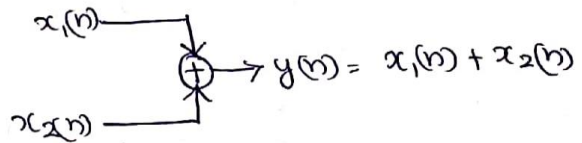# Block Diagram Representation :-

The discrete time systems are represented by block diagram these are also called as DT systems.

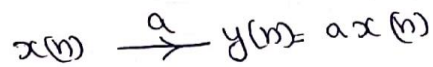summary of elementary blocks used to represent DT s/ms :-
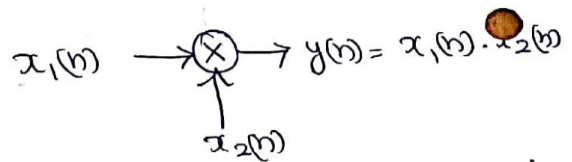
Name of the block	Symbols

1. Adder

$$x_1(n) \quad x_2(n) \xrightarrow{\oplus} y(n) = x_1(n) + x_2(n)$$

2. constant Multiplier

$$x(n) \xrightarrow{a} y(n) = a\,x(n)$$

3. signal Multiplier

$$x_1(n) \xrightarrow{\times} y(n) = x_1(n) \cdot x_2(n) \qquad x_2(n)$$

4. Delay Element

$$x(n) \rightarrow \boxed{z^{-1}} \rightarrow y(n) = x(n-1)$$

5. Advancing Element

$$x(n) \rightarrow \boxed{z^{+1}} \rightarrow y(n) = x(n+1)$$

i) obtain the DF-I and DF-II realisation of the system described by the differential Equation :-

$$y(n) - \tfrac{5}{6} y(n-1) + \tfrac{1}{6} y(n-2) = x(n) + 2x(n-1)$$

Taking z-transform on both sides

$$Y(z) - \tfrac{5}{6} z^{-1} Y(z) + \tfrac{1}{6} z^{-2} Y(z) = X(z) + 2 z^{-1} X(z)$$

$$Y(z)\left[1 - \tfrac{5}{6} z^{-1} + \tfrac{1}{6} z^{-2}\right] = X(z)\left[1 + 2z^{-1}\right]$$
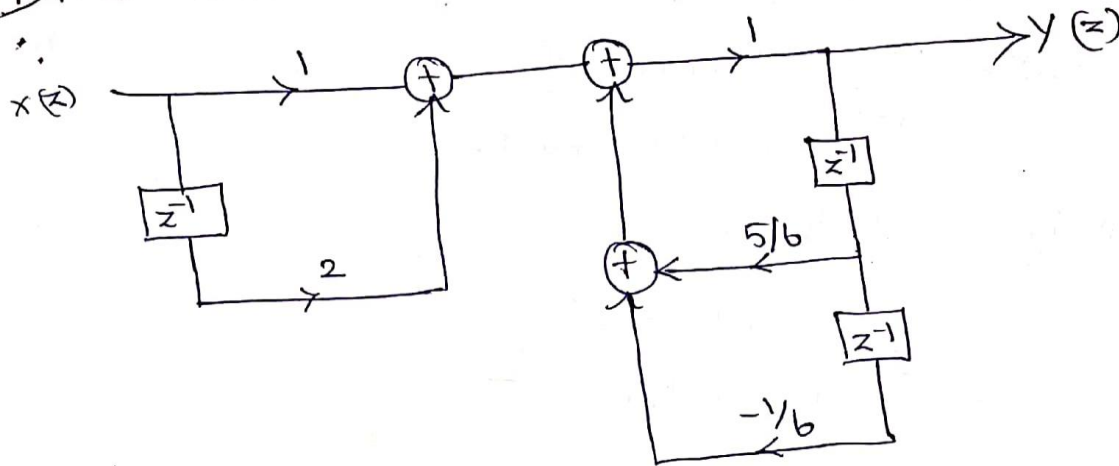
$$X(z) + 2z^{-1} X(z) = W(z) \longrightarrow ①$$

$$Y(z) - \tfrac{5}{6} z^{-1} Y(z) + \tfrac{1}{6} z^{-2} Y(z) = W(z)$$

$$W(z) - \tfrac{5}{6} z^{-1} Y(z) - \tfrac{1}{6} z^{-2} Y(z) = Y(z) \longrightarrow ②$$

DF-I Realisation :-

Direct Form - II

● $\dfrac{Y(z)}{X(z)} = \dfrac{1 + 2z^{-1}}{1 - \frac{5}{6}z^{-1} + \frac{1}{6}z^{-2}}$

$\dfrac{Y(z)}{X(z)} = \dfrac{Y(z)}{W(z)} \cdot \dfrac{W(z)}{X(z)}$

$\dfrac{W(z)}{X(z)} = \dfrac{1}{1 - \frac{5}{6}z^{-1} + \frac{1}{6}z^{-2}}$

● $X(z) = W(z) - \frac{5}{6}z^{-1}W(z) + \frac{1}{6}z^{-2}W(z)$

$W(z) = X(z) + \frac{5}{6}z^{-1}W(z) - \frac{1}{6}z^{-2}W(z) \longrightarrow ①$

$\dfrac{Y(z)}{W(z)} = 1 + 2z^{-1}$ $W(z) + 2z^{-1}W(z) = Y(z) \longrightarrow ②$

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Cascade Form :-

$$y(n) = 0.75\,y(n-1) - 0.125\,y(n-2) + 6x(n) + 7x(n-1) + x(n-2)$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{6 + 7z^{-1} + z^{-2}}{1 - 0.75z^{-1} + 0.125z^{-2}}$$

Multiply & divide by z^2

$$= \frac{z^2}{z^2} \cdot \frac{6 + 7z^{-1} + z^{-2}}{1 - 0.75z^{-1} + 0.125z^{-2}}$$

$$= \frac{6z^2 + 7z + 1}{z^2 - 0.75z + 0.125}$$

$$H(z) = \left(\frac{6z + 1}{z - 0.5}\right)\left(\frac{z + 1}{z - 0.25}\right)$$

$$\downarrow \qquad\qquad \downarrow$$
$$H_1(z) \qquad\quad H_2(z)$$

Parallel Form :-

$$H(z) = \frac{(6z + 1)(z + 1)}{(z - 0.5)(z - 0.25)}$$

$$\frac{(6z + 1)(z + 1)}{(z - 0.5)(z - 0.25)} = \frac{A}{z - 0.5} + \frac{B}{z - 0.25}$$
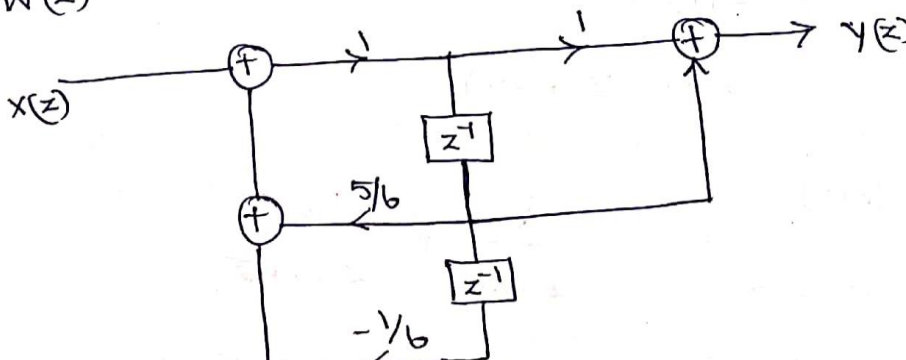
$$\therefore (6z+1)(z+1) = A(z-0.25) + B(z-0.5)$$

Put $z = 0.25$

$$3.875 = B(-0.25)$$

$$\boxed{B = -15.5}$$

Put $z = 0.5$

$$6 = A(0.25)$$

$$A = \frac{6}{0.25}$$

$$\boxed{A = 24}$$

$$H(z) = \underset{\downarrow}{\frac{24}{z-0.5}} - \underset{\downarrow}{\frac{15.5}{z-0.25}}$$

$$H_1(z) \qquad H_2(z)$$

Complete Realization :-