~~Q. Draw the block diagram representation for a second order system with system function~~

$$H(z) = \frac{1}{1 - \frac{11}{30}z^{-1} + \frac{1}{30}z^{-2}}$$ ~~in the following forms~~

(I) cascade form (II) Parallel form

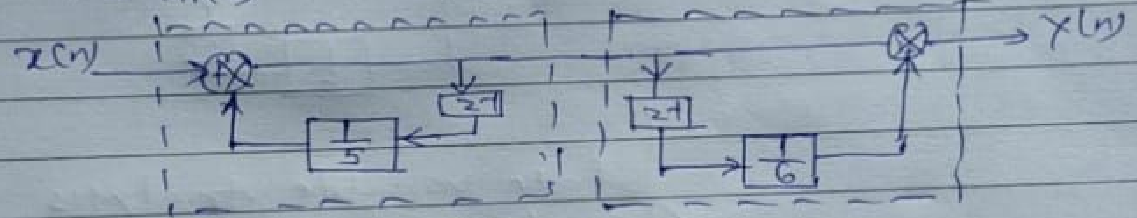
(Sol)ⁿ **Cascade form (series connection):**

$$H(z) = \frac{1}{1 - \frac{11}{30}z^{-1} + \frac{1}{30}z^{-2}}$$

$$= \frac{1}{\left(1-\frac{1}{5}z^{-1}\right)\left(1-\frac{1}{6}z^{-1}\right)}$$

$$= H_1(z) \cdot H_2(z)$$

~~The $H_1(z)$ and $H_2(z)$ are connected in cascade~~



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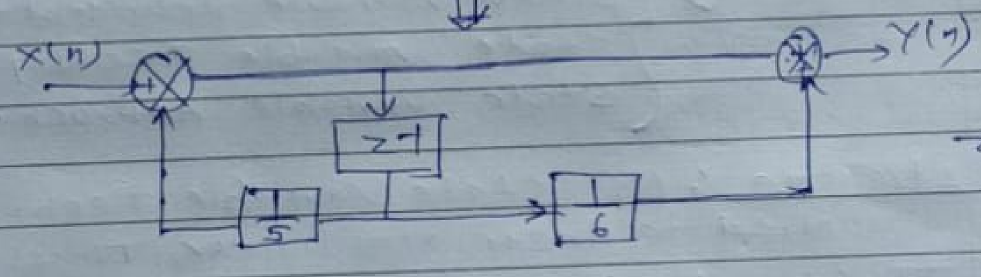

$z^{-1} \rightarrow$ Common

(II) **Parallel form:**

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$$H(z) = \frac{1}{\left(1-\frac{1}{5}z^{-1}\right)\left(1-\frac{1}{6}z^{-1}\right)}$$

$$= \frac{A}{1-\frac{1}{5}z^{-1}} + \frac{B}{1-\frac{1}{6}z^{-1}}$$

where, $$A = \cancel{\left(1-\frac{1}{5}z^{-1}\right)} \times \frac{1}{\cancel{\left(1-\frac{1}{5}z^{-1}\right)}\left(1-\frac{1}{6}z^{-1}\right)}\Bigg|_{z^{-1}=5}$$

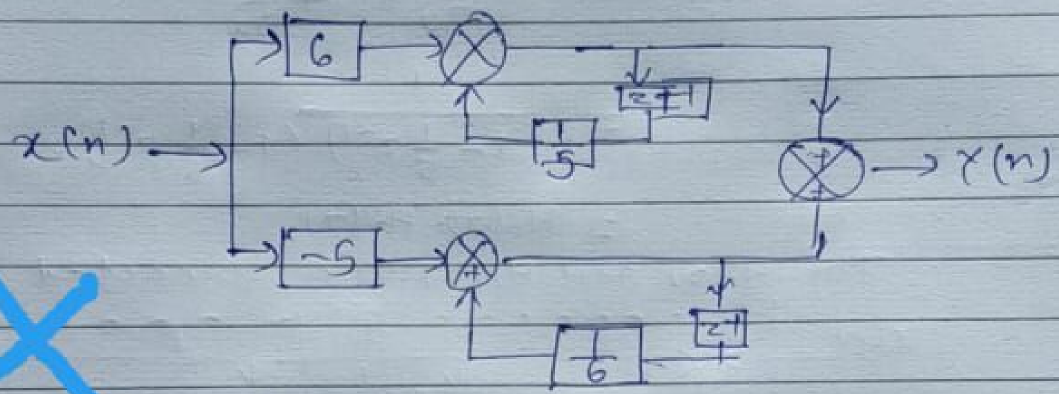
$$A = \frac{1}{1-\frac{5}{6}} = \frac{1}{\frac{6-5}{6}} = 6.$$

$$B = \left(1 - \frac{1}{6}z^{-1}\right) \times \frac{1}{\left(1-\frac{1}{5}z^{-1}\right)\left(1-\frac{1}{6}z^{-1}\right)}\Bigg|_{z^{-1}=6}$$

$$= \frac{1}{1-\frac{6}{5}} = \frac{1}{\frac{5-6}{5}} = \frac{1}{\frac{-1}{5}} = -5.$$

Therefore $H(z) = \dfrac{6}{1-\frac{1}{5}z^{-1}} - \dfrac{5}{1-\frac{1}{6}z^{-1}}$

The parallel combination is shown:



State variable Analysis
State variable Representation
State variable Technique.
State variable Approch

Advantage : (1) State variable Technique can be applied to linear, Non linear, Time variant, Time invariant system, Singel input singel output (SISO), Multiinput Multioutput (MIMO) system.
(2) It is a Time domain approach.
(3) This method is suitable for digital computer computation because this is a Time domain approach.
(4) nth order differential eqn can be expressed as 'n' equation of First order whose soln are easier.
(5) The system can be designed for optimal condn with respect to given Performance indices.

Disadvantage:

(1) Techniques are complex.

(2) Many computation are required.

Some important Definitions:

(1) State: The state of a system at any time "t_0" is the Minimum set of numbers $x_1, x_2 - - x_n$ which along with the input to the system for $t \geq t_0$ is sufficient to determine the behaviour of the system for all $t \geq t_0$.

(2) State variable: The smallest set of variable that determines the state of the system are known as state variable. The knowledge of capacitor voltage at $t=0$ i.e the initial voltage of the capacitor is form of a state variable. Similarly, initial current in an inductor is treated as a state variable

(3) state vector: The n state variable that completely describe the behaviour of a given system are said to be n-component of a vector.

(4) State space: The n-dimensional space whose co-ordinate axis consists of the x_1-axis, x_2-axis - - - x_n axis are called state space. Any state can be represented by a point in the state space

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