

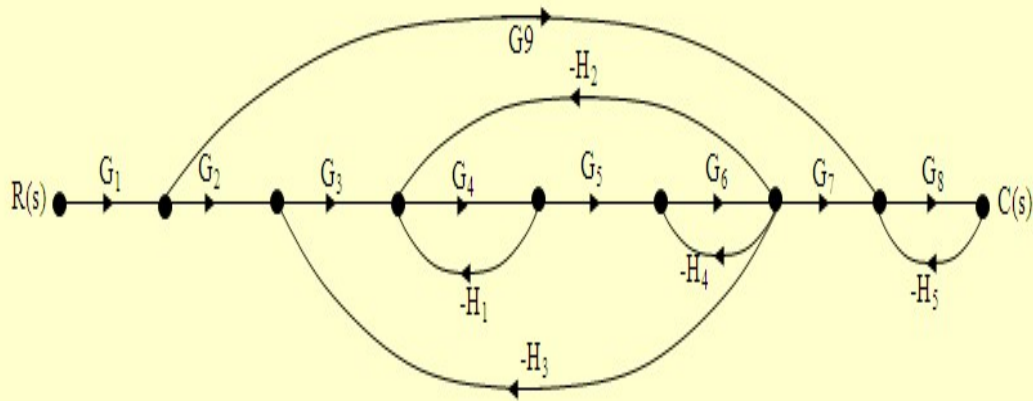
Example-1: Determine the transfer function $C(s)/R(s)$.

The block diagram shows a forward path with four blocks: G_1 , G_2 , G_3 , and G_4 . There are two feedback paths: H_1 (from the output of G_2 to the input of G_1) and H_2 (from the output of G_4 to the input of G_3). A third feedback path H_3 is a curved arrow from the output $C(s)$ back to the input $R(s)$.

$$T(s) = \frac{\sum P_k \Delta_k}{\Delta}$$

- $P_1 = G_1 G_2 G_3 G_4$ $\Delta_1 = 1$ There is no P_2 or Δ_2 or more.
- $\sum L_1 = -G_1 G_2 H_1 + G_2 G_3 H_3 - G_3 G_4 H_2$
- $\sum L_2 = G_1 G_2 G_3 G_4 H_1 H_2$
- $\Delta = 1 - \sum L_1 + \sum L_2 = 1 + G_1 G_2 H_1 - G_2 G_3 H_3 + G_3 G_4 H_2 + G_1 G_2 G_3 G_4 H_1 H_2$
- $T(s) = \frac{\sum P_1 \Delta_1}{\Delta} = \frac{G_1 G_2 G_3 G_4}{1 + G_1 G_2 H_1 - G_2 G_3 H_3 + G_3 G_4 H_2 + G_1 G_2 G_3 G_4 H_1 H_2}$

Example-2: Determine the transfer function $C(s)/R(s)$.



$$M_1 = G_1 G_2 G_3 G_4 G_5 G_6 G_7 G_8$$

$$\Delta_1 = 1$$

$$M_2 = G_1 G_5 G_8$$

$$\Delta_2 = 1 - [-G_4 H_1 - G_6 H_1 - G_3 G_4 G_5 G_6 H_3 - G_4 G_5 G_6 H_1] + G_4 H_1 G_6 H_4$$

$$= 1 + G_4 H_1 + G_6 H_4 + G_3 G_4 G_5 G_6 H_3 + G_4 G_5 G_6 H_1 + G_4 H_1 G_6 H_4$$

$$\Delta = 1 - [-G_4 H_1 - G_6 H_1 - G_3 G_4 G_5 G_6 H_3 - G_4 G_5 G_6 H_1 - G_6 H_1]$$

$$+ [G_4 H_1 G_6 H_4 + G_4 H_1 G_6 H_3 + G_6 H_4 G_6 H_3 + G_6 H_3 G_4 G_5 G_6 H_1 + G_6 H_3 G_3 G_4 G_5 G_6 H_3]$$

$$+ G_4 H_1 G_6 H_4 G_6 H_3$$

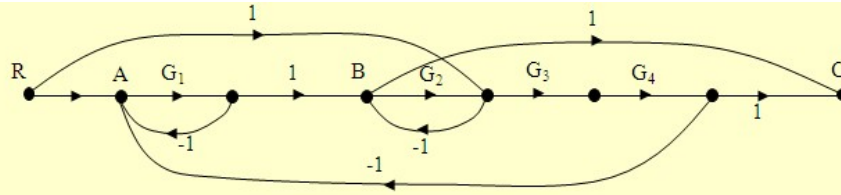
$$\Delta = 1 + G_4 H_1 + G_6 H_4 + G_3 G_4 G_5 G_6 H_3 + G_4 G_5 G_6 H_1 + G_6 H_3$$

$$+ G_4 H_1 G_6 H_4 + G_4 H_1 G_6 H_3 + G_6 H_4 G_6 H_3 + G_6 H_3 G_4 G_5 G_6 H_1 + G_6 H_3 G_3 G_4 G_5 G_6 H_3$$

$$+ G_4 H_1 G_6 H_4 G_6 H_3$$

$$T(s) = \frac{C(s)}{R(s)} = \frac{M_1 \Delta_1 + M_2 \Delta_2}{\Delta} = \frac{G_1 G_2 G_3 G_4 G_5 G_6 G_7 G_8 + G_1 G_5 G_8 [1 + G_4 H_1 + G_6 H_4 + G_3 G_4 G_5 G_6 H_3 + G_4 G_5 G_6 H_1 + G_4 H_1 G_6 H_4]}{\Delta}$$

Example-3: Determine the transfer function $C(s)/R(s)$.



$$M_1 = G_1 G_2 G_3 G_4 \quad \Delta_1 = 1$$

$$M_2 = G_1 \quad \Delta_2 = 1$$

$$M_3 = G_3 G_4 \quad \Delta_3 = 1 + G_1$$

$$M_4 = -1 \quad \Delta_4 = 1 + G_1$$

$$M_5 = -G_3 G_4 G_1 \quad \Delta_5 = 1$$

$$\Delta = 1 - (-G_1 - G_2 - G_1 G_2 G_3 G_4) + G_1 G_2 = 1 + G_1 + G_2 + G_1 G_2 G_3 G_4 + G_1 G_2$$

$$a) \frac{C}{M} = \frac{G_1 G_2 G_3 G_4 + G_1 + G_3 G_4 (1 + G_1) - (1)(1 + G_1) - G_1 G_3 G_4}{1 - (-G_1 - G_2 - G_1 G_2 G_3 G_4) + G_1 G_2}$$