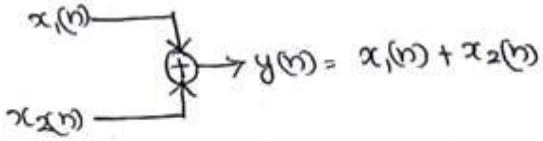
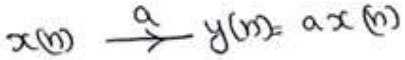
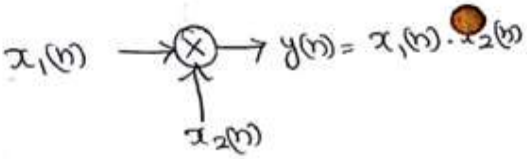
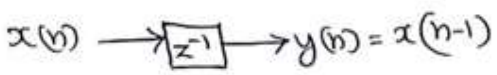
The discrete time systems are represented by block diagram these are also called as DT systems.

Summary of elementary blocks used to represent DT s/ms :-

Name of the block	Symbols.
1. Adder	
2. constant Multiplier	
3. signal Multiplier	
4. Delay element	
5. Advancing element	

1) Obtain the DF-I and DF-II realisation of the system described by the differential equation :-

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

Taking z- transform on both sides

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

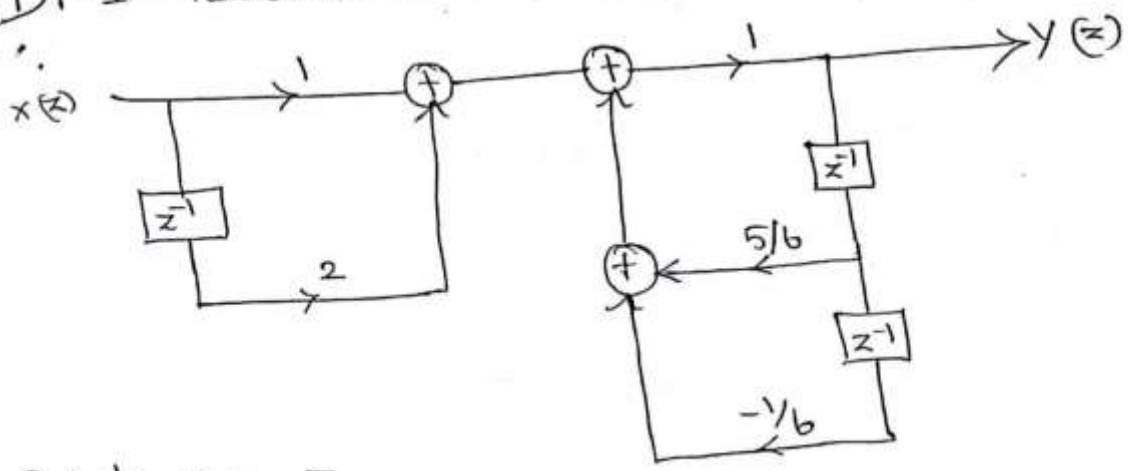
$$Y(z) \left[1 - \frac{5}{6} z^{-1} + \frac{1}{6} z^{-2}\right] = X(z) \left[1 + 2z^{-1}\right]$$

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

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

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

DF-I Realisation :-



Direct form - II

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

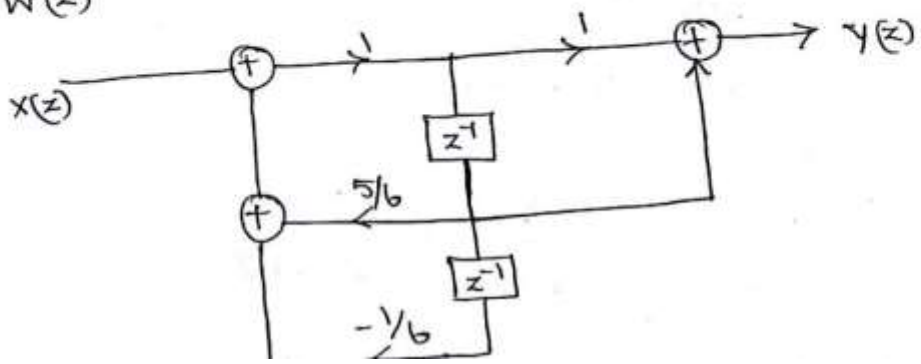
$$\frac{Y(z)}{X(z)} = \frac{Y(z)}{W(z)} \cdot \frac{W(z)}{X(z)}$$

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

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

$W(z) = X(z) + 5/6\, z^{-1} W(z) - 1/6\, z^{-2} W(z) \rightarrow (1)$

$\frac{Y(z)}{W(z)} = 1+2z^{-1}$ $\quad W(z) + 2z^{-1} W(z) = Y(z) \rightarrow (2)$



Cascade Form :-

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

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

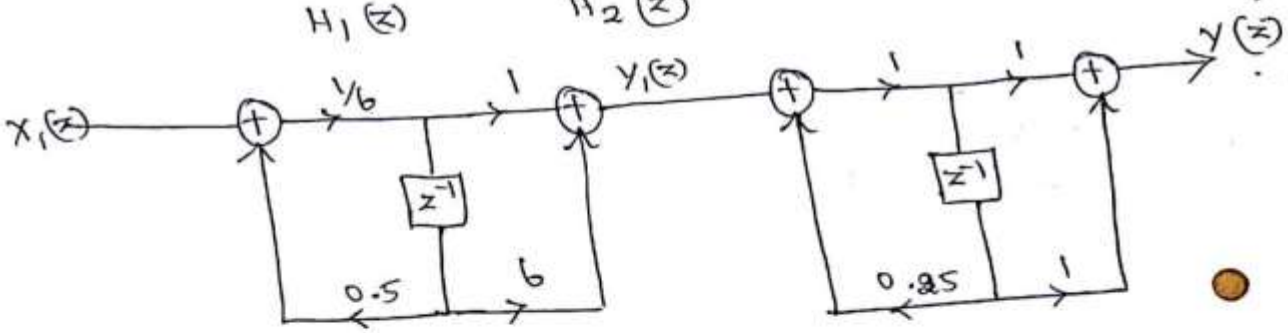
Multiply & divide by z^2

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

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

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

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



Parallel Form :-

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

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

$$(6z+1)(z+1) = A(z-0.25) + B(z-0.5)$$

Put $z = 0.25$

$$3.875 = B(-0.25)$$

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

Put $z = 0.5$

$$6 = A(0.25)$$

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

$$\boxed{A = 24}$$

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

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

Complete Realization :-