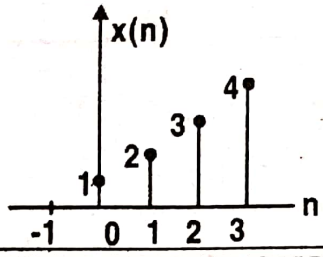
OPERATIONS ON DISCRETE-TIME SIGNALS

Think that the signal is being passed through a system and the system performs the specified operation on the signal.

ORIGINAL DISCRETE TIME SIGNAL

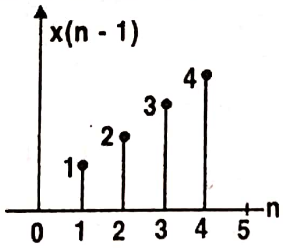
x(n) = {1,2,3,4}



x (n) INPUT ⟶ SYSTEM ⟶ y (n) OUTPUT

TIME-SHIFTING OPERATIONS

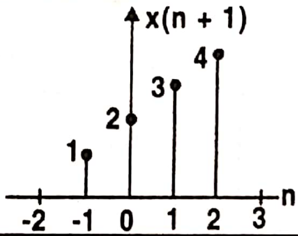
(1)DELAYING:



x (n) ⟶ S ⟶ y (n) = x (n - 1)

n	O/P
0	x (–1) = 0
1	x (0) = 1
2	x (1) = 2
3	x (2) = 3
4	x (3) = 4

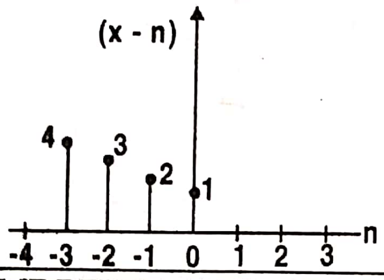
(2) ADVANCING:



x (n) ⟶ S ⟶ y (n) = x (n + 1)

n	O/P
–1	x (0) = 1
0	x (1) = 2
1	x (2) = 3
2	x (3) = 4

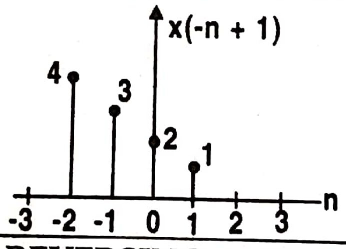
(3) TIME REVERSING:



x (n) ⟶ S ⟶ y (n) = x (-n)

n	O/P
0	x (0) = 1
–1	x (1) = 2
–2	x (2) = 3
–3	x (3) = 4

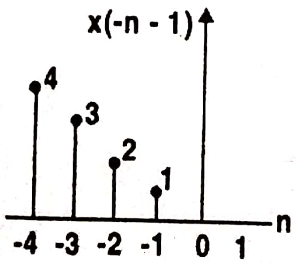
(4) TIME REVERSING AND DELAYING



x (n) ⟶ S ⟶ y (n) = x (-n + 1)

n	O/P
–1	x (0) = 1
0	x (1) = 2
–1	x (2) = 3
–2	x (3) = 4

(5) TIME REVERSING AND ADVANCING



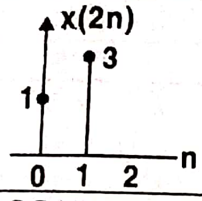
x (n) ⟶ S ⟶ y (n) = x (-n - 1)

n	O/P
0	x (–1) = 0
-1	x (0) = 1
–2	x (0) = 2
-3	x (2) = 3
–4	x (3) = 4

TIME SCALING OPERATIONS

(1) DOWN SCALING (COMPRESSION)

(Down Sampling)
Decimation[1]

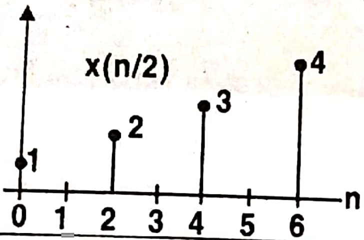


$$x(n) \rightarrow \boxed{S} \rightarrow y(n) = x(2n)$$

n	O/P
0	x (0) = 1
1	x (2) = 3
2	x (4) = 0

(2) UP SCALING (EXPANSION)

(Up Sampling)
(Interpolation)

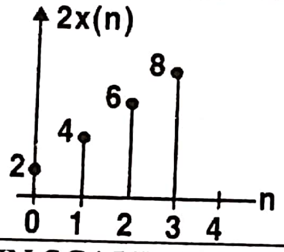


$$x(n) \rightarrow \boxed{S} \rightarrow y(n) = x\left(\frac{n}{2}\right)$$

n	O/P
0	x (0) = 1
1	x (1/2)
2	x (1) = 2
3	x (3/2)
4	x (2) = 3
5	x (5/2)
6	x (3) = 4

AMPLITUDE SCALING OPERATIONS

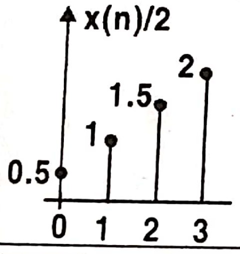
(1) UPSCALING (AMPLIFYING)



$$x(n) \rightarrow \boxed{S} \rightarrow y(n) = 2x(n)$$

n	O/P
0	2x (0) = 2
1	2x (1) = 4
2	2x (2) = 6
3	2x (3) = 8

(2) DOWN SCALING (ATTENUATION)

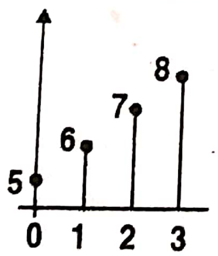


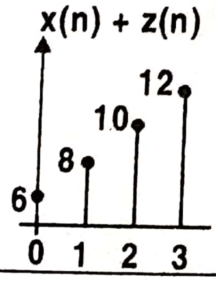
$$x(n) \rightarrow \boxed{S} \rightarrow y(n) = \frac{x(n)}{2}$$

n	O/P
0	x (0)/2 = 0.5
1	x (1)/2 = 1
2	x (2)/2 = 1.5
3	x (3)/2 = 2

ADDITION

Let z (n) = {5, 6, 7, 8}





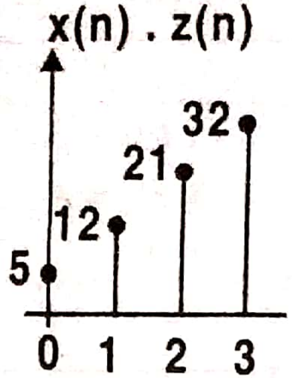
$$x(n) \rightarrow \boxed{S} \rightarrow y(n) = x(n) + z(n)$$

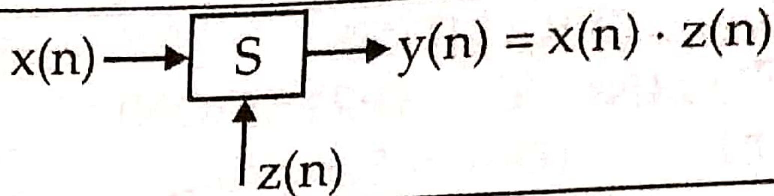
$$z(n) \uparrow$$

n	O/P
0	x (0) + z (0) = 6
1	x (1) + z (1) = 8
2	x (2) + z (2) = 10
3	x (3) + z (3) = 12

[1] The word decimation has a strange origin. During the period of the Roman empire, if a legion broke ranks and ran during battle, its members were lined up and every tenth person was killed. The process was called ***Decimation***.

MULTIPLICATION





n	O/P
0	$x(0) \cdot z(0) = 5$
1	$x(1) \cdot z(1) = 12$
2	$x(2) \cdot z(2) = 21$
3	$x(3) \cdot z(3) = 32$