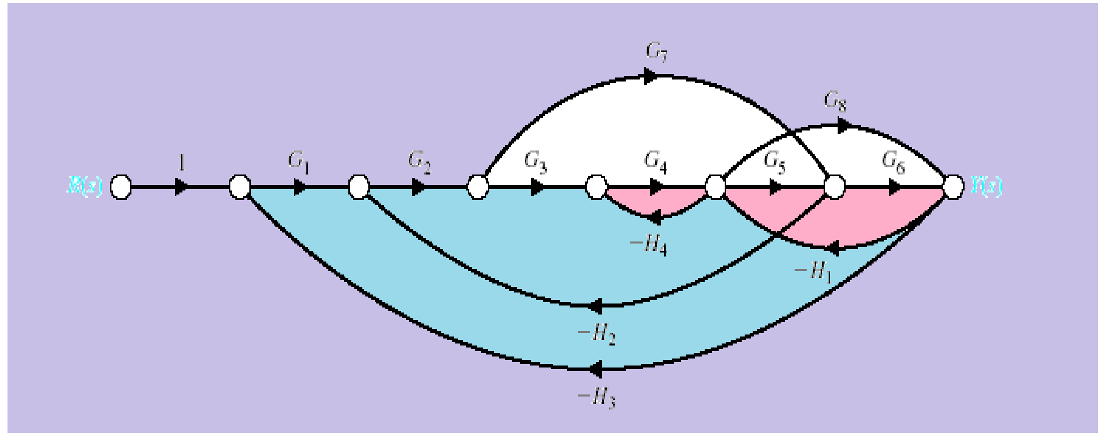


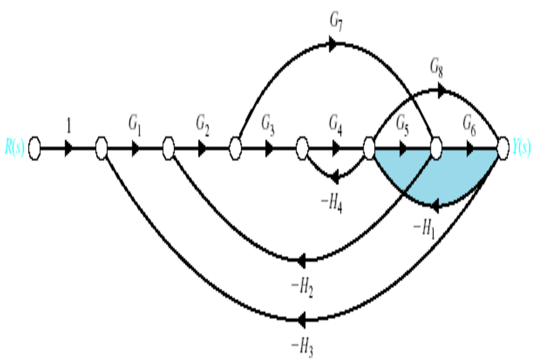
Forward Paths





Loops





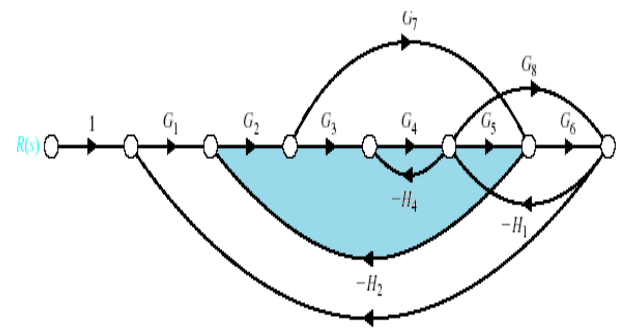
$L_1 = -G_5 G_6 H_1$

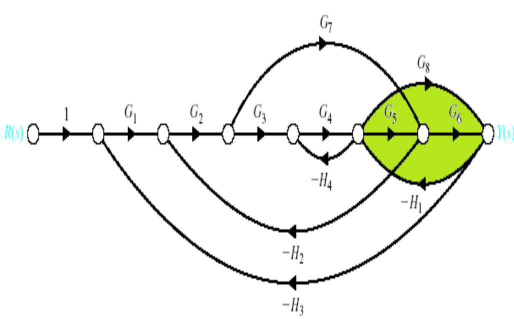
$L_2 = -G_2 G_3 G_4 G_5 H_2$

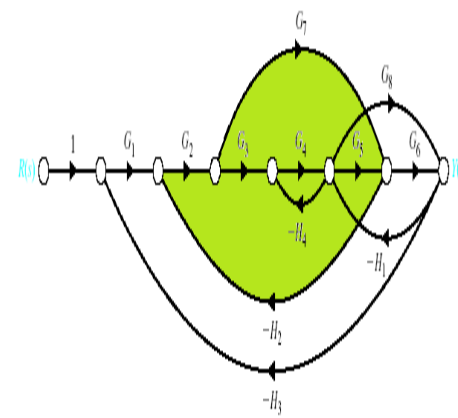
$L_3 = -G_8 H_1$

$L_4 = -G_2 G_7 H_2$

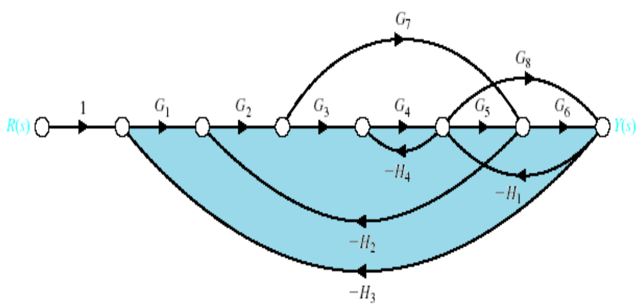
$L_5 = -G_4 H_4$



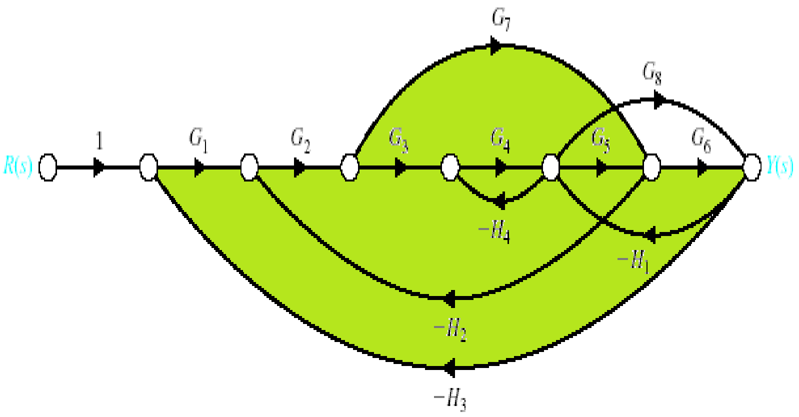




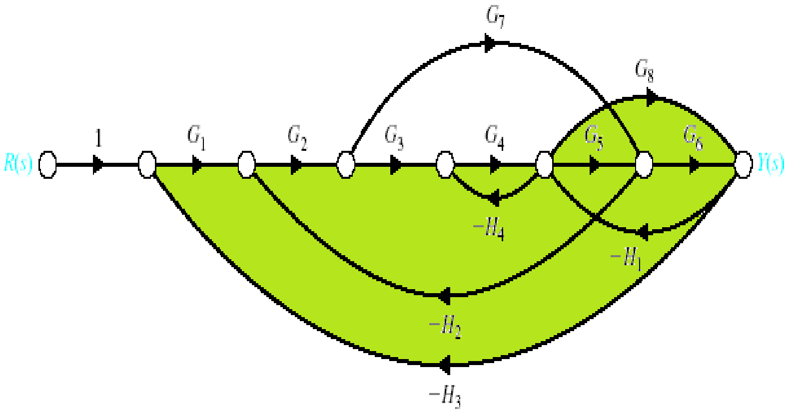
Loops



$L_6 = -G_1 G_2 G_3 G_4 G_8 H_3$

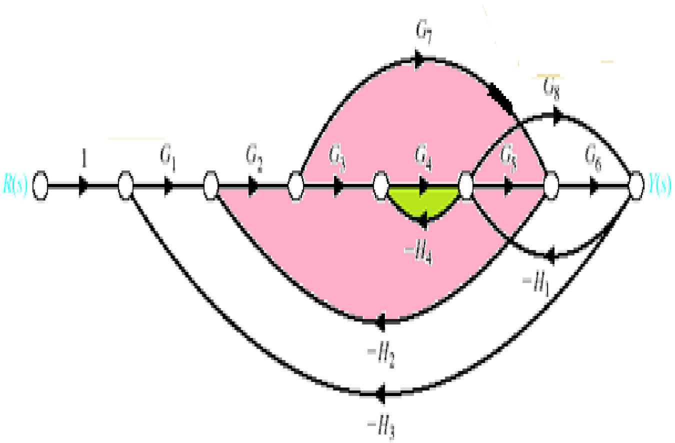


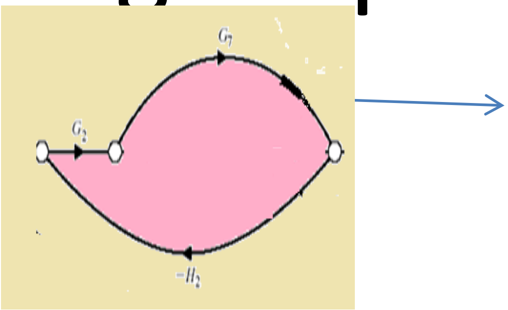
$L_7 = -G_1 G_2 G_7 G_6 H_3$



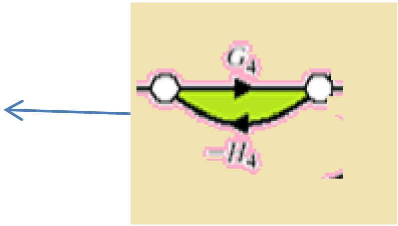
$L_8 = -G_1 G_2 G_3 G_4 G_5 G_6 H_3$

Pair of Non-touching loops



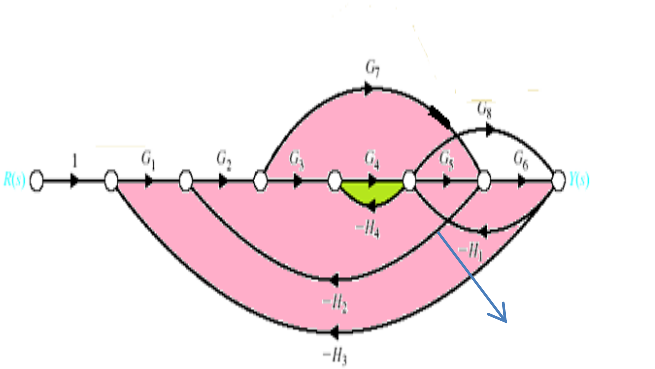


L_5



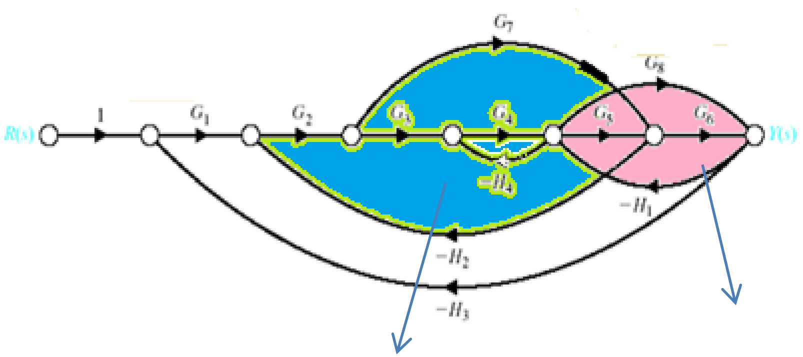
L_4

L_4L_5



L_7

L_5L_7

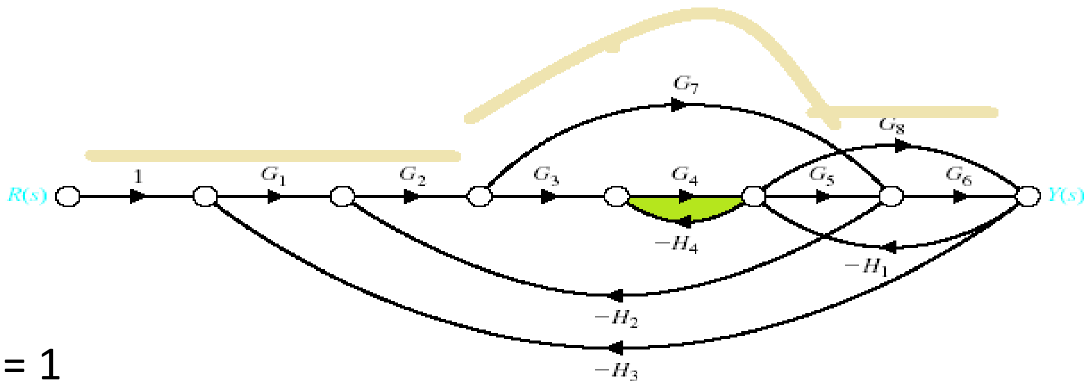


L_4

L_3

L_3L_4

Non-touching loops for paths

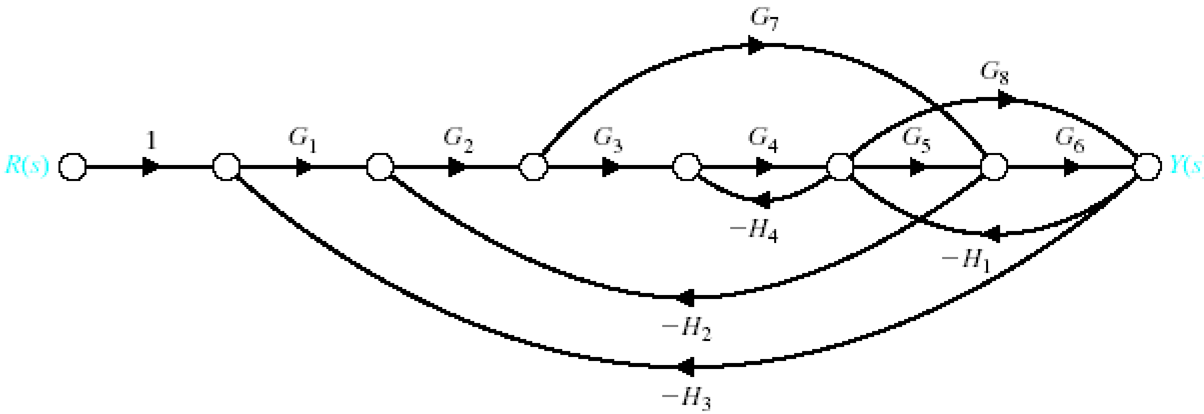


$\Delta_1 = 1$

$\Delta_2 = -G_4 H_4$

$\Delta_3 = 1$

Signal-Flow Graph Models



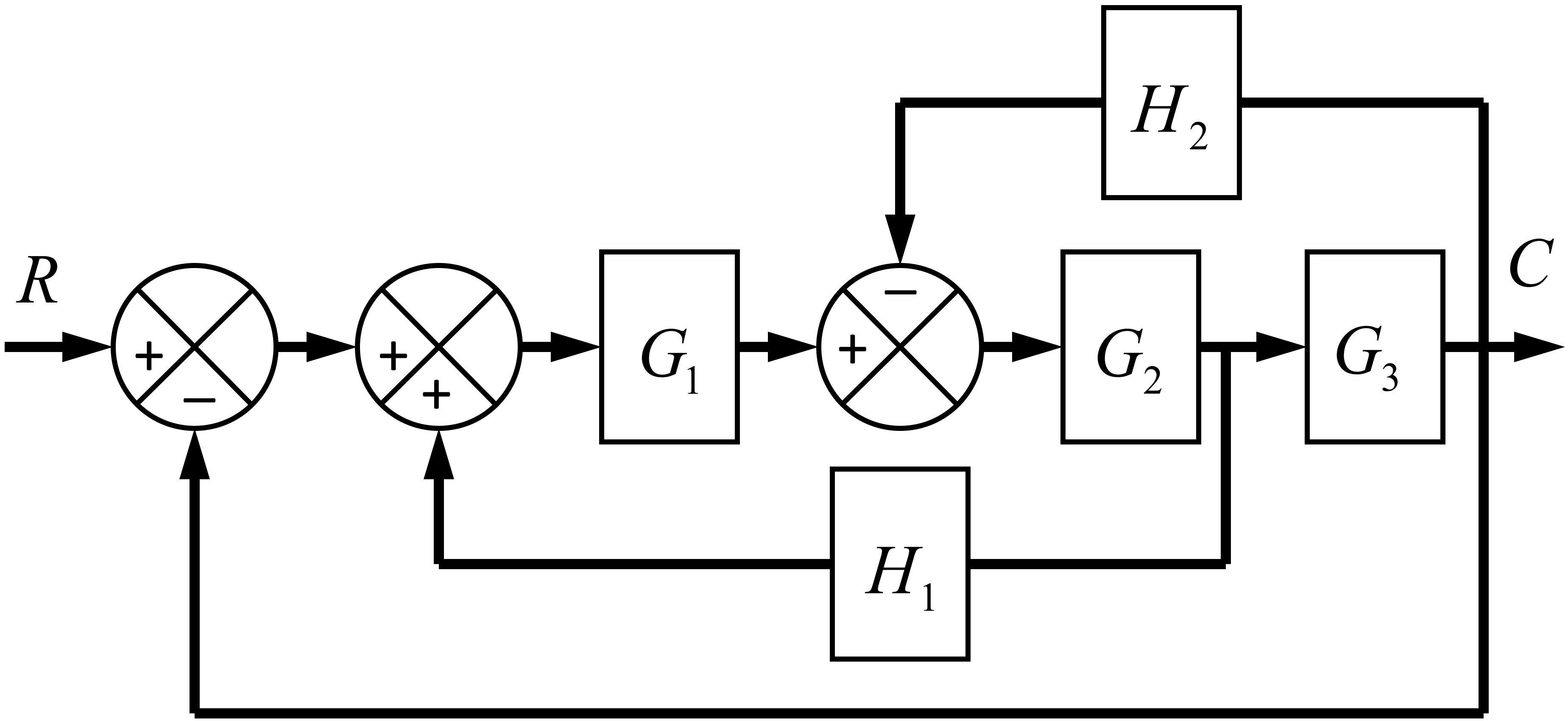
$$\frac{Y(s)}{R(s)} = \frac{P_1 + P_2 \cdot \Delta_2 + P_3}{\Delta}$$

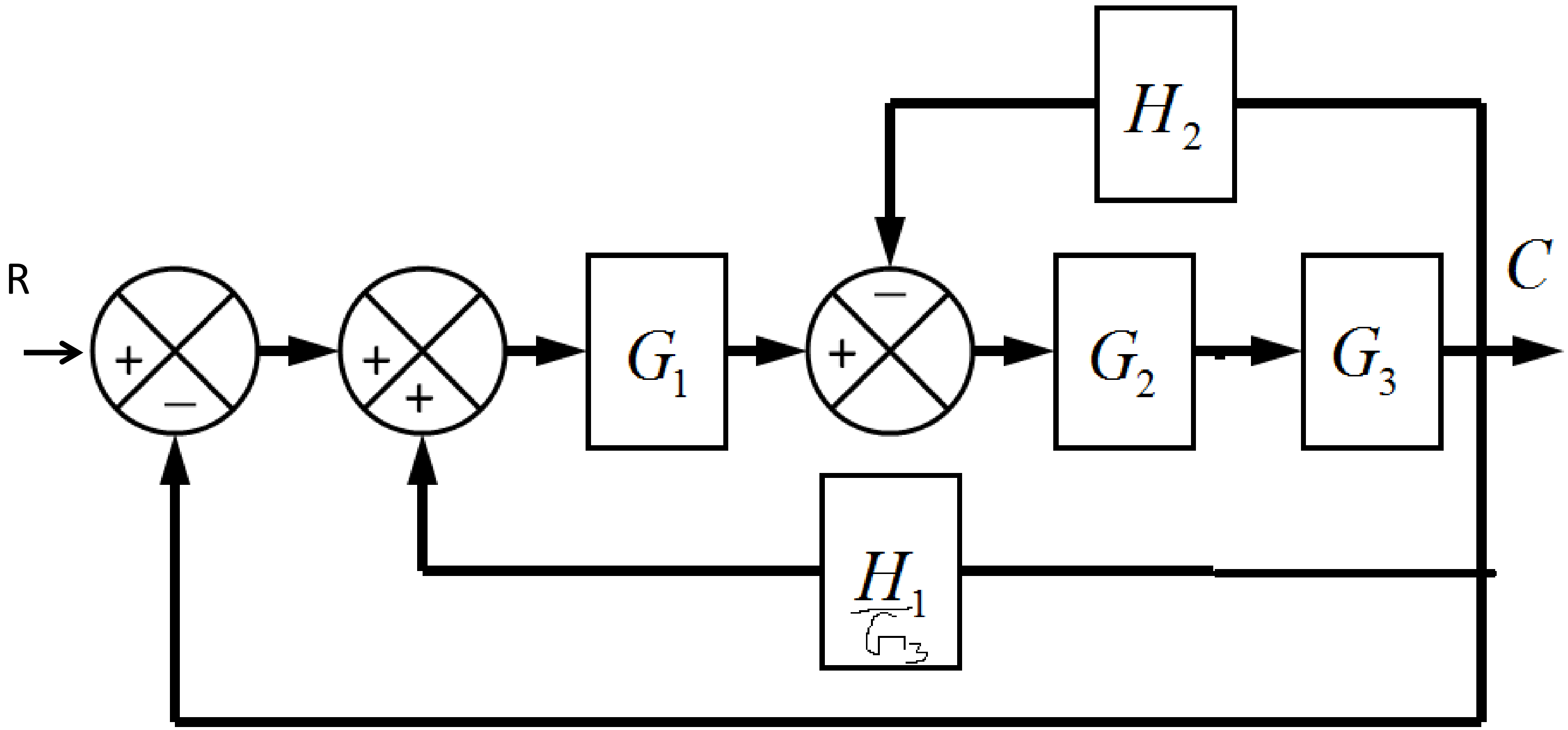
$P_1 = G_1 \cdot G_2 \cdot G_3 \cdot G_4 \cdot G_5 \cdot G_6$ $\qquad P_2 = G_1 \cdot G_2 \cdot G_7 \cdot G_6$ $\qquad P_3 = G_1 \cdot G_2 \cdot G_3 \cdot G_4 \cdot G_8$

$\Delta = 1 - (L_1 + L_2 + L_3 + L_4 + L_5 + L_6 + L_7 + L_8) + (L_5 \cdot L_7 + L_5 \cdot L_4 + L_3 \cdot L_4)$

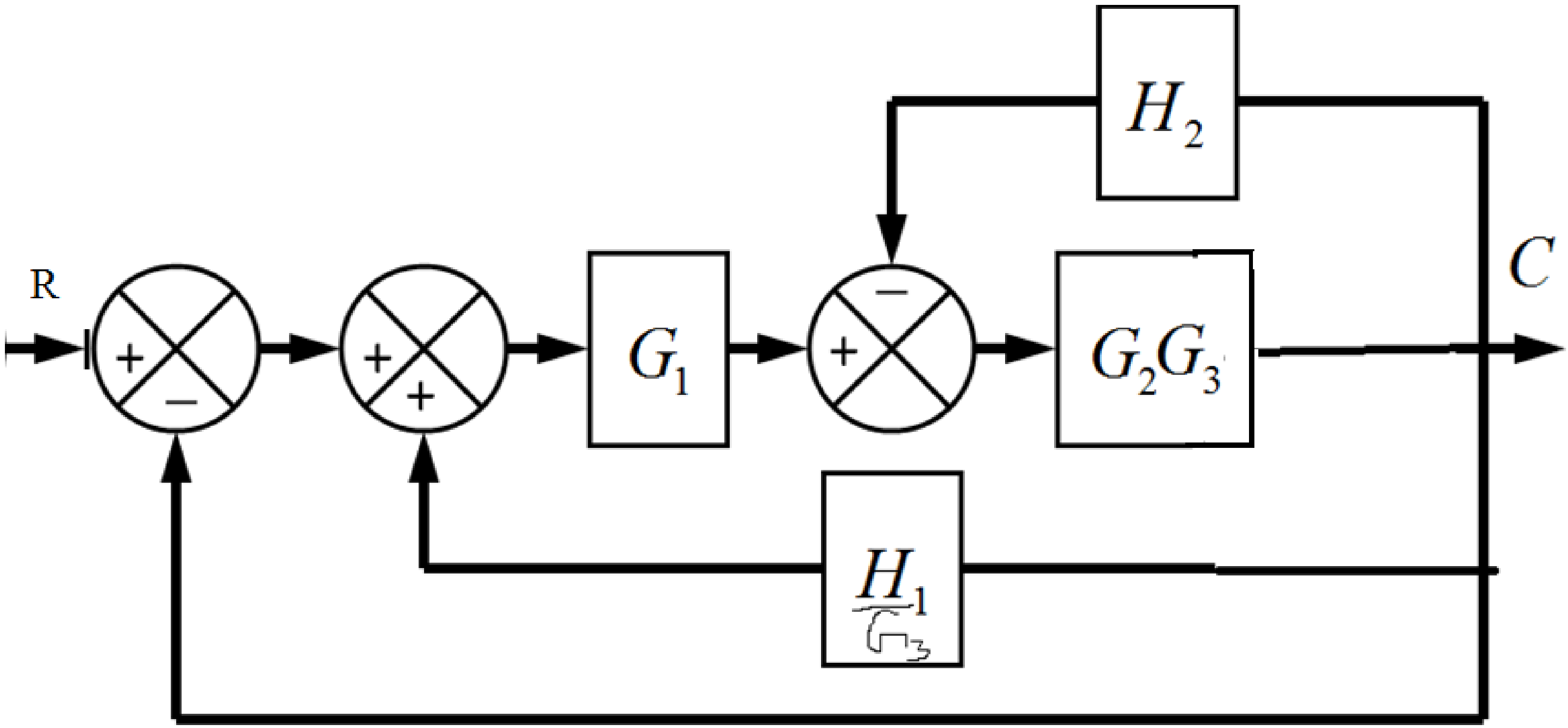
$\Delta_1 = \Delta_3 = 1$ $\qquad \Delta_2 = 1 - L_5 = 1 + G_4 \cdot H_4$

Block Diagram Reduction Example





R
+
−
+
+
G_1
+
−
H_2
G_2
G_3
C
H_1



R
+
−
+
+
G_1
−
+
H_2
G_2G_3
C
H_1
G_3