SIGNALS & SYSTEMS

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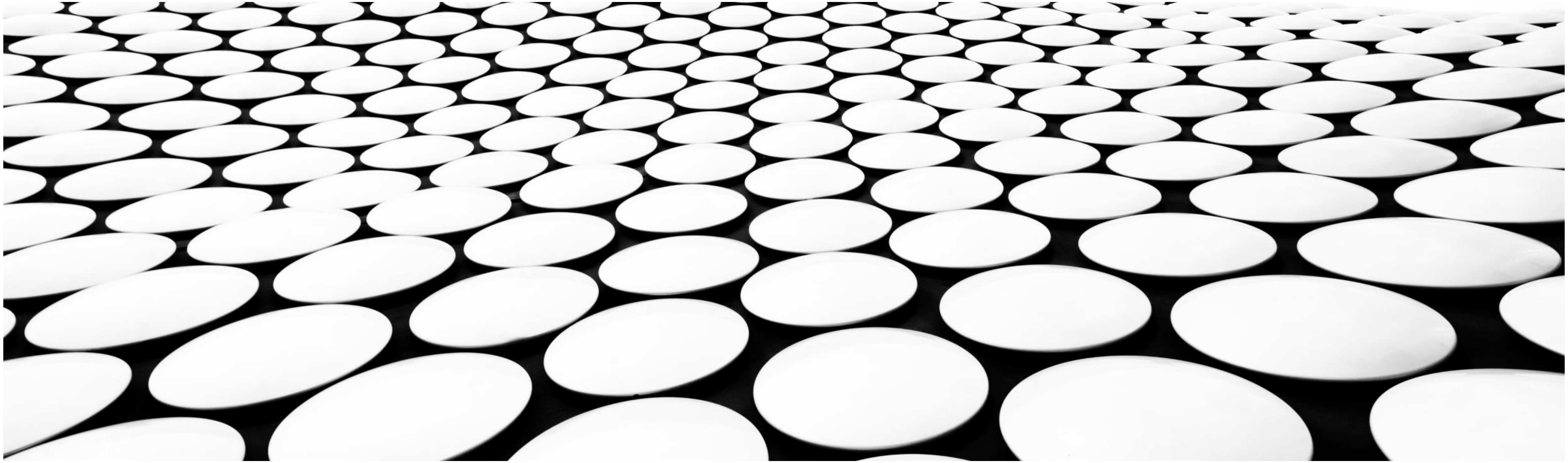

-: Discrete or Linear convolution: -

$x_1(n)$ and $x_2(n)$

$$x_3(t) = \int_{-\infty}^{\infty} x_1(\lambda)\, x_2(t-\lambda)\, d\lambda$$

$$x_3(n) = x_1(n) * x_2(n) = \sum_{m=-\infty}^{\infty} x_1(m)\, x_2(n-m)$$

$x_1(n) \rightarrow N_1$ samples

$x_2(n) \rightarrow N_2$ samples

$x_1(n) = \{2, 0, 1, 2\} \rightarrow 4$

$x_2(n) = \{-1, -2, 0, 1, 5\} \rightarrow 5$

Sequence for $x_3(n) \rightarrow N_1 + N_2 - 1$

$\underline{4 + 5 - 1}$

⑧

Aperiodic convolution.

$x_1(n) \rightarrow$ N_1 samples

$x_2(n) \rightarrow$ N_2 samples

$$x_3(n) = \sum_{m=-\infty}^{\infty} x_1(m)\, x_2(n-m)$$

Change of index :- $\underbrace{x_1(n) \rightarrow x_1(m)}_{\text{fixed}}$ and $\underbrace{x_2(n) \rightarrow x_2(m)}_{\text{move / shift}}$

Folding :- $x_2(-m)$

Shifting :- $x_2(n-m)$

Multiplication :- $\underbrace{x_1(m) \times x_2(n-m)}$

Summation :- $\sum_{m=-\infty}^{\infty}$ ↙ summ up

Linear convolution or discrete time conv.

Graphical Method ✓

↓

Semister exam

Tabular Method ✗

Matrix method ✓

↓

Short cut tricks

$x_1(n) = \{\underset{\underset{n=0}{\uparrow}}{1}, 2, 3, 1\}$ and $h(n) = \{\underset{\underset{n=-1}{\swarrow}}{1}, \underset{\underset{n=0}{\uparrow}}{2}, 1, -1\}$

$$\begin{array}{c|cccc} x(n)\downarrow \; \backslash \; h(n)\rightarrow & 1 & 2 & 1 & -1 \\ \hline 1 & 1 & 2 & 1 & -1 \\ 2 & 2 & 4 & 2 & -2 \\ 3 & 3 & 6 & 3 & -3 \\ 1 & 1 & 2 & 1 & -1 \end{array}$$

$x_3(n) \rightarrow N_1 + N_2 - 1$ ✓

$4 + 4 - 1 = \boxed{7}$

$n_1 = 0, \; n_2 = -1$

$\text{starting pt} = n_1 + n_2 = 0 - 1 = -1$

$\text{end. pt} = n_1 + n_2 + N_1 + N_2 - 2$

$= -1 + 4 + 4 - 2$

$= 5$

$x_3(n) = \{\underset{\underset{n=-1}{\swarrow}}{1}, \underset{\underset{n=0}{\uparrow}}{4}, \overset{n=1}{8}, \overset{n=2}{8}, \overset{n=3}{3}, \overset{n=4}{-2}, \overset{n=5}{-1}\}$ ✓

starting pt of seq

In general, $x_1(n) \rightarrow \underline{n=n_1}$, $N_1 \rightarrow$ No of seq. for $x_1(n)$

$x_2(n) \rightarrow n=n_2$ $N_2 \rightarrow$ No of seq. for $x_2(n)$

For linear conv, we can predict the starting and ending point for $\underline{\underline{x_3(n)}}$

so, the starting value is n_1+n_2

ending value is $n_1+n_2+N_1+N_2-2$