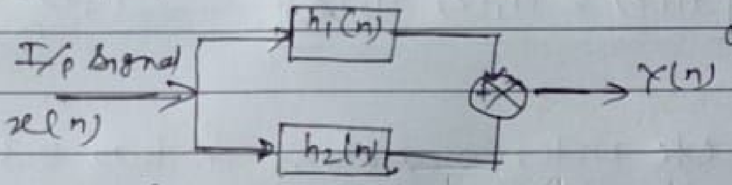
Interconnection of the system:

(1) Parallel interconnection of the system.
(2) Series or cascade interconnection of the system
(3) feedback interconnection of the system.

(1) Parallel interconnection of the system:

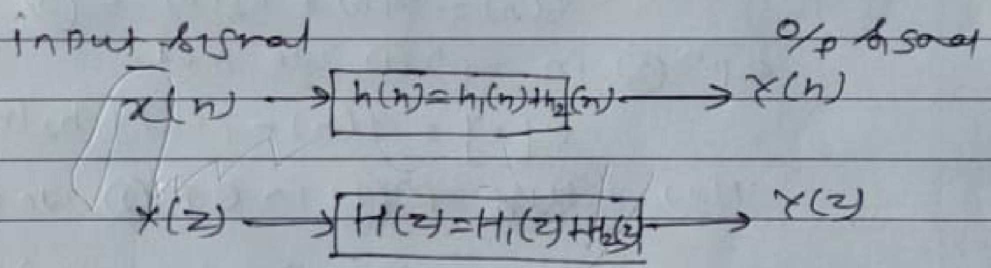


If two Linear time invariant (LTI) system with impulse response $[h_1(n)]$ and $[h_1(n)]$ are connected in parallel as shown in above fig. Then the overall impulse response $h[n]$ is given by

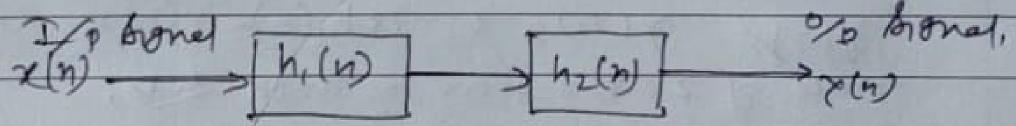
$$h(n) = h_1(n) + h_2(n)$$

Taking Z Transform

$$H(z) = H_1(z) + H_2(z).$$



(2) Series or cascade interconnection of the system;

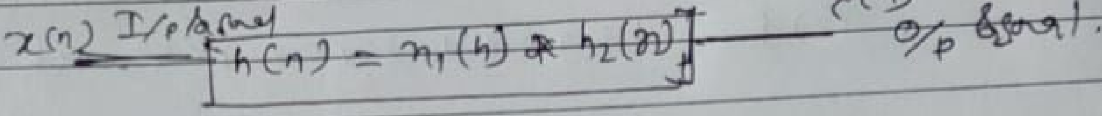


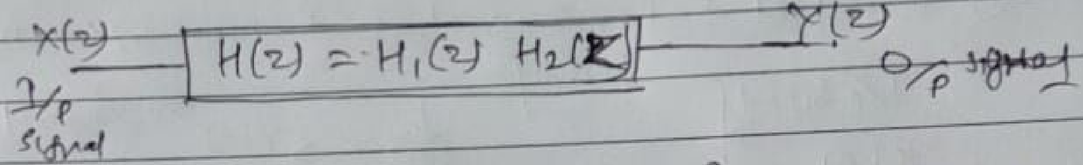
If two linear time invariant (LTI) system with impulse response $h_1(n)$ and $h_2(n)$ are connected in series or cascade. as shown in above fig. then the overall Impulse response $h[n]$ is given by

$$h[n] = h_1(n) * h_2(n)$$

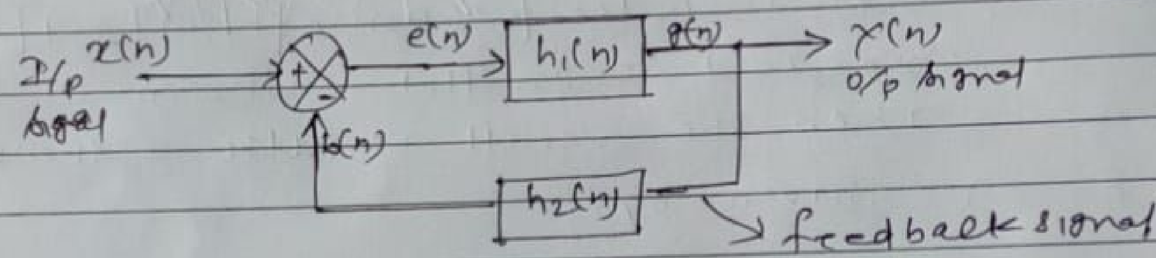
Taking Z Transform on both sides

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





(3) Feedback interconnection of two Discrete time invariant (LTI) system.



From fig: $e(n) = x(n) - b(n)$ — (1)

$$y(n) = e(n) * h_1(n) \quad \text{— (2)}$$

$$b(n) = y(n) * h_2(n) \quad \text{— (3)}$$

eq^n (3) in eq^n (1), we get.

$$e[n] = x(n) - y(n) * h_2(n) \quad \text{— (4)}$$

Now, putting eq^n (4) in eq^n (2), we get

$$y(n) = \{x(n) - y(n) * h_2(n)\} * h_1(n)$$

Taking Z Transform on both sides

$$y(n) = x(n) * h_1(n) - y(n) * h_2(n) * h_1(n) \quad \text{— (5)}$$

Taking Z-Transform on both sides,

$$Y(z) = X(z) H_1(z) - Y(z) H_1(z) H_2(z)$$

$$\Rightarrow Y(z) + Y(z) H_1(z) H_2(z) = X(z) H_1(z)$$

$Y(z)[1 + H_1(z) H_2(z)]$

$$\frac{Y(z)}{X(z)} = \frac{H_1(z)}{1 + H_1(z) H_2(z)}$$

$$\boxed{H(z) = \frac{Y(z)}{X(z)} = \frac{H_1(z)}{1 + H_1(z) H_2(z)}}$$