BLOCK DIAGRAM REPRESENTATION :-

A block Diagram is the interconnection of Sub-system representing certain basic mathematical operation in such a way that the overall diagram obey's the systems mathematical model.

$$Y(S) = H(S) \cdot X(S)$$

Transfer Function :-

$$H(S) = \frac{Y(S)}{X(S)}$$

Four Methods of system realization :-

* Direct Form I
* Direct Form II
* cascade Form
* parallel Form

Direct Form - I

$$H(S) = \frac{S^2+3S+2}{S^2+2S+2}$$

$$H(S) = \frac{S^2\left(1+3/S+2/S^2\right)}{S^2\left(1+2/S+2/S^2\right)}$$

$$H(S) = \frac{Y(S)}{X(S)} = \frac{1+3/S+2/S^2}{1+2/S+2/S^2}$$

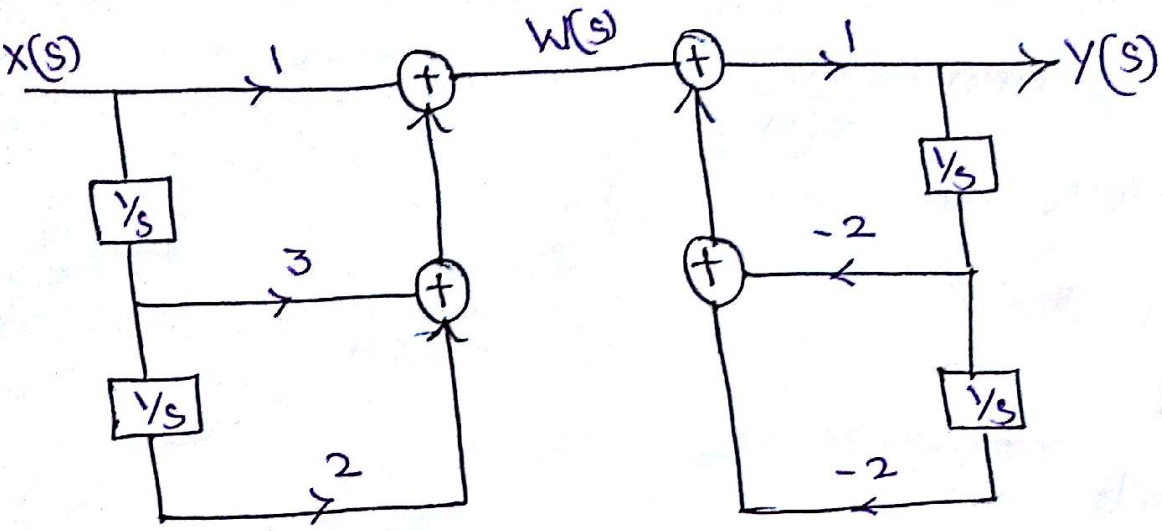
$$Y(S)\left[1+2/S+2/S^2\right] = X(S)\left[1+3/S+2/S^2\right]$$

$$Y(S) + 2/S\,Y(S) + 2/S^2\,Y(S) = X(S) + 3/S\,X(S) + 2/S^2\,X(S)$$

$$X(S) + 3/S\,X(S) + 2/S^2\,X(S) = W(S) \longrightarrow (1)$$

$$W(S) = Y(S) + 2/S\,Y(S) + 2/S^2\,Y(S)$$

$$W(S) - 2/S\,Y(S) - 2/S^2\,Y(S) = Y(S) \longrightarrow (2)$$



Direct Form - II

$$H(S) = \frac{S^2 + 4S + 2}{S^2 + 5S + 2}$$

$$\frac{Y(S)}{X(S)} = \frac{Y(S)}{W(S)} \cdot \frac{W(S)}{X(S)}$$

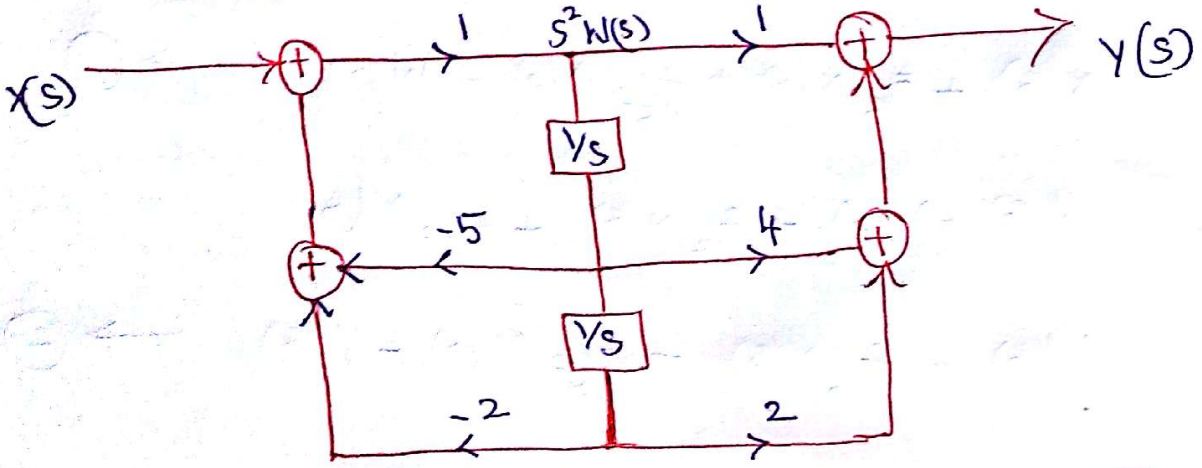
$$\frac{Y(S)}{W(S)} = S^2 + 4S + 2$$

$$Y(S) = S^2 W(S) + 4S W(S) + 2 W(S) \rightarrow (2)$$

$$\frac{W(S)}{X(S)} = \frac{1}{S^2 + 5S + 2}$$

$$X(S) = S^2 W(S) + 5S W(S) + 2 W(S)$$

$$S^2 W(S) = X(S) - 5S W(S) - 2W(S) \rightarrow (1)$$

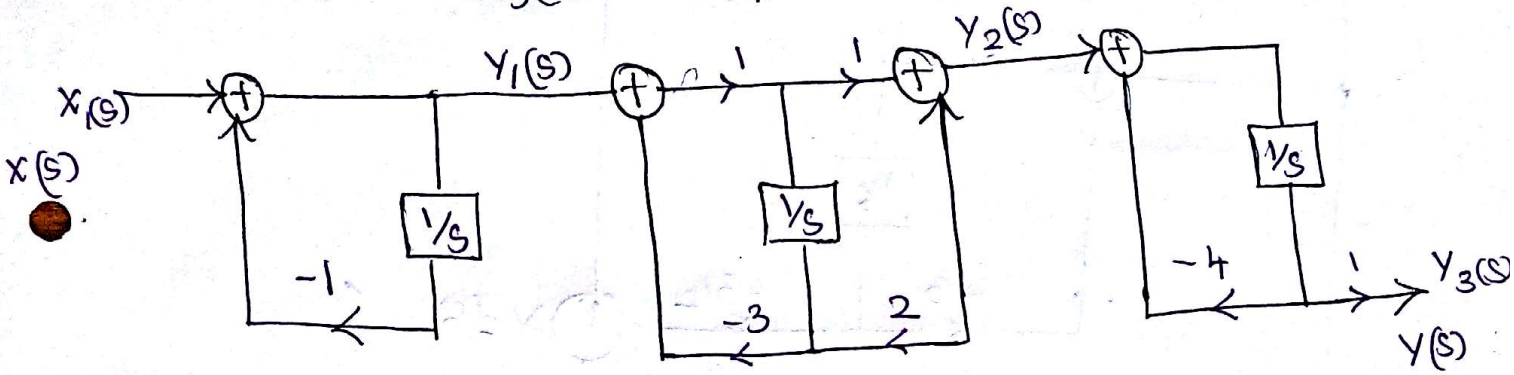


Cascade Form :-

$$H(S) = \frac{S(S+2)}{(S+1)(S+3)(S+4)}$$

$$H_1(S) = \frac{Y_1(S)}{X_1(S)} = \frac{S}{S+1}, \quad H_2(S) = \frac{Y_2(S)}{X_2(S)} = \frac{S+2}{S+3}$$

$$H_3(S) = \frac{Y_3(S)}{X_3(S)} = \frac{1}{S+4}$$



Parallel Form :-

$$H(S) = \frac{S(S+2)}{(S+1)(S+3)(S+4)}$$

$$= \frac{A}{S+1} + \frac{B}{S+3} + \frac{C}{S+4}$$

$$S(S+2) = A(S+3)(S+4) + B(S+1)(S+4) + C(S+1)(S+3)$$

$S = -1$: $A = -1/6$

$S = -3$: $B = -3/2$

$S = -4$: $C = 8/3$

$$H(S) = \frac{-1/6}{S+1} + \frac{3/2}{S+3} + \frac{8/3}{S+4}$$

$\frac{-1/6}{S+1} \rightarrow H_1(S)$

$\frac{3/2}{S+3} \rightarrow H_2(S)$

$\frac{8/3}{S+4} \rightarrow H_3(S)$

Complete Realization :-