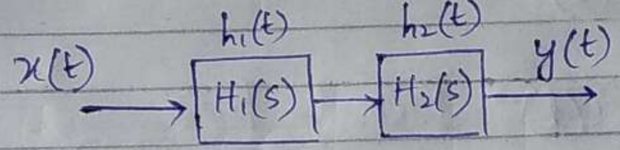
-: BLOCK DIAGRAM REPRESENTATION USING LT :-

System Interconnections :-

(i) Series (ii) Parallel (iii) Feedback.

(i)

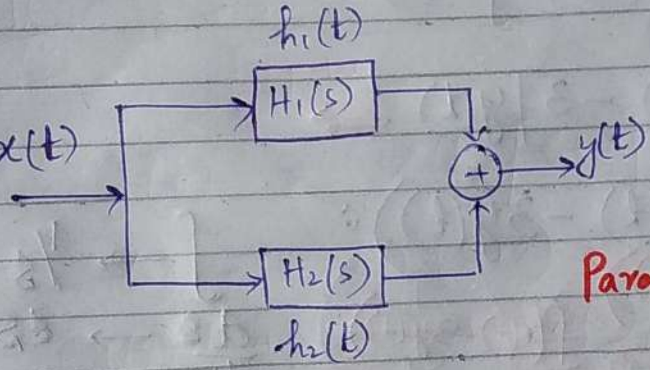


$\Rightarrow$ Series

overall impulse response $h(t) = h_1(t) * h_2(t)$

$$H(s) = H_1(s)\,H_2(s)$$

(ii)

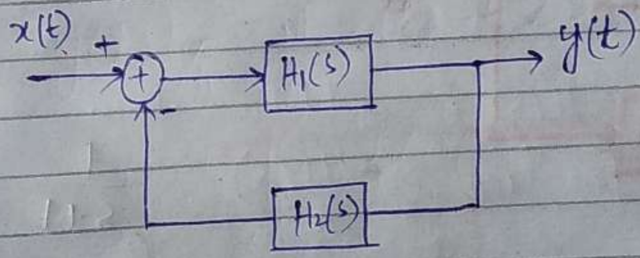


$h(t) = h_1(t) + h_2(t)$

$= H_1(s) + H_2(s)$

Parallel

(iii)



Feedback

Block diagram to draw poles :-

$H(s) = \frac{\text{Zeros}}{\text{poles}}$

Exp 9.28 :- $H(s) = \frac{1}{s+3}$

$$\frac{Y(s)}{X(s)} = \frac{1}{s+3}$$

$$sY(s) + 3Y(s) = X(s)$$

In time domain

$$\frac{d}{dt}y(t) + 3y(t) = x(t)$$

Take Integration

$$\int \frac{d}{dt}y(t) + 3\int y(t) = \int x(t)$$

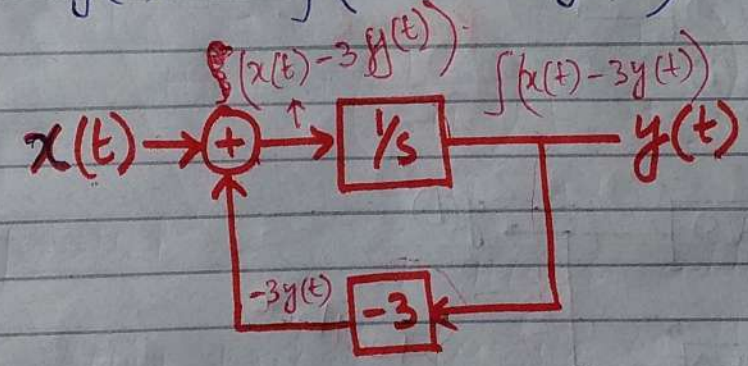
$$y(t) = \int x(t) - 3\int y(t) \Longrightarrow$$

or

$$y(t) = \int \left(x(t) - 3y(t)\right)$$

$\int \rightarrow 1/s$

$\frac{d}{dt} \rightarrow s$



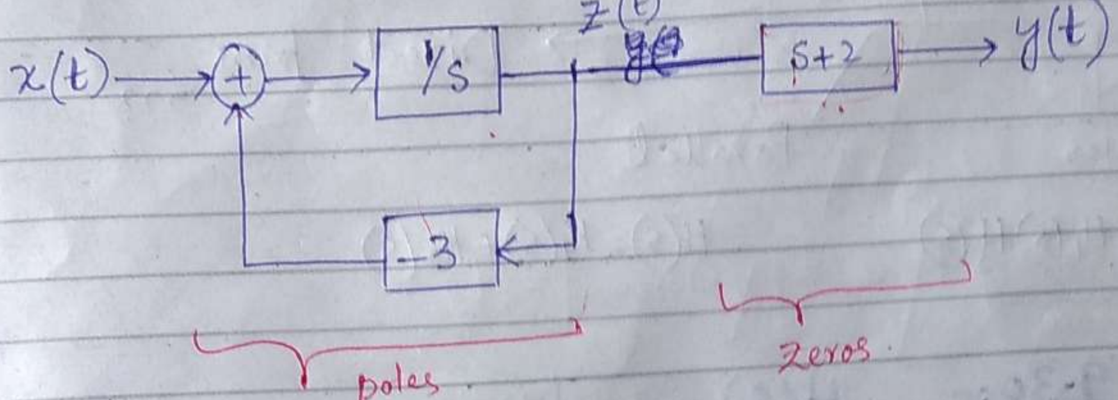
$\frac{1}{s+1}$

Block Diagram for Zeros :-

Exp 9.29 :-

$$H(s) = \frac{s+2 \rightarrow \text{zeros}}{s+3 \rightarrow \text{poles}}$$

$$H(s) = \underbrace{\left(\frac{1}{s+3}\right)}_{\text{poles}} \cdot \underbrace{(s+2)}_{\text{zeros}}$$



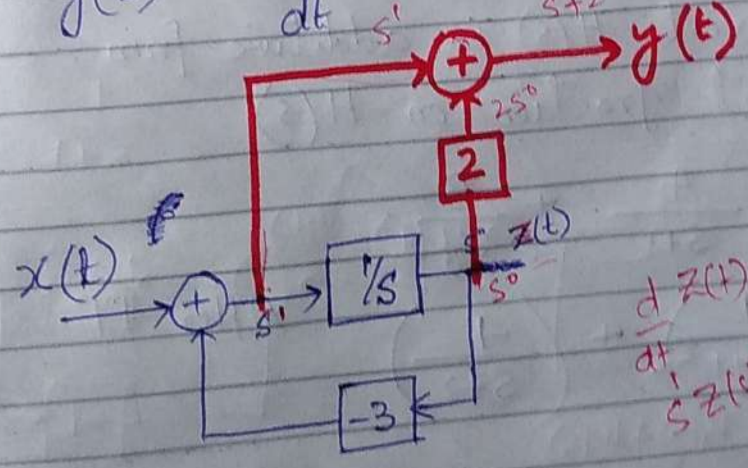
$$y(t) = z(t)\left[s+2\right]$$

$$Y(s) = Z(s)\,(s+2)$$

$$Y(s) = s\,Z(s) + 2Z(s)$$

Take in time domain

$$y(t) = \frac{d}{dt} z(t) + 2\,z(t)$$

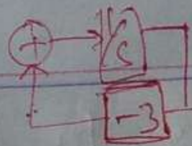


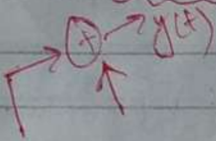
$$\frac{d}{dt} z(t) = Z(s)$$

$s\,Z(s) \times 1/s$

$s + 2s$

$s+2$

$\frac{1}{s+3}$ 



Summary :-

(i) poles → feedback
→ Coefficients with opposite sign.

(ii) Zeros → feed forward direction
→ Coefficients with same sign.

Block Diagrams → Direct form ???
→ Series
→ Parallel

Series: $H(s) = H_1(s) . H_2(s)$

Parallel: $H(s) = H_1(s) + H_2(s)$

Exp 9.30 :- $H(s) = \frac{1}{(s+1)(s+2)}$

For Series :-

$$H(s) = \underbrace{\left(\frac{1}{s+1}\right) \cdot \left(\frac{1}{s+2}\right)}_{H_1(s) . H_2(s)}$$

For parallel :- Convert $H(s)$ in additive form

Apply partial fraction on $H(s)$

$$H(s) = \frac{A}{s+1} + \frac{B}{s+2}$$

After PF

$$H(s) = \underbrace{\left(\frac{1}{s+1}\right) + \left(\frac{-1}{s+2}\right)}_{H_1(s) + H_2(s)}$$

For Direct form

$$H(s) = \frac{1}{s^2+3s+2}$$

$(s+1)(s+2)$
$= s^2+2s+s+2$
$= s^2+3s+2$

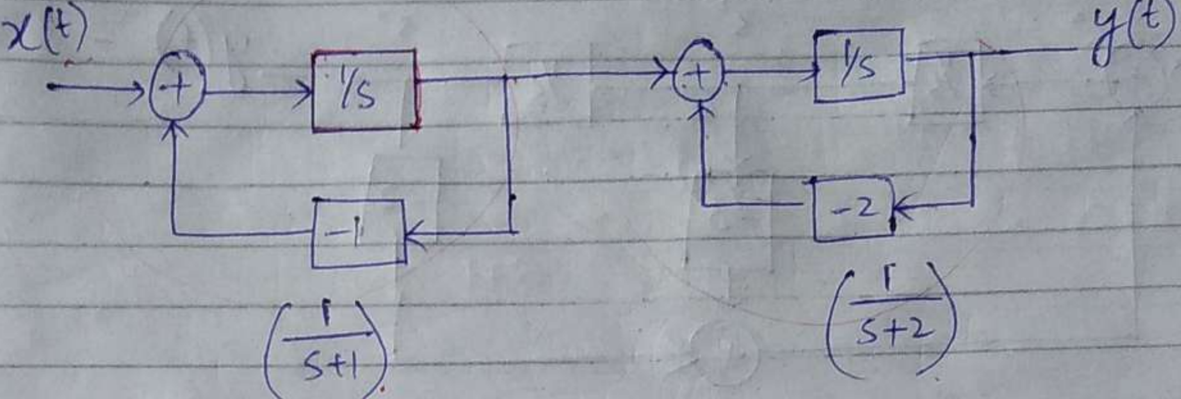
EXP 9.30

$$H(s) = \frac{1}{(s+1)(s+2)}$$

Series :-

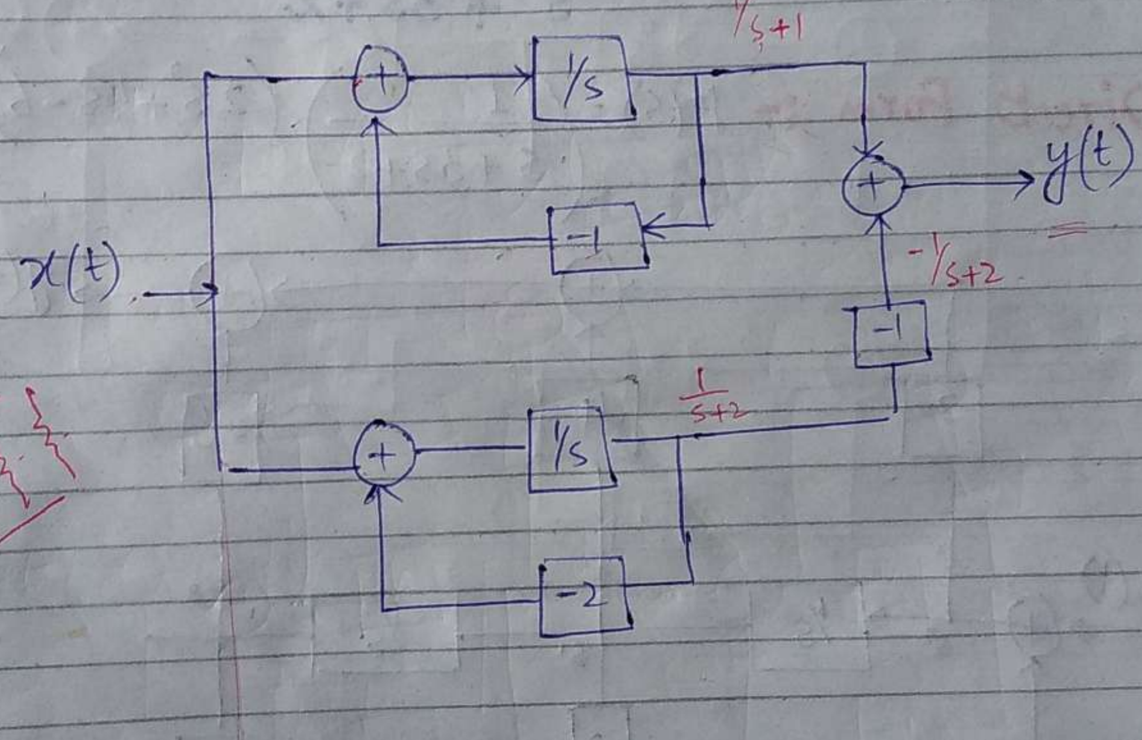
$$H(s) = \left(\frac{1}{s+1}\right)\left(\frac{1}{s+2}\right)$$

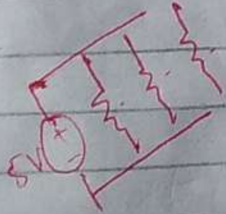
$$H_1(s) \cdot H_2(s)$$



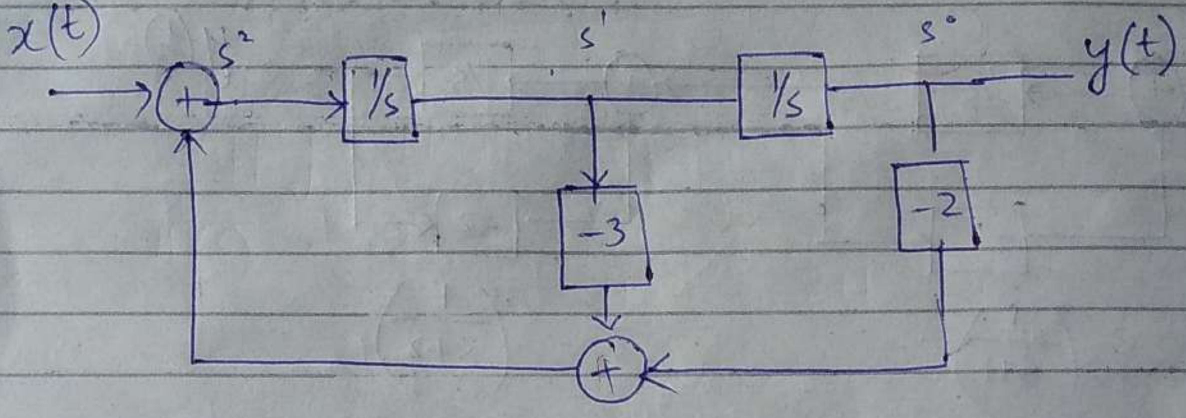
Parallel :-

$$H(s) = \frac{1}{s+1} + \frac{(-1)}{s+2}$$



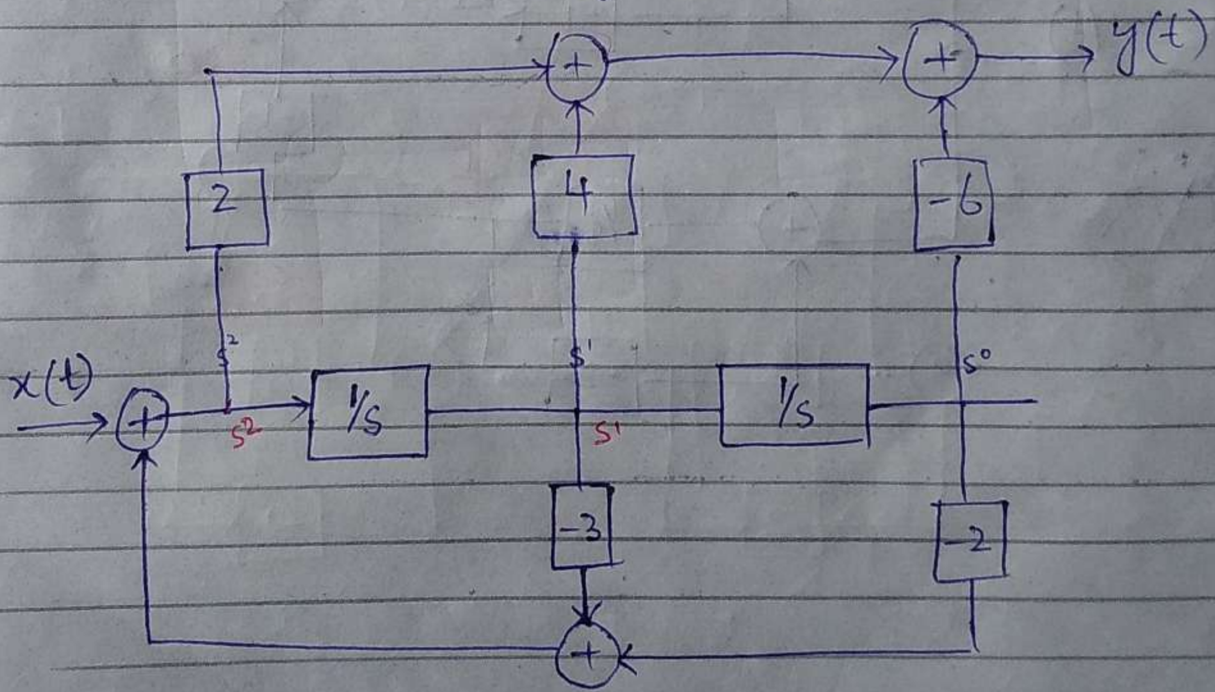


Direct form :- $H(s) = \dfrac{1}{s^2+3s+2}$



Exp 9.31 :- $H(s) = \dfrac{2s^2+4s-6}{s^2+3s+2}$

Direct Form :- $H(s) = \left(\dfrac{1}{s^2+3s+2}\right)\left(2s^2+4s-6\right)$



Series :- $H(s) = \dfrac{2s^2+4s-6}{s^2+3s+2}$

$$H(s) = \left(\frac{1}{s^2+3s+2}\right) 2\left[s^2+2s-3\right]$$

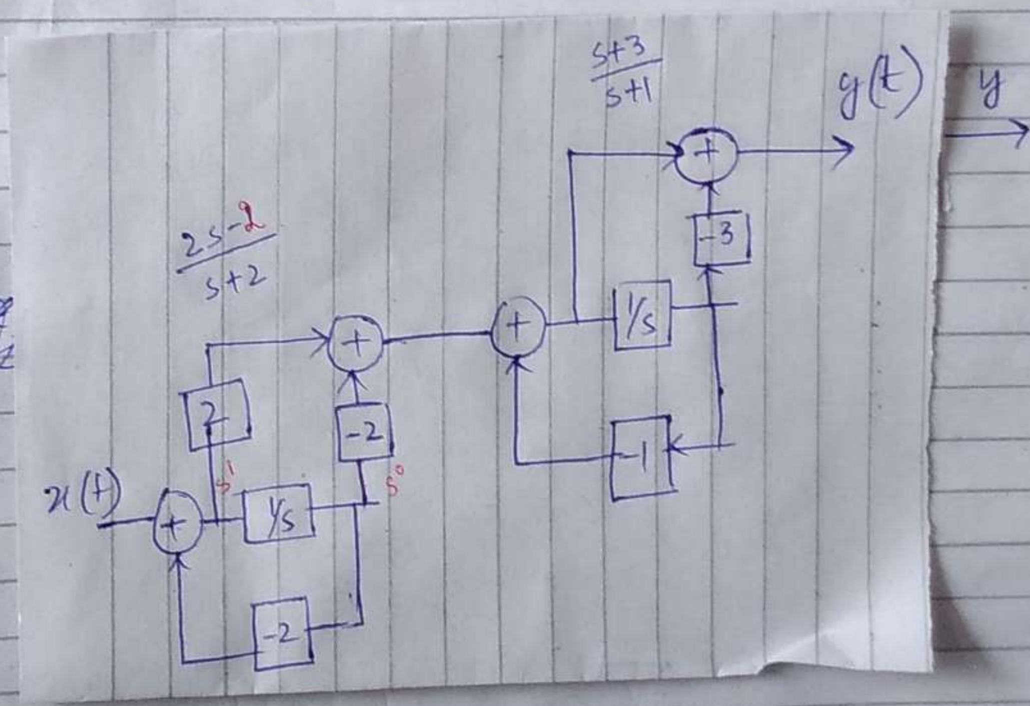
Make factors

$s^2+3s+2 \Rightarrow (s+2)(s+1) \longrightarrow$ poles

$s^2+2s-3 \Rightarrow (s-1)(s+3) \longrightarrow$ Zeros

$$\therefore \quad H(s) = \frac{2(s-1)(s+3)}{(s+2)(s+1)}$$

$$H(s) = \left(\frac{2(s-1)}{s+2}\right)\left(\frac{s+3}{s+1}\right)$$



Parallel :-

$$H(s) = \frac{2s^2+4s-6}{s^2+3s+2}$$

Apply PF

$$H(s) = 2 + \frac{6}{s+2} - \frac{8}{s+1}$$