Type 2: Signal Flow Graph and Block Diagram Algebra

For Concept, refer to Control Systems K-Notes, Signal Flow Graphs

Common Mistakes:
If two touching loops have been counted individually then they must not be counted as part of a single loop again.
The input to a signal flow graph cannot be connected to any loops it should have only one outgoing branch. If no such input is given we have to assume a hypothetical input. (Refer Q.5)

Sample Problem 2:

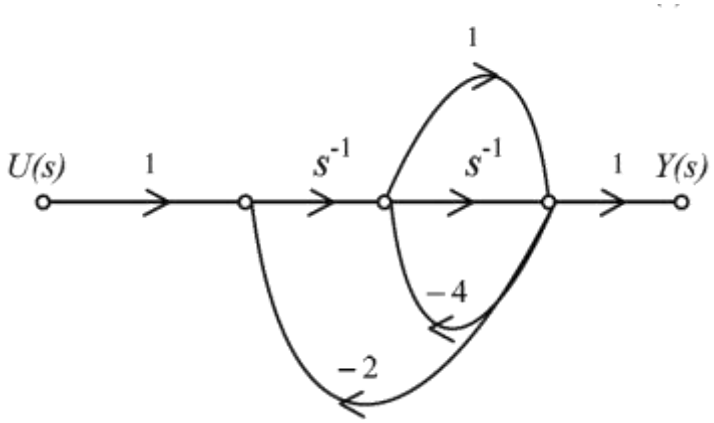
The signal flow graph for a system is given below. The transfer function $\frac{Y(s)}{U(s)}$ for this system is

(A) $\frac{s+1}{5s^2+6s+2}$

(B) $\frac{s+1}{s^2+6s+2}$

(C) $\frac{s+1}{s^2+4s+2}$

(D) $\frac{1}{5s^2+6s+2}$



Solution: (A) is correct option

Forward paths

$P_1=U\text{-}X_1\text{-}X_2\text{-}X_3\text{-}Y=S^{-2}$

$P_2=U\text{-}X_1\text{-}X_2\text{-}X_3\text{-}Y=S^{-1}$

Loops:

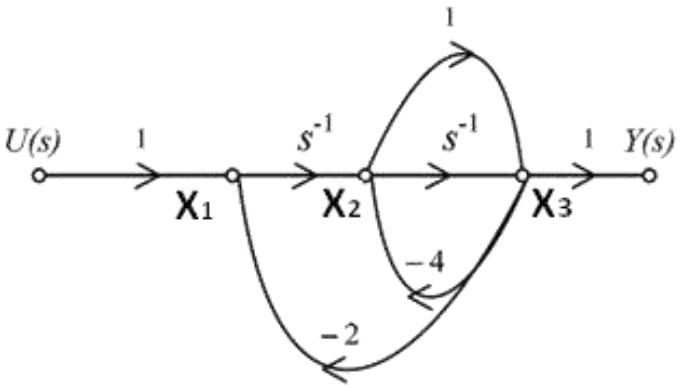
$L_1=X_1\text{-}X_2\text{-}X_3\text{-}X_1=-2S^{-2}$

$L_2=X_1\text{-}X_2\text{-}X_3\text{-}X_1=-2S^{-1}$

$L_3=X_2\text{-}X_3\text{-}X_2=-4S^{-2}$

$L_4=X_2\text{-}X_3\text{-}X_2=-4$

$\Delta_1=1,\ \Delta_2=1$



$$\text{T.F.} = \frac{s^{-2}+s^{-1}}{1-(-2s^{-2}-2s^{-1}-4s^{-1}-4)}$$

$$= \frac{s+1}{5s^2+6s+2}$$

Unsolved Problems:

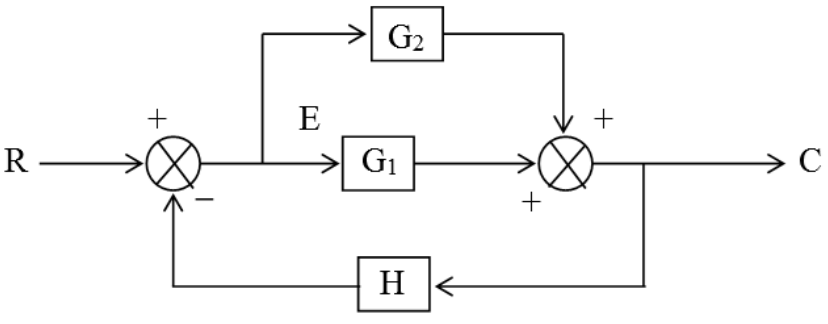
Q.1 The transfer function relating E and R for the block diagram given below is

(A) $\frac{1}{1+(G_1+G_2)H}$

(B) $\frac{1}{1+G_1G_2H}$

(C) $\frac{G_1G_2}{1+(G_1+G_2)}$

(D) $\frac{G_1G_2}{1+G_1G_2H}$



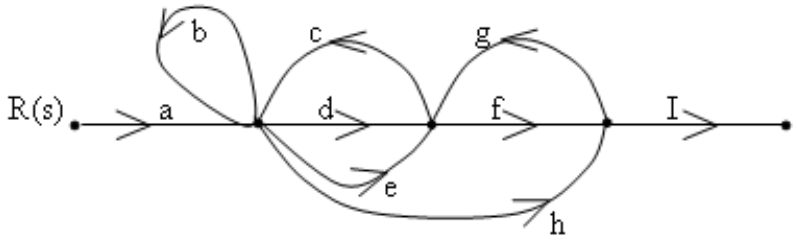
Q.2 The number of forward paths and the number of non-touching loop pairs for the signal flow graph given in the figure are, respectively,

(A) 1, 3

(B) 3, 2

(C) 3, 1

(D) 2, 4



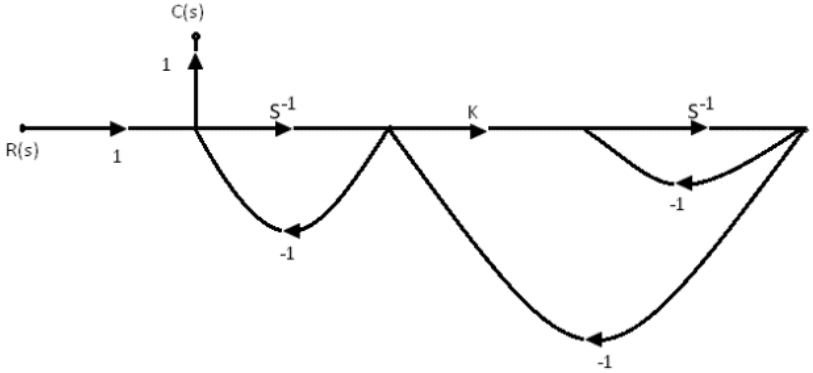
Q.3 Fig shows the signal flow graph of the system. Find the transfer function $\frac{C(s)}{R(s)} = ?$

(A) $\frac{K+1}{s^2+(K+1)s+1}$

(B) $\frac{s(K+1)}{s^2+(K+2)s+1}$

(C) $\frac{s}{s^2+(K+1)s+1}$

(D) $\frac{s(K+1)}{s^2+2s+1}$



Q.4 Three blocks G_1, G_2 & G_3 are connected in some fashion such that overall transfer function is $\frac{G_1+G_3(1+G_1G_2)}{1+G_1G_2}$ .The blocks are connected in the following manner

(A) G_1, G_2 with negative feedback and combination in parallel with G_3

(B) G_1, G_3 with negative feedback and G_2 in parallel

(C) G_1, G_2 in cascade & combination in parallel with G_3

(D) G_1, G_3 in cascade & combination in parallel with G_2

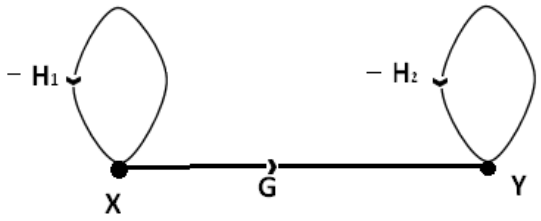
Q.5 find Y/X

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

(B) $\frac{GH_2}{1+H_1}$

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

(D) $\frac{GH_1}{1+H_2}$



Q.6 The overall transfer function relating C and R for the system whose block diagram as shown in figure is

(A) $\frac{G_1G_2 + G_1G_3}{1 + G_2 + G_3 + G_1G_2H_1}$

(B) $\frac{G_1G_3 + G_2H_1}{1 + G_2G_3H_1 + G_1G_3}$

(C) $\frac{G_2G_3 + G_1H_1}{1 + G_2G_1H_1 + G_3 + G_2}$

(D) $\frac{G_1G_3 + G_3H_1}{1 + G_2G_1H_1 + G_3 + G_2}$