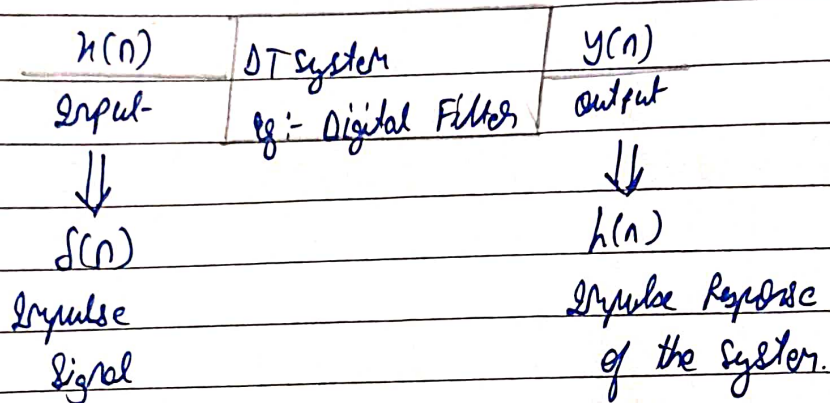


Lec 5

* Impulse Response of Digital Signal:-

\Rightarrow Impulse signal gives the $h(n)$ as output.

When $h(n)$ is given:-

$$x(n) \boxed{h(n)} \rightarrow y(n) = x(n) * h(n)$$

Linear convolution

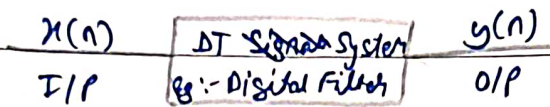
\Rightarrow $h(n)$ is representation of signal.

* Linear Convolution:-

$$y(n) = \sum_{m=-\infty}^{\infty} x(m) h(n-m) \quad \text{IMP}$$

\Rightarrow Linear convolution application is to find the output of a filter.

* Types of Filter:-



IIR Filter

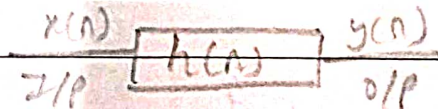
FIR Filter

Eg:- $h(n) = (0.5)^n u(n)$
 Infinite
 Impulse
 Response

Eg:- $h(n) = \delta[n-5, 6, 7]$
 Finite
 Impulse
 Response.

Eg:- Given $h(n) = \delta[n-5, 6, 7]$, Find the response of filter to the $x(n)$ input = $\delta[n-1, 2, 3, 4]$.

Ans. To find response :- O/P:- (y(n))



Step 1:-

Find $y(n)$ for $n \geq 0$

$$y(n) = \sum_{m=-\infty}^{\infty} x(m)h(n-m)$$

$$n=0; y(0) = \sum x(m)h(-m)$$

$$y(1) = \sum x(m)h(1-m)$$

$$y(2) = \sum x(m)h(2-m)$$

\vdots

$$x(m) = \{2, 3, 4\}$$

↑

$$h(m) = \{5, 6, 7\}$$

↑

$$h(-m) = \{7, 6, 5\}$$

↑

$$h(1-m) = \{7, 6, 5\}$$

↑

\vdots

$x(m)$	1	2	3	4
$h(-m)$	6	5		
$h(1-m)$	7	6	5	
$h(2-m)$		7	6	5
$h(3-m)$			7	6
$h(4-m)$				7

~~$$y(n) = \sum x(m)h(n-m)$$~~

$$y(0) = \sum x(n) h(-n)$$

$$y(0) = [7 \times 0 + 1 \times 6 + 2 \times 5] \\ = 16$$

$$y(1) = 1 \times 7 + 2 \times 6 + 3 \times 5 = 34$$

$$y(2) = 7 \times 2 + 6 \times 3 + 5 \times 4 = 52$$

$$y(3) = 7 \times 3 + 6 \times 4 = 45$$

$$y(4) = 7 \times 4 = 28$$

Step 2:-

Find $y(n)$ for $n < 0$

$$\therefore y(-1) = x(n) h(-1-n)$$

$$y(-2) = x(n) h(-2-n)$$

⋮

$$x(n) = x(n) = 2, 1, 2, 3, 4, 3$$

$x(n)$		1	2	3	4
$h(-n)$	0	6	5	5	
$h(-1-n)$	7	6	5		
$h(-2-n)$	7	6	5		

$$y(0) = 16$$

$$y(-1) =$$

$x(n)$		1	2	3	4
$h(-n)$		7	6	5	
$h(-1-n)$		7	6	5	
$h(-2-n)$	7	6	5		

$$y(0) = 16$$

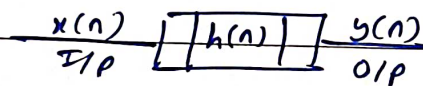
$$y(-1) = 5$$

$$y(-2) = 20$$

$$\therefore y(n) = \underline{5, 16, 34, 52, 45, 28}$$

Q2) - Given $h(n) = \underline{5, 6, 7}$. Find the response of the filter to the input values $x(n) = \underline{1, 2, 3, 4}$

Ans



Soln :-

Find $y(n)$ for $n \geq 0$

$$y(n) = \sum_{m=-\infty}^{M=\infty} x(m) h(n-m)$$

$$y(0) = \sum x(m) h(-m)$$

$$y(1) = \sum x(m) h(1-m)$$

$$y(2) = \sum x(m) h(2-m)$$

$x(m)$	1	2	3	4	
$h(-m)$ 7, 6	5				$y(0) = 5$
$h(1-m)$ 7	6	5			$y(1) = 16$
$h(2-m)$	7	6	5		$y(2) = 34$
$h(3-m)$		7	6	5	$y(3) = 52$
$h(4-m)$			7	6	5 $y(4) = 45$
$h(5-m)$				7	6 5 $y(5) = 28$

Step 2:-

For $n < 0$

$$y(-1) = x(n) h(-1-n)$$

$$y(-2) = x(n) h(-2-n)$$

$x(n)$	1	2	3	4	
$h(n)$ 7, 6	5				$y(0) = 5$
$h(-1-n)$ 7, 6, 5					$y(-1) = 0$
	-	-	-	-	$y(-2) = 0$
					\vdots

$$\therefore y(n) = \underset{\uparrow}{5}, 16, 34, 52, 45, 283$$

* NOTE :-

Length of linear convolution = Length of 1st signal + Length of 2nd signal - 1.