SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB212 – DIGITAL SIGNAL PROCESSING

II YEAR/ IV SEMESTER

UNIT 1 – DISCRETE FOURIER TRANSFORM

TOPIC – Overlap Save & Overlap Add Method

EMPATHY

Difficult to filter long data sequences

Real time filtering

Filtering of long data sequence is Slow

SECTIONED CONVOLUTION

- The response of an LTI system for any arbitrary input is given by linear convolution of the input and the impulse response of the system
- The input sequence or impulse response sequence is very much larger than the other, then it is very difficult to compute the linear convolution for the following reasons:
- The entire sequence should be available before convolution can be carried out. This makes long delay in getting the output
- Large amounts of memory is required to store the sequences

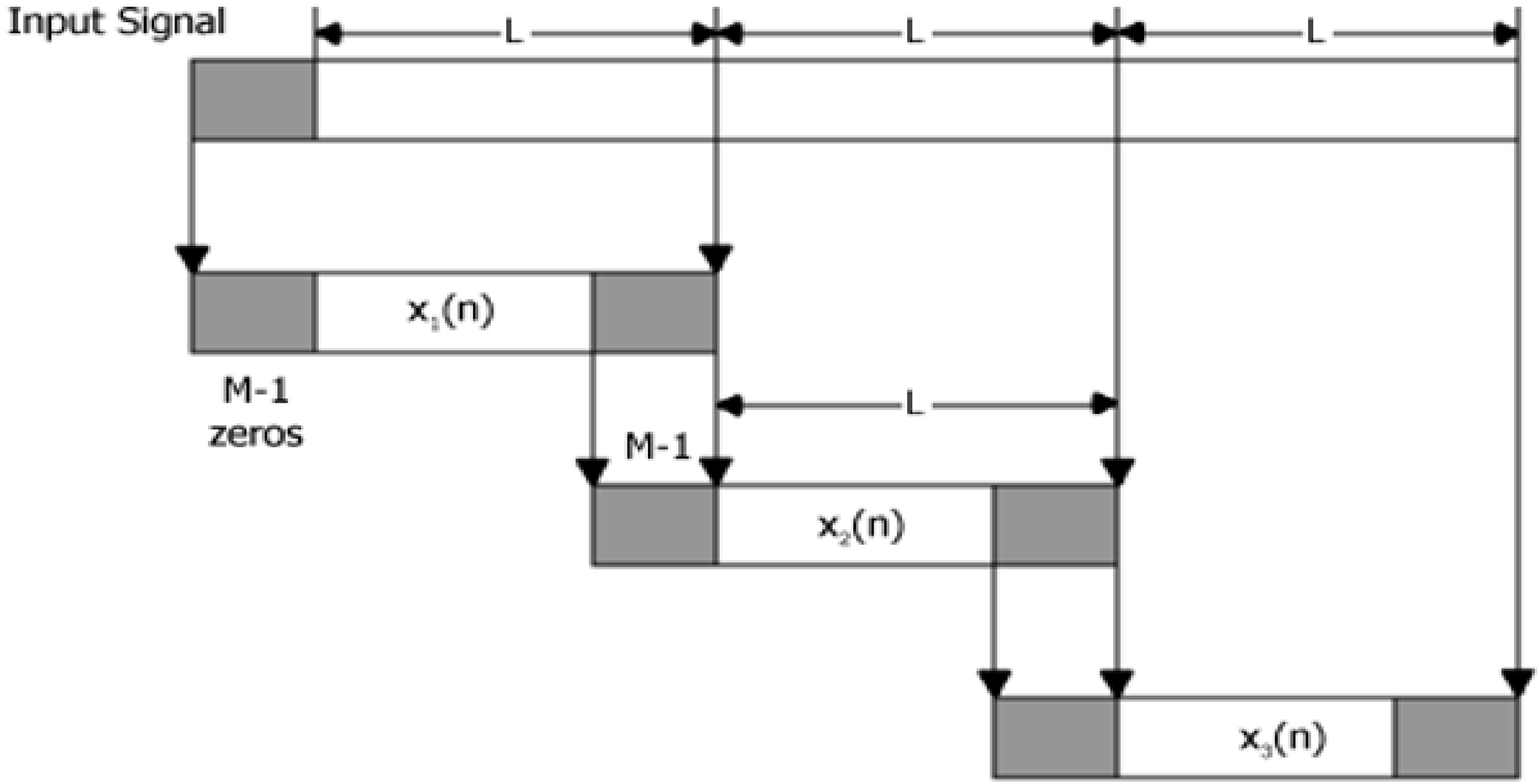
SECTIONED CONVOLUTION

- In this technique the larger sequence is sectioned (or splitted) into the size of smaller sequence
- Then the linear convolution of each section of longer sequence and the smaller sequence is performed
- The output sequences obtained from the convolutions of all the sections are combined to get the overall output sequence

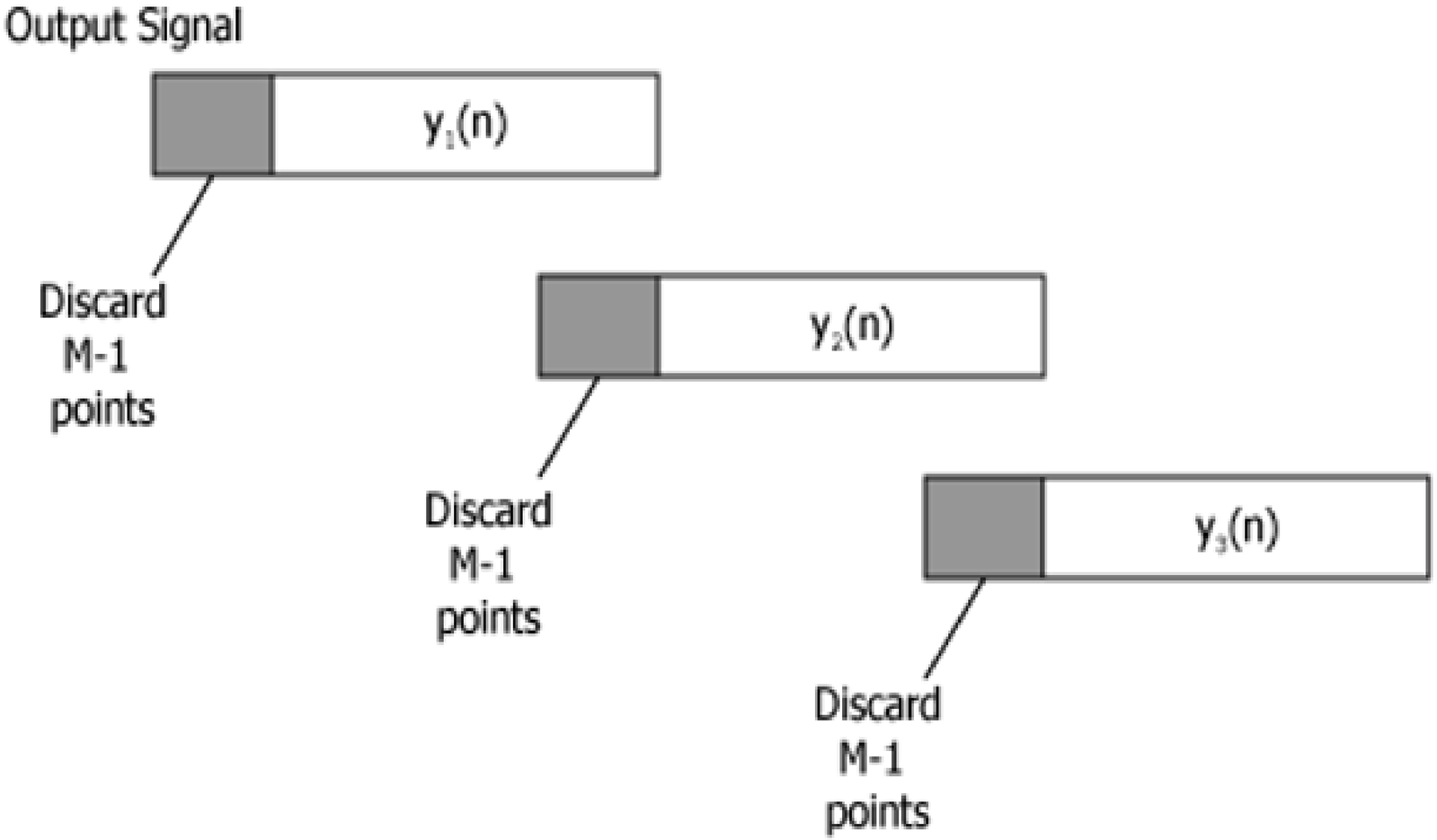
CIRCULAR CONVOLUTION

- There are two methods of sectioned convolutions. They are
- **Overlap add method**
- **Overlap save method**

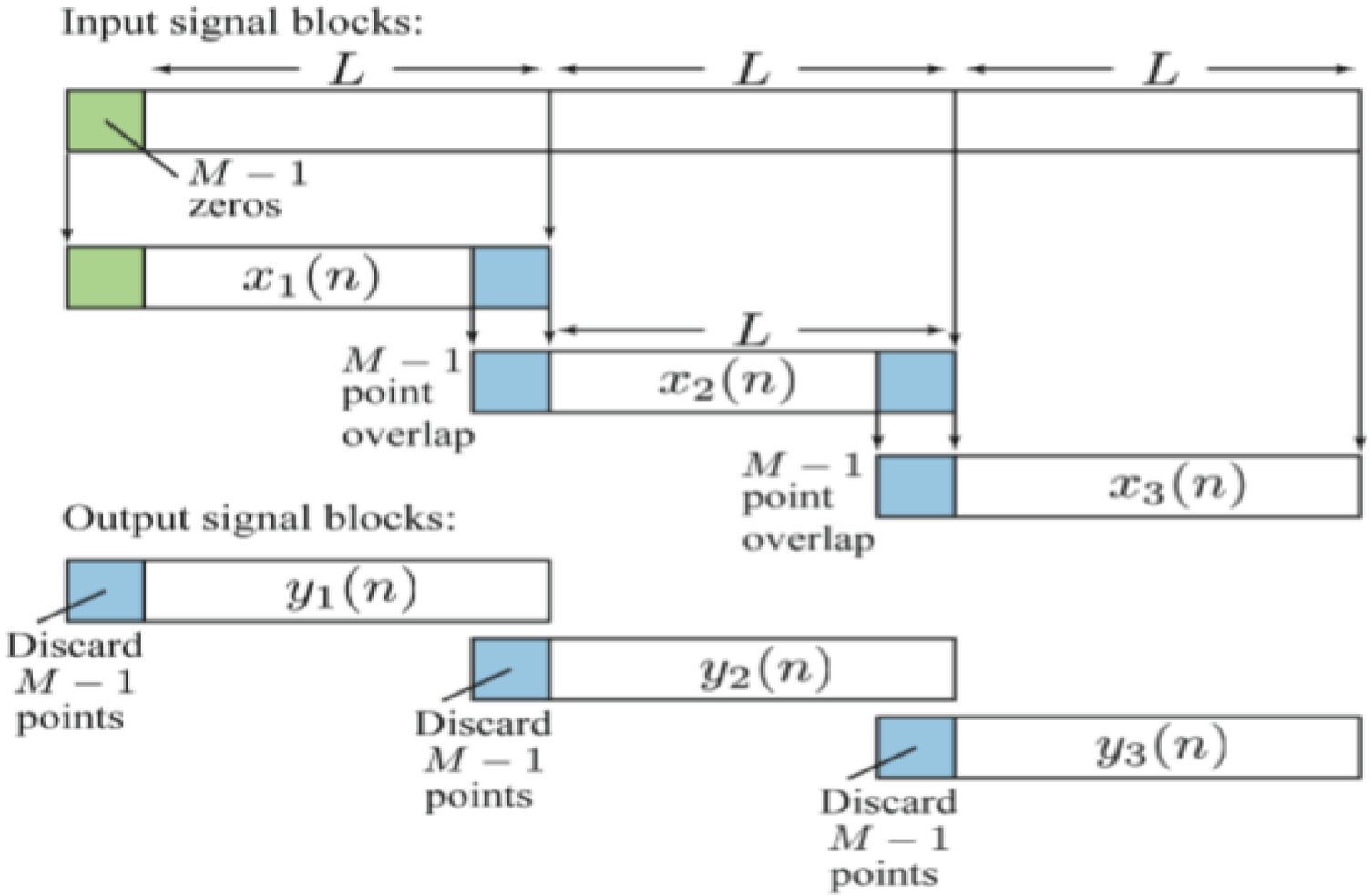
OVERLAP SAVE METHOD



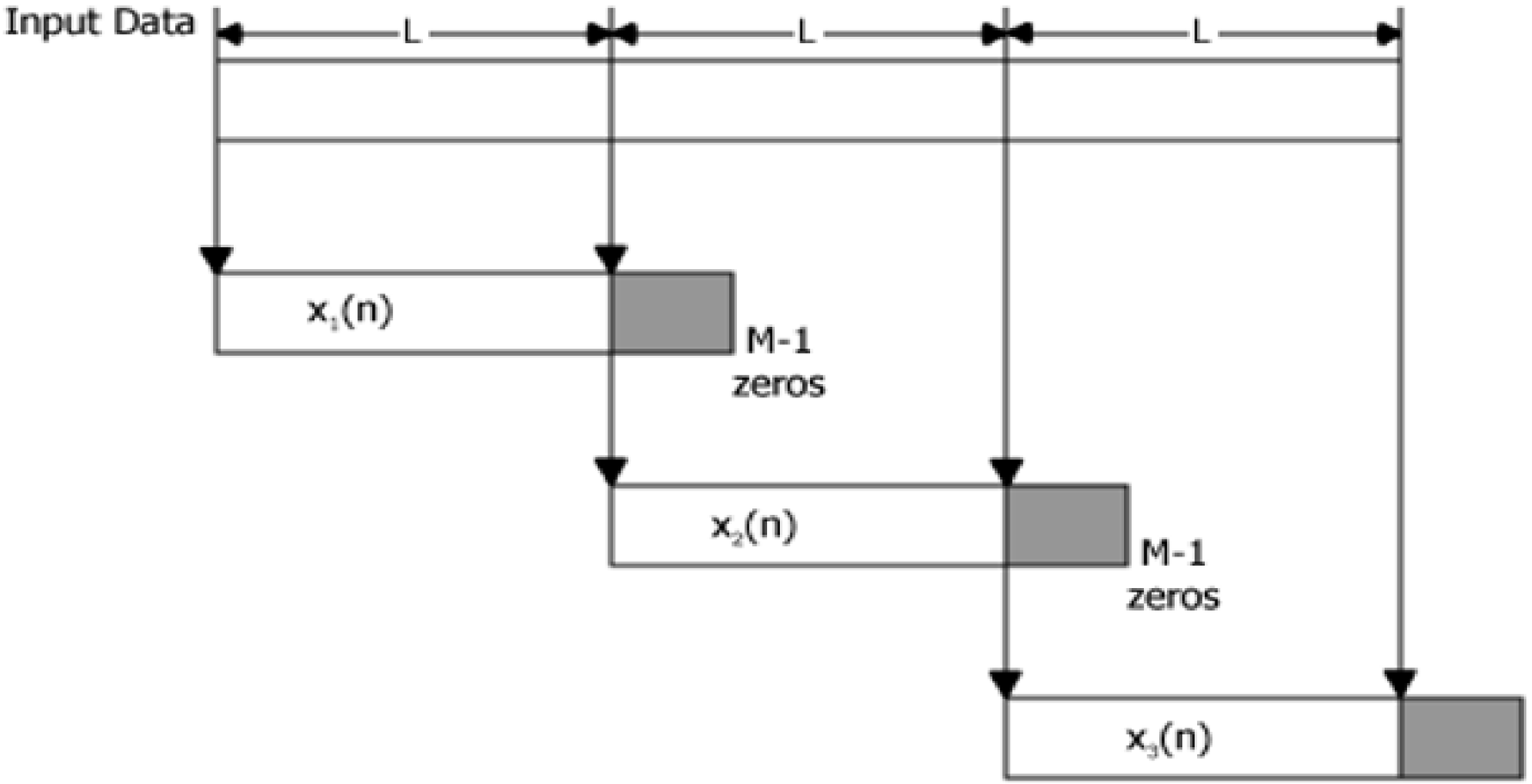
OVERLAP SAVE METHOD



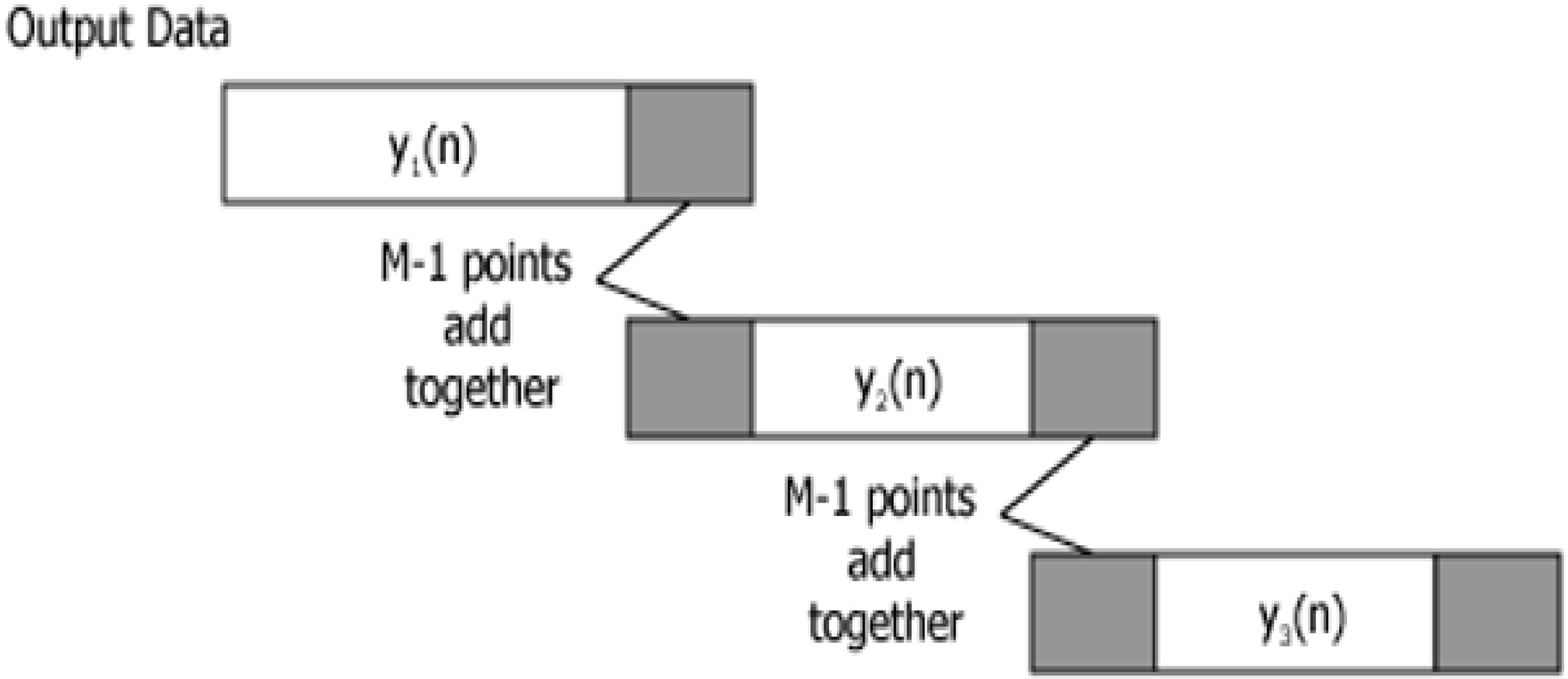
OVERLAP SAVE METHOD



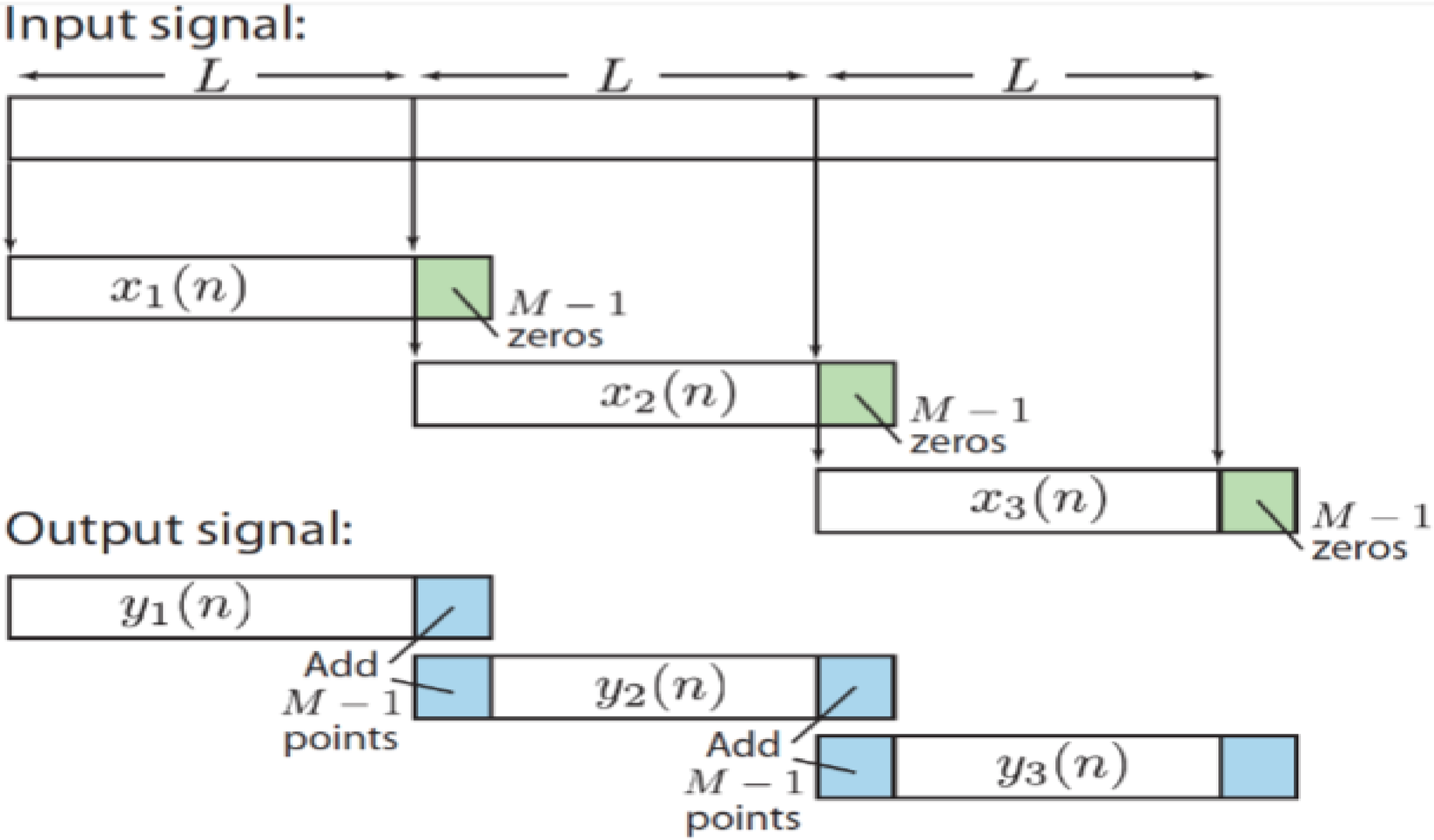
OVERLAP ADD METHOD



OVERLAP ADD METHOD



OVERLAP ADD METHOD



OVERLAP ADD METHOD

- Step 1: Divide the longer sequence into small sequences

x(n) – Long sequence and h(n) – Small Sequence

Then divide x(n) into $x_1(n)$, $x_2(n)$, $x_3(n)$……..

- Length of $x_1(n)$ (or) Length of $x_2(n)$ (or) Length of $x_3(n)$…. = Length of h(n)….
- Step 2: Find $y_1(n)$ then $y_1(n) = x_1(n) * h(n)$
- Step 3: Find $y_2(n)$, $y_3(n)$ ……
- Step 4: Combine all the outputs $y_1(n)$, $y_2(n)$, $y_3(n)$ …….

OVERLAP ADD METHOD

- **Find the linear convolution x(n) = {1,2,3,4,4,3,2,1} and h(n) = {-1,1} using Overlap Add Method:**
- **Step 1:** Divide longer sequence into small subsequences
- x(n) = Longer sequence and h(n) = Small sequence

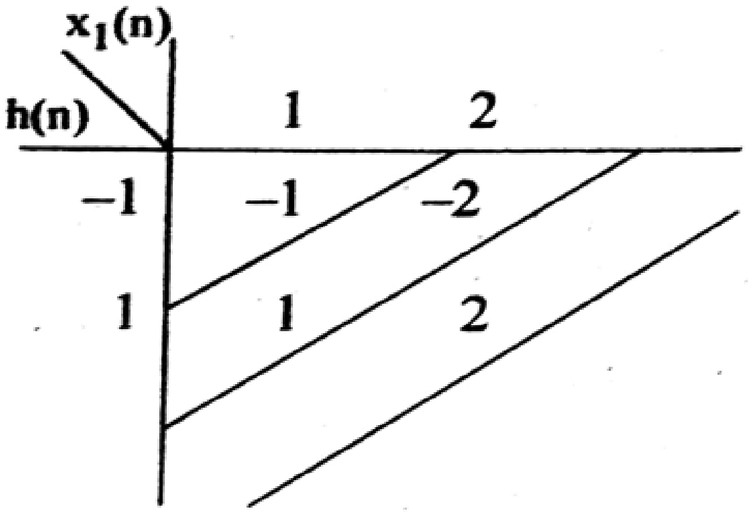
x(n) is divided as below

- $x_1(n) = \{1,2\}$, $x_2(n) = \{3,4\}$, $x_3(n) = \{4,3\}$, $x_4(n) = \{2,1\}$
- Length of $x_1(n)$ or $x_2(n)$ or $x_3(n)$ or $x_4(n)$ = Length of h(n)

OVERLAP ADD METHOD

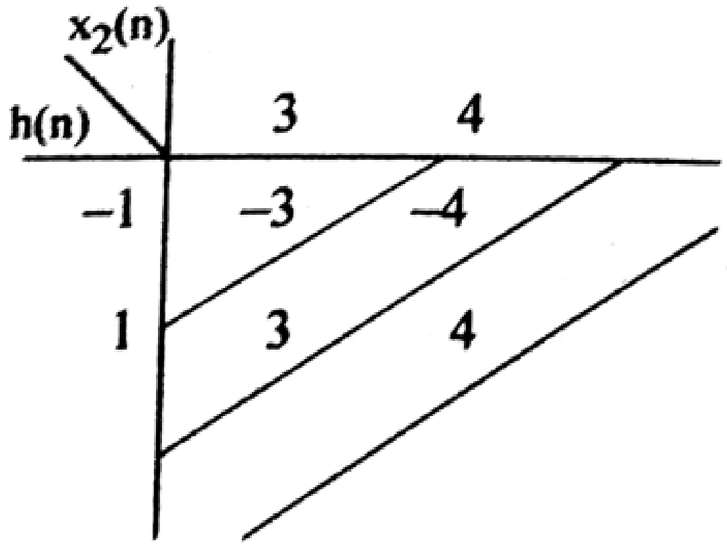
Step 2 : Find $y_1(n)$

$$y_1(n) = x_1(n) * h(n)$$



$$y_1(n) = \{-1, -1, 2\}$$

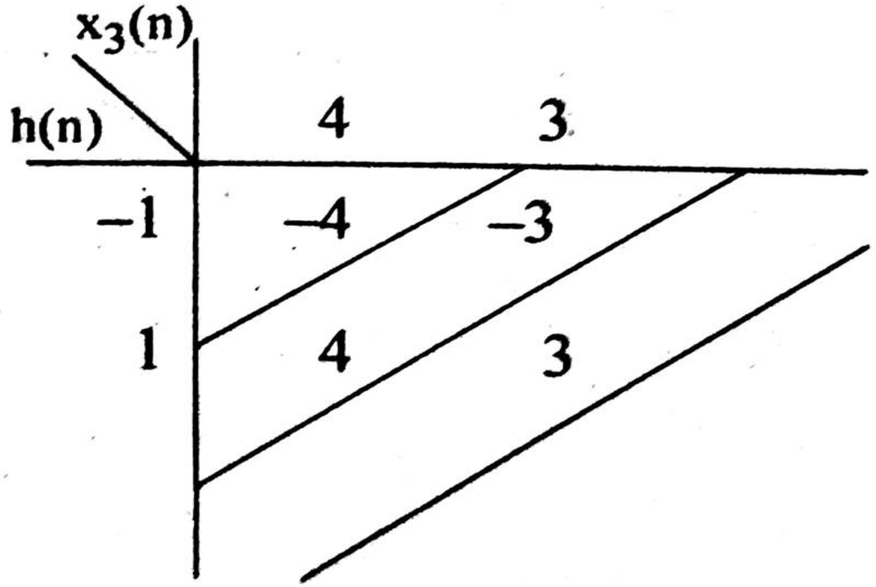
Step 3 : Find $y_2(n) = x_2(n) * h(n)$



$$y_2(n) = \{-3, -1, 4\}$$

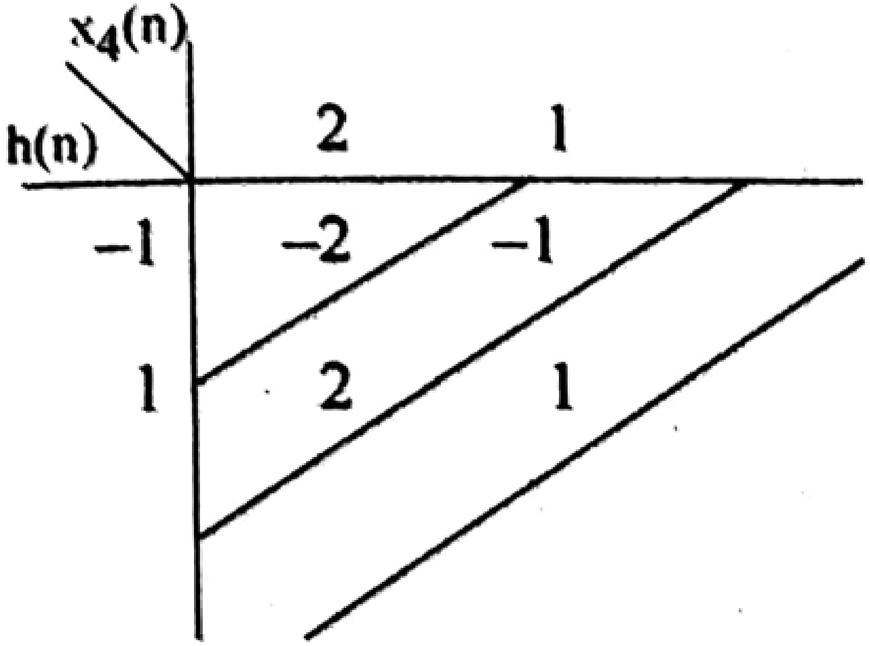
OVERLAP ADD METHOD

$y_3(n) = x_3(n) * h(n)$



$y_3(n) = \{-4, 1, 3\}$

$y_4(n) = x_4(n) * h(n)$



$y_4(n) = \{-2, 1, 1\}$

OVERLAP ADD METHOD

Step 4 : **Combine all the outputs :**

n	0	1	2	3	4	5	6	7	8
$y_1(n)$	–1	–1	2						
$y_2(n)$			–3	–1	4				
$y_3(n)$					–4	1	3		
$y_4(n)$							–2	1	1
	–1	–1	–1	–1	0	1	1	1	1

$$y(n) = \{-1, -1, -1, -1, 0, 1, 1, 1, 1\}$$

OVERLAP SAVE METHOD

- **Find the linear convolution x(n) = {1,2,3,4,4,3,2,1} and h(n) = {-1,1} using Overlap Save Method:**

Find $y_1(n)$:

$x_1(n) = \{1, 2, 3\}$

$h(n) = \{-1, 1, 0\}$

$y_1(n) = x_1(n) \circledcirc h(n)$

circular convolution is done using Matrix Method

$$\begin{bmatrix} 1 & 3 & 2 \\ 2 & 1 & 3 \\ 3 & 2 & 1 \end{bmatrix} \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -1+3+0 \\ -2+1+0 \\ -3+2+0 \end{bmatrix}$$

$$= \begin{bmatrix} 2 \\ -1 \\ -1 \end{bmatrix}$$

$$\boxed{y_1(n) = [2, -1, -1]}$$

OVERLAP SAVE METHOD

Find $y_2(n)$:

$$x_2(n) = \{3, 4, 4\}$$

$$h(n) = \{-1, 1, 0\}$$

$$y_2(n) = x_2(n) \odot h(n)$$

$$\begin{bmatrix} 3 & 4 & 4 \\ 4 & 3 & 4 \\ 4 & 4 & 3 \end{bmatrix} \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -3+4+0 \\ -4+3+0 \\ -4+4+0 \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix}$$

$$\boxed{y_2(n) = [1, -1, 0]}$$

OVERLAP SAVE METHOD

Find $y_3(n)$:

$$x_3(n) = \{4, 3, 2\}$$

$$h(n) = \{-1, 1, 0\}$$

$$y_3(n) = x_3(n) \circledcirc h(n)$$

$$\begin{bmatrix} 4 & 2 & 3 \\ 3 & 4 & 2 \\ 2 & 3 & 4 \end{bmatrix} \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -4+2+0 \\ -3+4+0 \\ -2+3+0 \end{bmatrix} = \begin{bmatrix} -2 \\ 1 \\ 1 \end{bmatrix}$$

$$\boxed{y_3(n) = [-2, 1, 1]}$$

OVERLAP SAVE METHOD

Find $y_4(n)$:

$$x_4(n) = \{2, 1, 0\}$$

$$h(n) = \{-1, 1, 0\}$$

$$y_4(n) = x_4(n) \circledcirc h(n)$$

$$\begin{bmatrix} 2 & 0 & 1 \\ 1 & 2 & 0 \\ 0 & 1 & 2 \end{bmatrix} \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} -2+0+0 \\ -1+2+0 \\ 0+1+0 \end{bmatrix} = \begin{bmatrix} -2 \\ 1 \\ 1 \end{bmatrix}$$

$$\boxed{y_4(n) = [-2, 1, 1]}$$

OVERLAP SAVE METHOD

Step 3 : Find y(n) :

Here, original h(n) length = 2.

So, 1 sample is overlapped, and 1 sample is discarded.

n	0	1	2	3	4	5	6	7	8	9
$y_1(n)$	2	−1	−1							
$y_2(n)$			~~1~~	−1	0					
$y_3(n)$					~~−2~~	1	1			
$y_4(n)$							~~−2~~	1	1	
	*	−1	−1	−1	0	1	1	1	1	

~~X~~ → indicates that the sample is discarded.

$y(n) = \{*, -1, -1, -1, 0, 1, 1, 1, 1\}$

DIFFERENCE B/W OVERLAP ADD & OVERLAP SAVE METHOD

S.No.	Overlap Add Method	Overlap Save Method
1	Linear convolution of each section of longer sequence with small sequence is performed	Circular convolution of each section of longer sequence with smaller sequence is performed
2	Zero padding is not required	Zero padding is required to convert input sequences to size of output sequence
3	The overlapped samples in output are added to get overall output	In the output the last N_2-1 sampling (or) First N_2-1 samples are discarded

APPLICATIONS

Communication Signal Processing

* To remove noise which are added during transmission can be removed using filter where the operation involved is convolution

ASSESSMENT

1. List the methods involved to compute sectioned convolution.
2. Mention some applications of sectioned Convolution.
3. What is meant by sectioned Convolution.
4. Find the linear convolution x(n) = {1,2,3,4,4,3,2,1} and h(n) = {-1,1} using Overlap Save Method
5. What is the difference between overlap add and overlap save method.
6. Determine linear convolution x(n) = {1,2,3,4,4,3,2,1} and h(n) = {-1,1} using Overlap Add Method

THANK YOU