SIGNALS & SYSTEMS

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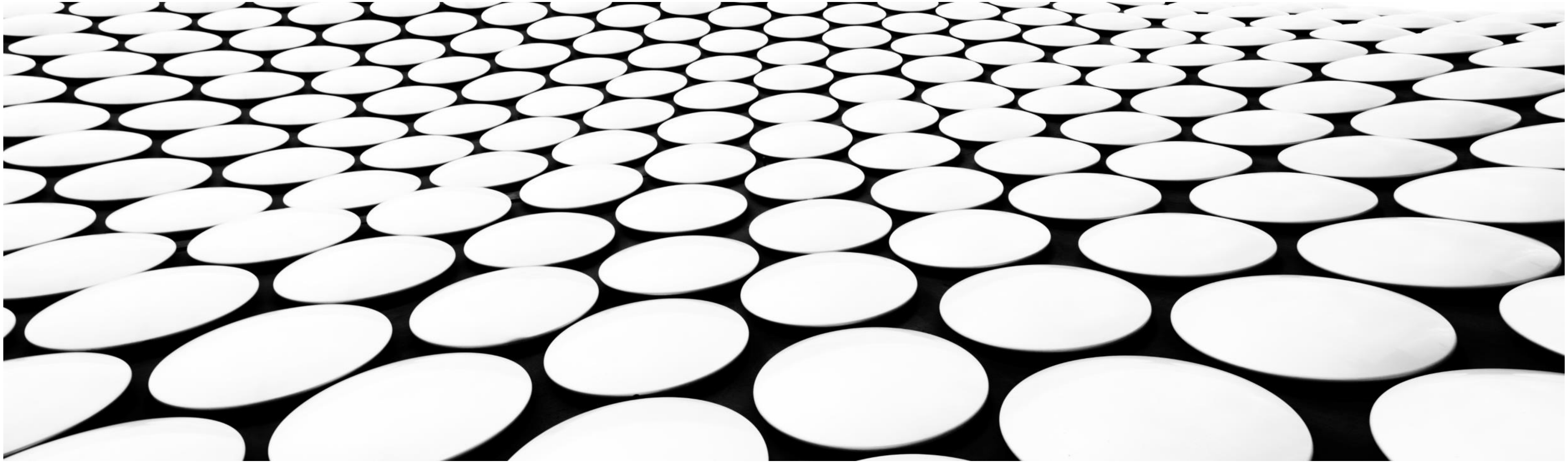


Question:-

Determine the response of the LTI system whose input x(n) and impulse response h(n) are given by.

$x(n) = \{\underset{\uparrow}{1}, 2, 3, 1\}$ and $h(n) = \{1, \underset{\uparrow}{2}, 1, -1\}$

n=-1

Graphical method of linear convolution:-

Sol^n:-

The graphical representation of x(n) and h(n) after replacing n by m are shown below. The sequence h(m) is folded with respect to m = 0 to obtain h(–m).

$n \to m$

$h(m) \to h(-m)$

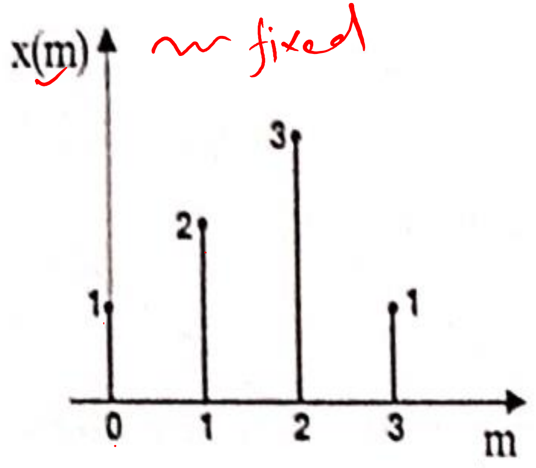


Fig 1 : Input sequence.

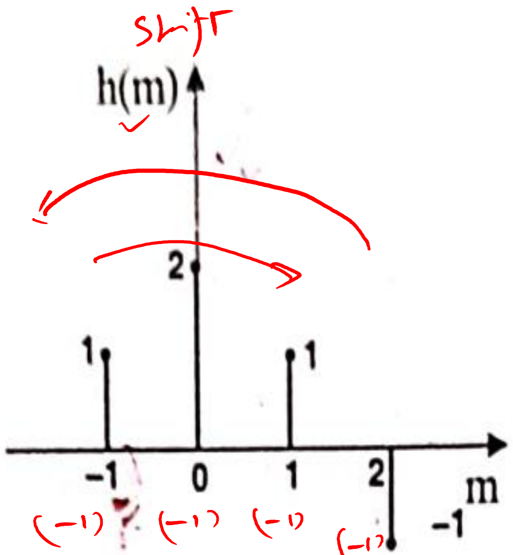


Fig 2 : Impulse response.

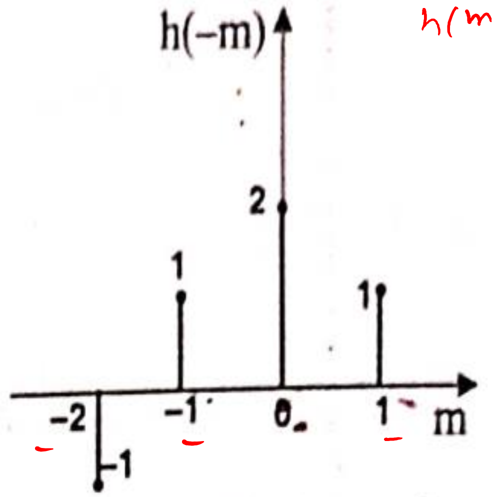
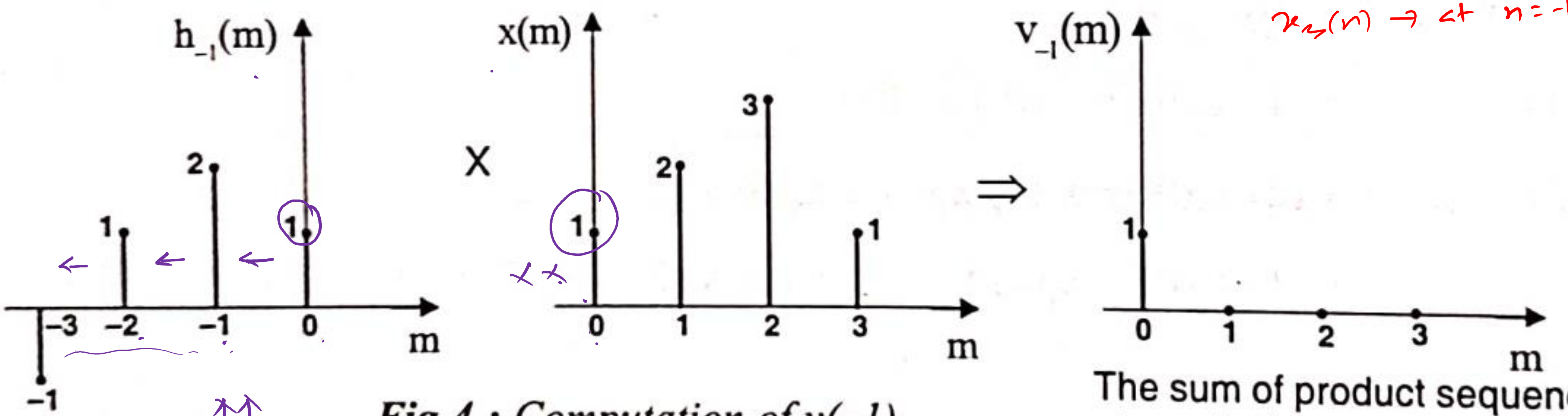


Fig 3 : Folded impulse response.

$\sum_{m=-\infty}^{\infty} x(m)\, h(n-m)$ $N=7$ $n=-1$ $n=5$

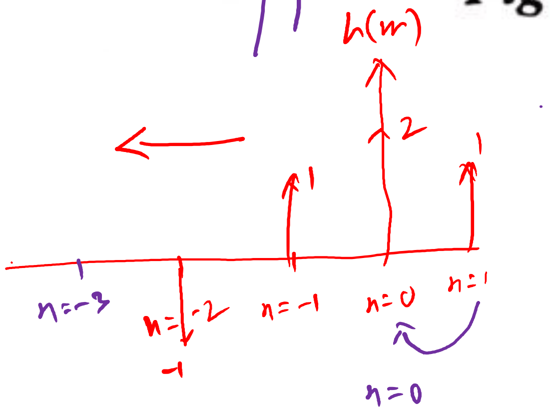
When n = −1 ; $y(-1) = \sum_{m=-\infty}^{+\infty} x(m)\,h(-1-m) = \sum_{m=-\infty}^{+\infty} x(m)\,h_{-1}(m) = \sum_{m=-\infty}^{+\infty} v_{-1}(m)$



$x_3(n) \to$ at $n=-1$

Fig 4 : Computation of y(−1).

The sum of product sequence $v_{-1}(m)$ gives $y(-1)$. ∴ $y(-1) = 1$



(−1)

$h(n-m) \quad n=0 \quad h(-m)$

When $n = 0$; $y(0) = \sum_{m=-\infty}^{+\infty} x(m)\, h(0-m) = \sum_{m=-\infty}^{+\infty} x(m)\, h_0(m) = \sum_{m=-\infty}^{+\infty} v_0(m)$

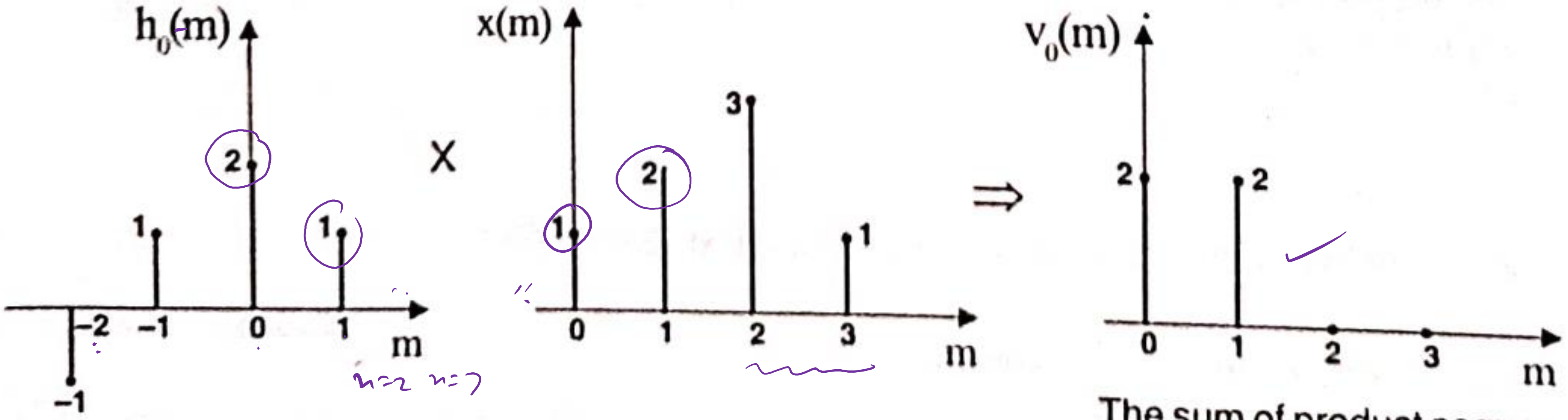


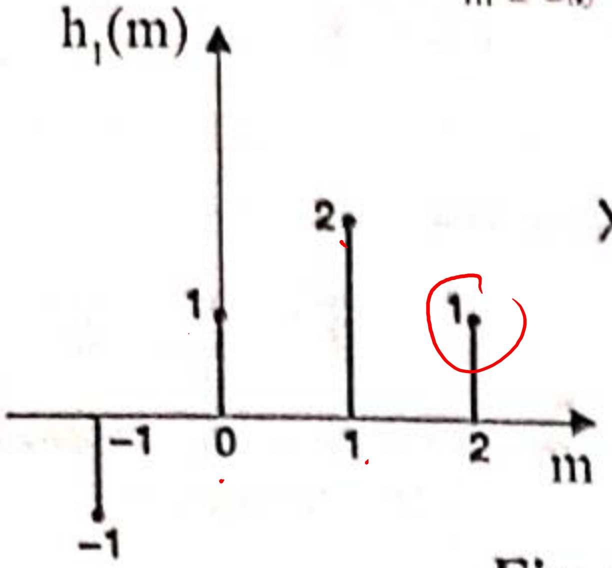
Fig 5 : Computation of y(0).

The sum of product sequence $v_0(m)$ gives $y(0)$. $\therefore$ $y(0) = 2 + 2 = 4$

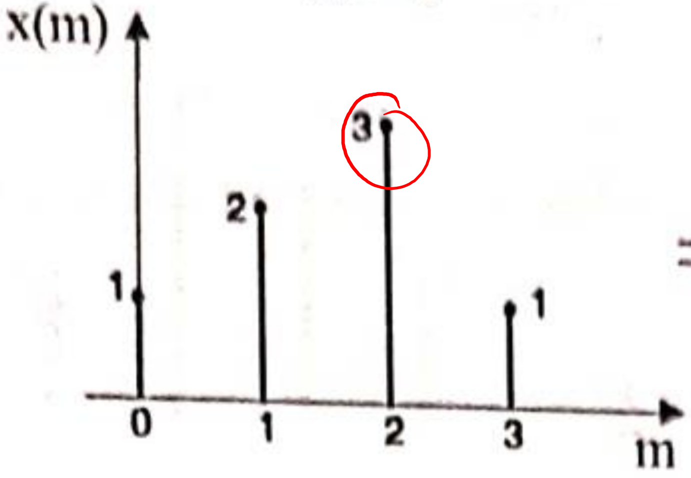
$2 \times 1 + 1 \times 2 = 4.$

$n=-1$, $n=0$ $n=1=$

When n = 1 ; $y(1) = \sum_{m=-\infty}^{+\infty} x(m)\, h(1-m) = \sum_{m=-\infty}^{+\infty} x(m)\, h_1(m) = \sum_{m=-\infty}^{+\infty} v_1(m)$



X



$\Rightarrow$

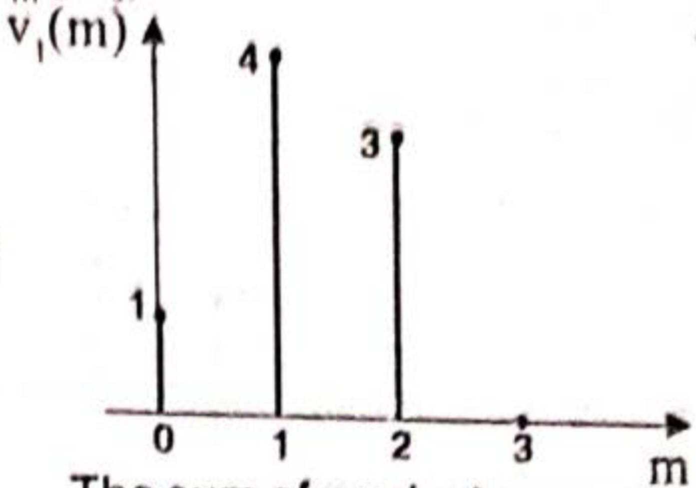
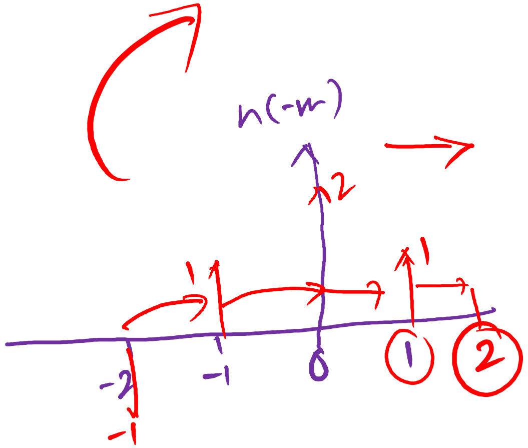


Fig 6 : Computation of y(1).

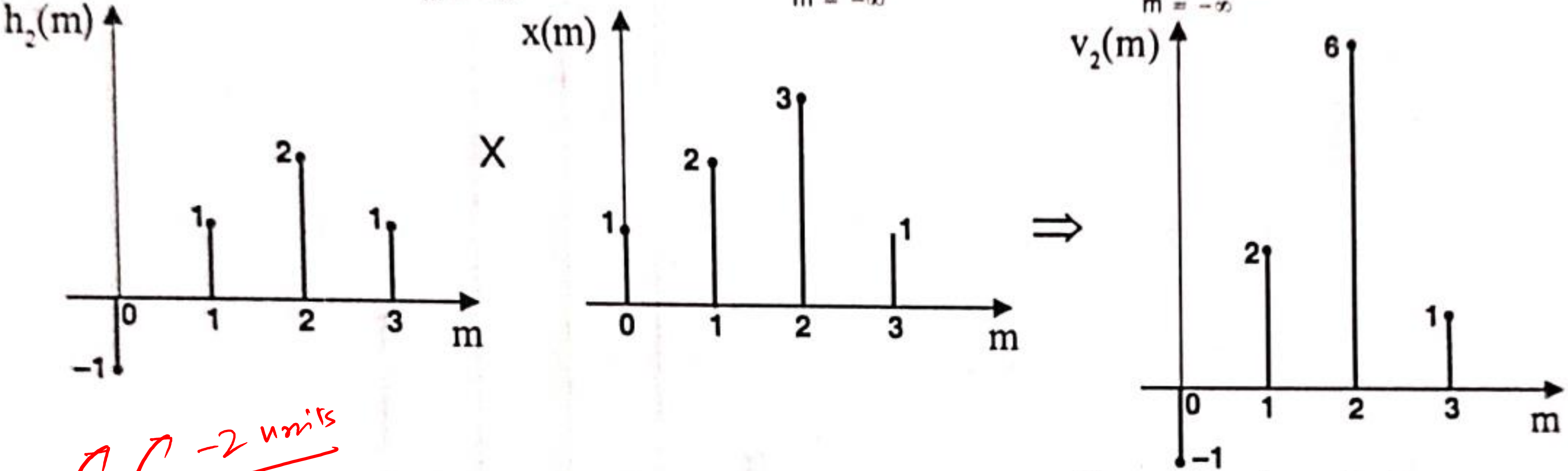
The sum of product sequence $v_1(m)$ gives y(1). $\therefore$ $y(1) = 1 + 4 + 3 = 8$



$h(n-m) = h(1-m)$

$1 + 4 + 3 = 8.$

When n = 2 ; $y(2) = \sum_{m=-\infty}^{+\infty} x(m)\, h(2-m) = \sum_{m=-\infty}^{+\infty} x(m)\, h_2(m) = \sum_{m=-\infty}^{+\infty} v_2(m)$



h(-m)

-2 units

Fig 7 : Computation of y(2).

The sum of product sequence $v_2(m)$ gives $y(2)$. $\therefore\ y(2) = -1 + 2 + 6 + 1 = 8$

n=3

When n = 3 ; $y(3) = \sum_{m=-\infty}^{+\infty} x(m)\, h(3-m) = \sum_{m=-\infty}^{+\infty} x(m)\, h_3(m) = \sum_{m=-\infty}^{+\infty} v_3(m)$

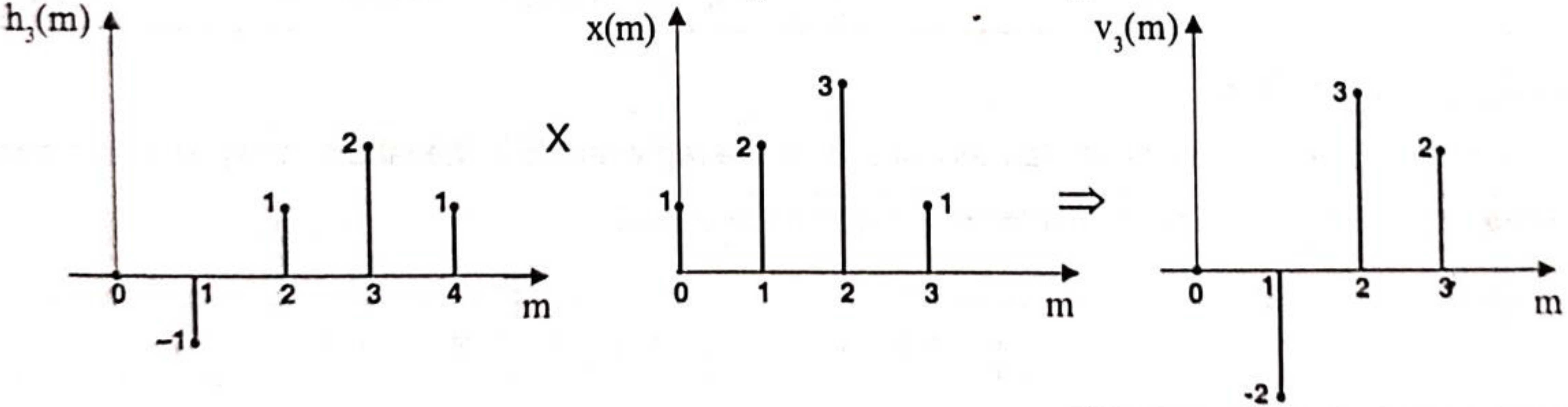


Fig 8 : Computation of y(3).

The sum of product sequence $v_3(m)$ gives y(3). $\therefore$ $y(3) = -2 + 3 + 2 = 3$

h(-m) $\longrightarrow$ 3 units towards right

When n = 4 ; $y(4) = \sum_{m=-\infty}^{+\infty} x(m)\,h(4-m) = \sum_{m=-\infty}^{+\infty} x(m)\,h_4(m) = \sum_{m=-\infty}^{+\infty} v_4(m)$

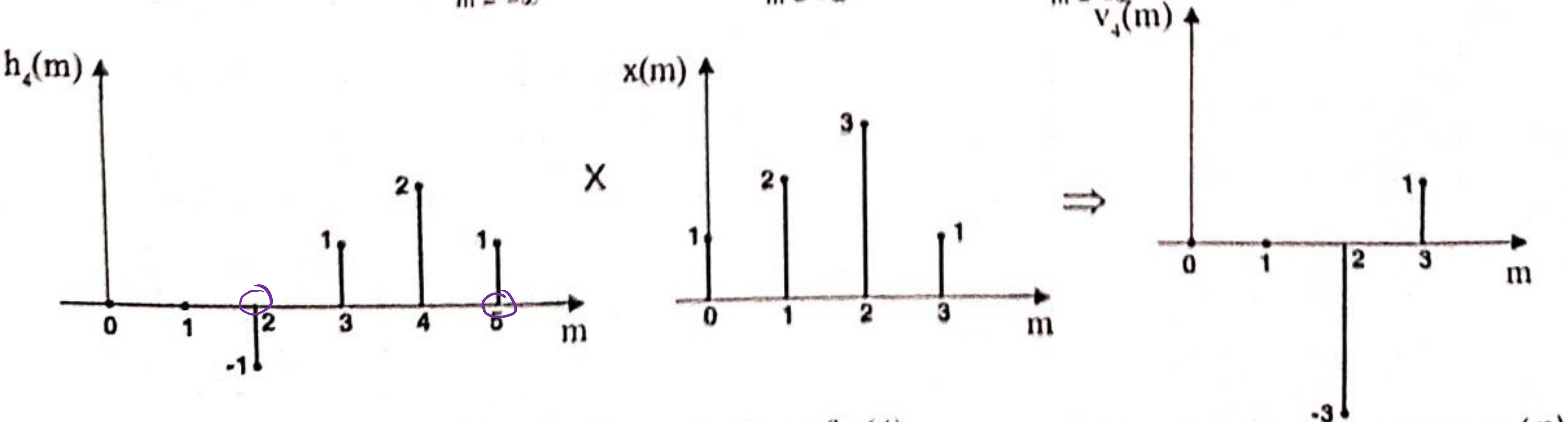
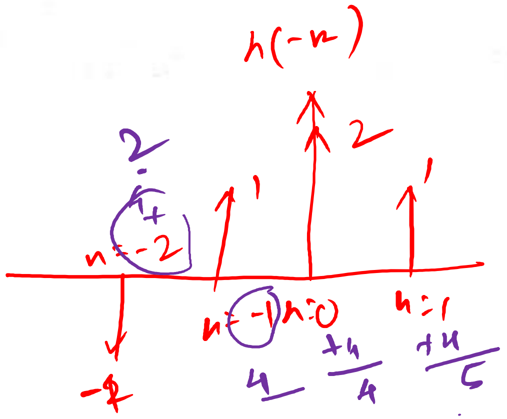


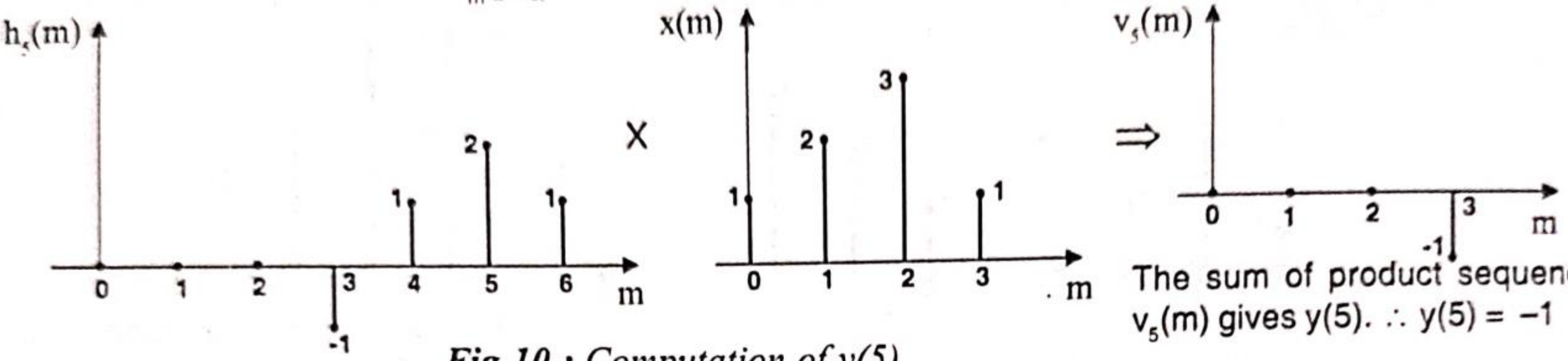
Fig 9 : Computation of y(4).

The sum of product sequence $v_4(m)$ gives $y(4)$. $\therefore y(4) = -3 + 1 = -2$



$h(n-m) = h(4-m)$

When n = 5 ; $y(5) = \sum_{m=-\infty}^{+\infty} x(m)\, h(5-m) = \sum_{m=-\infty}^{+\infty} x(m)\, h_5(m) = \sum_{m=-\infty}^{+\infty} v_5(m)$



The sum of product sequence $v_5(m)$ gives y(5). $\therefore$ $y(5) = -1$

Fig 10 : Computation of y(5).

5 units shifting towards right

The output sequence, $y(n) = \{1, \underset{\uparrow}{4}, 8, 8, 3, -2, -1\}$

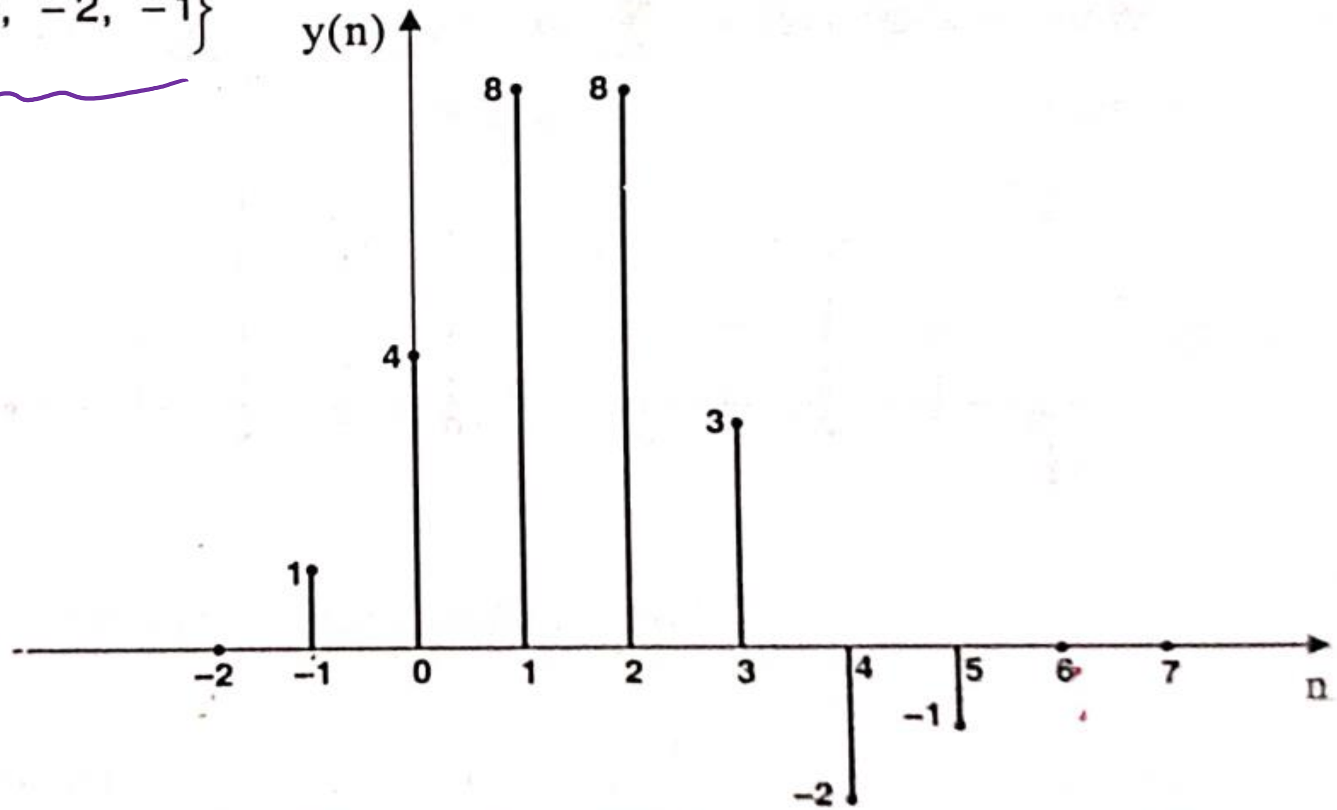


Fig 11 : Graphical representation of y(n).