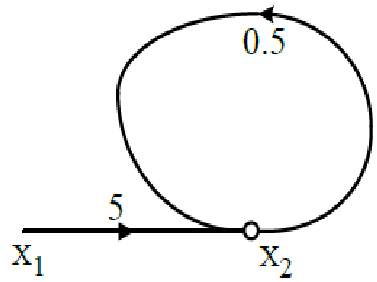
Signal Flow Graph

1. **In the signal flow graph shown in figure $X_2 = TX_1$ where T, is equal to**



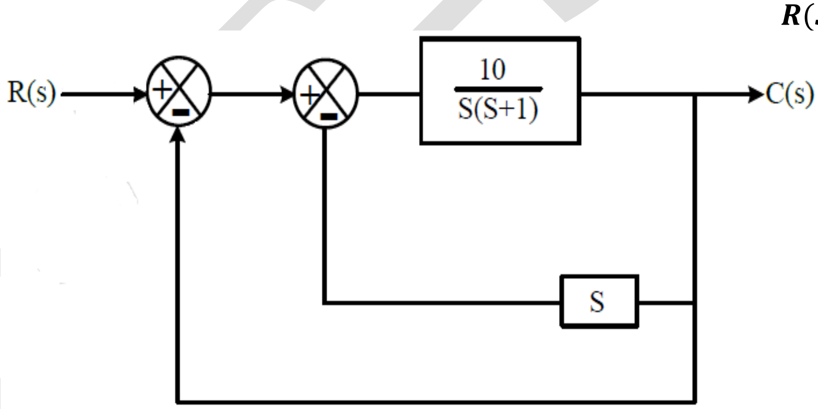
(a) 2.5 (b) 5 (c) 5.5 (d) 10 **[GATE 1987: 2 Marks]**

Soln. $X_2 = TX_1$

$$\frac{X_2}{X_1} = \frac{5}{\Delta} = \frac{5}{1-0.5}$$

Option (d)

2. **For the system shown in figure the transfer function $\frac{C(S)}{R(S)}$ is Equal to**



(a) $\frac{10}{S^2+S+10}$ (b) $\frac{10}{S^2+11S+10}$ (c) $\frac{10}{S^2+9S+10}$ (d) $\frac{10}{S^2+2S+10}$

[GATE 1987: 2 Marks]

Soln. The forward path transmittance $= \frac{10}{(S+1)}$

The two closed loop are $L_1 = \frac{-10}{(S+1)}$

$$L_2 = \frac{-10S}{(S+1)}$$

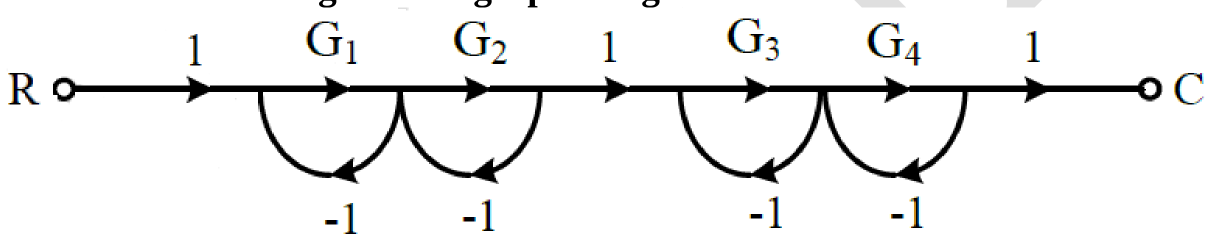
$$\frac{C(S)}{R(S)} = \frac{\frac{10}{(S+1)}}{1-\{\frac{-10}{S\,S+1\,S+1}\frac{10}{}\}}$$

$$= \frac{10}{+1\ [1+\frac{10}{S\ S+1}+\frac{10}{S+1}]} = \frac{10S\ S+1}{S\,S+1\,[S\,S+1+10+10S]}$$

$$= \frac{10}{S^2+S+10S+10} = \frac{10}{S^2+11S+10}$$

Option (b)

3. The C/R for the signal flow graph in figure is



(a) $\frac{G_1G_2G_3G_4}{(1+G_1G_2)(1+G_3G_4)}$ (b) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2+G_1G_2)(1+G_3+G_4+G_3G_4)}$

(c) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)(1+G_3+G_4)}$ (d) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2+G_3+G_4)}$

[GATE 1989: 2 Marks]

Soln. The forward path transmittance = $G_1\,G_2\,G_3\,G_4$

Individual loops are, $-G_1$, $-G_2$, $-G_3$, $-G_4$.

Product of non-touching loops, G_1G_3, G_1G_4, G_2G_3, G_2G_4

$\Delta = 1 - [-G_1 - G_2 - G_3 - G_4] + [G_1G_3 + G_1G_4 + G_2G_3 + G_2G_4]$

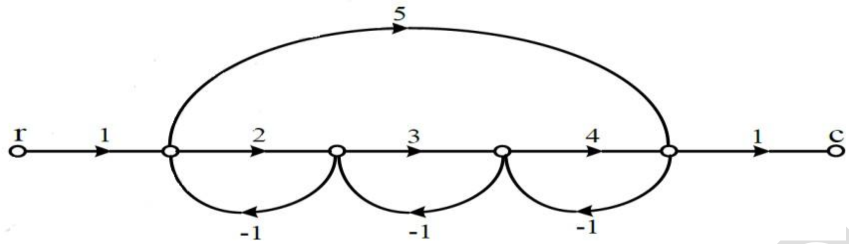
$$\frac{S}{R} = \frac{G_1G_2G_3G_4}{1+G_1+G_2+G_3+G_4+G_1G_3+G_1G_4+G_2G_3+G_2G_4}$$

$$= \frac{G_1\,G_2\,G_3\,G_4}{(1+G_1+G_2)(1+G_3+G_4)}$$

Option (c)

Signal Flow Graph

4. In the signal flow graph of figure the gain c/r will be



(a) $\frac{11}{9}$ (b) $\frac{22}{15}$ (c) $\frac{24}{23}$ (d) $\frac{44}{23}$ **[GATE 1991: 2 Marks]**

Soln. The forward path $P_1 = 1 \times 2 \times 3 \times 4 = 24$

The forward path $P_2 = 5$

$\Delta_1 = 1 \; L_1 = -2, L_2 = -3, L_3 = -4$

Non touching loops $\rightarrow L_1 L_3$

The loop $L_2 = -3$ does not touch the path P_2

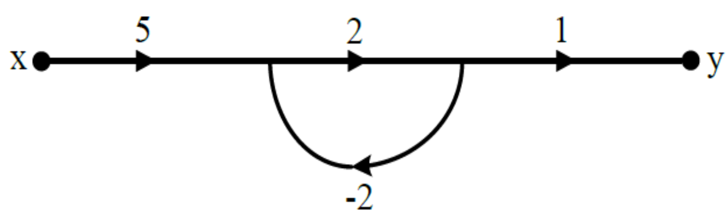
So, $\Delta_2 = 1 - L_2)$

$= 1 + 3 = 4$

$$\frac{S}{R} = \frac{P_1\Delta_1 + P_2\Delta_2}{\Delta} = \frac{24\times1+5\times4}{1-(-2-3-4-5)+(-2)\times(-4)} = \frac{44}{23}$$

Option (d)

5. In the signal flow graph of figure y/x equals



(a) 3 (b) 5/2 (c) 2 (d) None of the above

[GATE 1997: 2Marks]

Soln. Transfer function

$$\frac{Y}{X} = \frac{P_k \Delta_k}{\Delta}$$

$P = 5 \times 2 \times 1 = 10$

$\Delta_K = 1$

$\Delta = 1 - -4 = 5$

$$\frac{}{X} = \frac{10}{5} = 2$$

Option (c)

Signal Flow Graph

6. The gain margin of the system under closed loop unity negative feedback is $(s)H(s) = \frac{100}{(S+10)^2}$

(a) 0 dB (b) 20 dB (c) 26 dB (d) 46 dB

[GATE 2011: 2 Marks]

Soln. The gain margin of the system under closed loop unity negative feedback is $(s)H(s) = \frac{100}{(S+10)^2}$

$\emptyset = -90^0 - 2tan^{-1}(\frac{\ }{10})$

Flow phase cross aver frequency $\emptyset = -180^0$

$-180^0 = -90^0 - 2tan^{-1}(\frac{\omega}{10})$

$\omega = 10\ rad/sec$

$(j\omega)(j\omega) = \frac{100}{j\omega(j\omega+10)^2}$

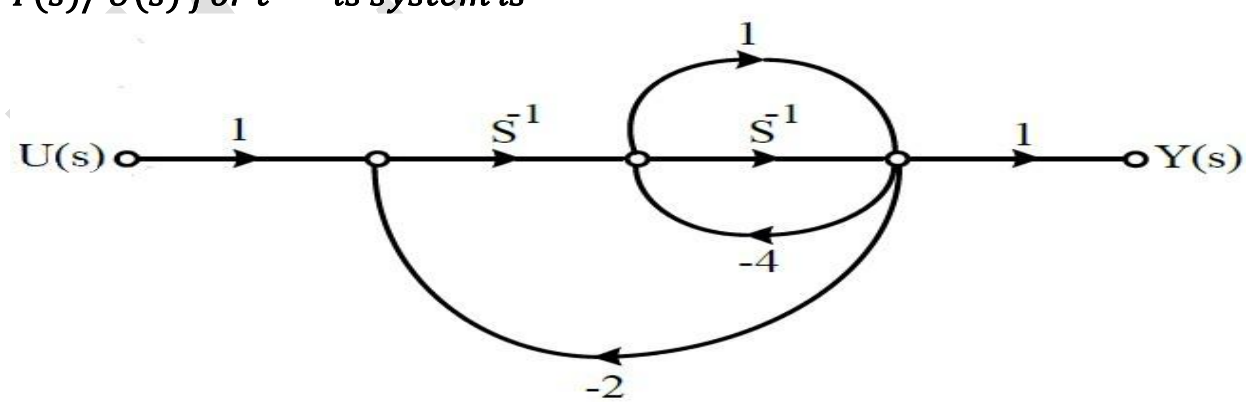
$|(j\omega)H(j\omega)| = \frac{100}{\omega(\omega+10)^2} = \frac{100}{100(100+100)} = \frac{1}{20}$

$Gain\ margin\ (G.M)$ =1/$|(j\omega)H(j\omega)|$

$G.M\ in\ dB$ = $20\log_{10} 20$ = **26db**

Option (c)

7. The signal flow graph for a system is given below. The transfer function $Y(s)/\ U(s)\ for\ t\quad is\ system\ is$



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

[GATE 2013: 2 Marks]

Signal Flow Graph

Soln. The forward path transmittance $P_1 = S^{-1} \times S^{-1} = \frac{1}{S^2}$

The forward path transmittance $P_2 = S^{-1} = \frac{1}{S}$ $\Delta_1 = 1$, $\Delta_2 = 1$

$$\Delta = 1 - (-2S^{-2} - 2S^{-1} - 4S^{-1} - 4)$$

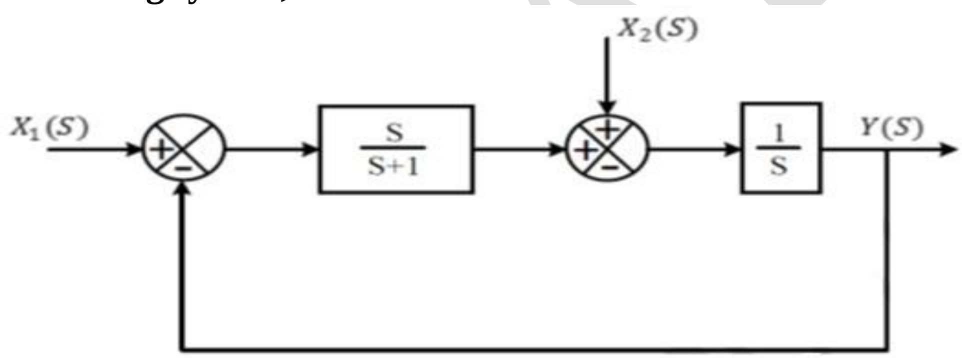
$$= 1 + \frac{2}{S^2} + \frac{2}{S} + \frac{4}{S} + 4$$

$$= (5S^2 + 6S + 2)/S^2$$

$$\frac{(S)}{X(S)} = \frac{P_k\,\Delta_k}{\Delta} = \frac{\boldsymbol{P_1}\Delta_1 + \boldsymbol{P_2}\Delta_2}{\Delta} = \frac{S+1}{5S^2+6S+2}$$

Option (a)

8. For the following system,



When $X_1(S) = 0$, the transfer function $Y(S)/\,X_2(S)$ is

(a) $\frac{S+1}{S^2}$ (b) $\frac{1}{S+1}$ (c) $\frac{S+2}{(S+1)}$ (d) $\frac{S+1}{(S+2)}$ **[GATE: 2014: 1 Mark]**

Soln. With $X1(s) = 0$, the block diagram is

$$T\ S = \frac{Y(S)}{X_2\,(S)} = \frac{\mathrm{G(S)}}{1 + \mathrm{G(S)H(S)}}$$

$$\mathrm{G\ S} = \frac{1}{S},\ \mathrm{H\ S} = \frac{s}{S+1}$$

$$\mathrm{T(S)} = \frac{(\mathrm{S}+1)}{\mathrm{S}(\mathrm{S}+2)}$$

Option (d)