COLLEGE OF ENGINEERING AND TECHNOLOGIES

ALMUSTAQBAL UNIVERSITY

Digital Signal Processing (DSP)

CTE 306

Lecture 4

- Type of Signals -

(2023 - 2024)

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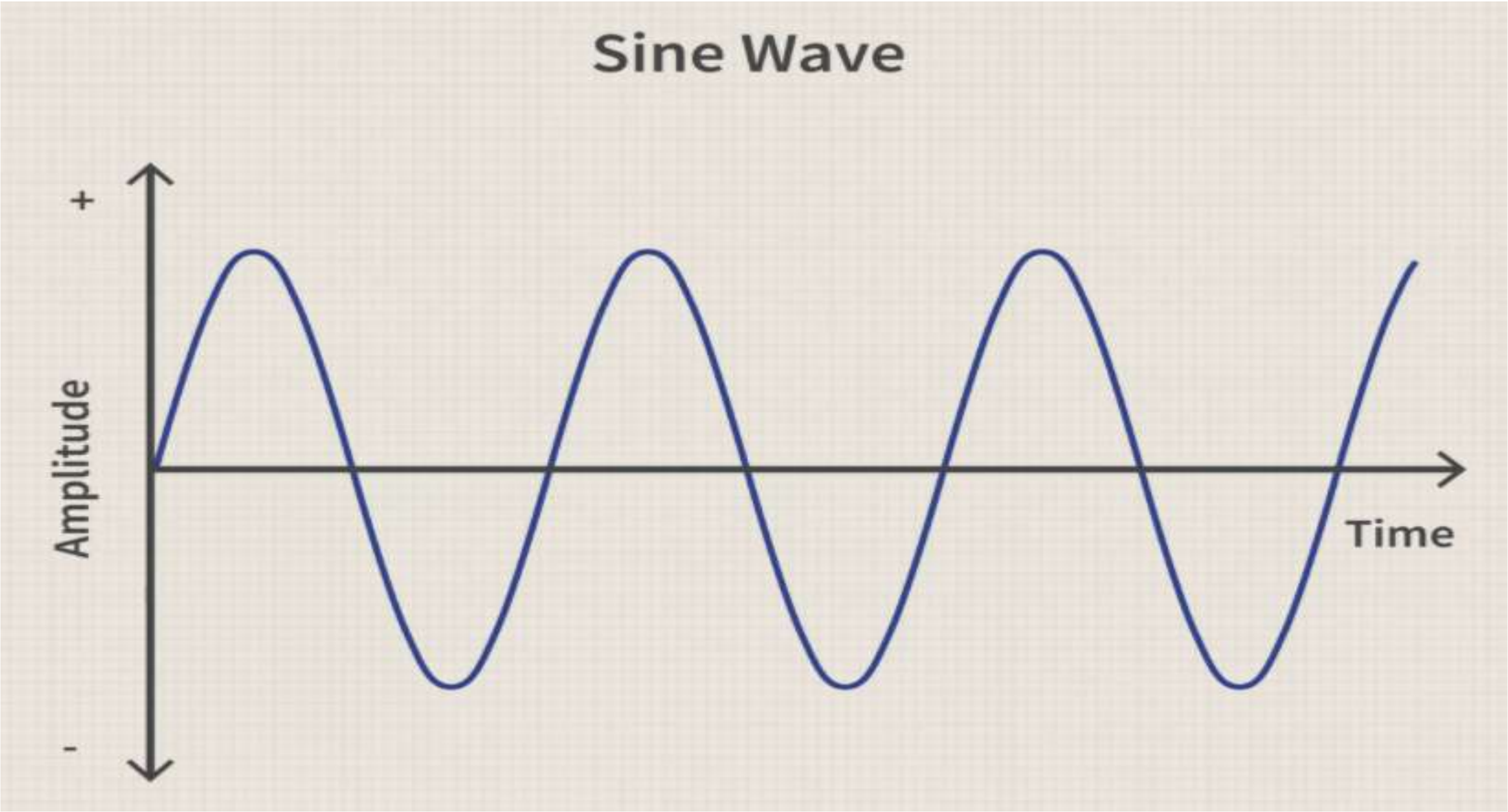
Basic Signals

- Sinusoidal Signal.
- Exponential Signal.
- Unit Step Function.
- Unit Ramp Function.
- Unit Impulse Function.

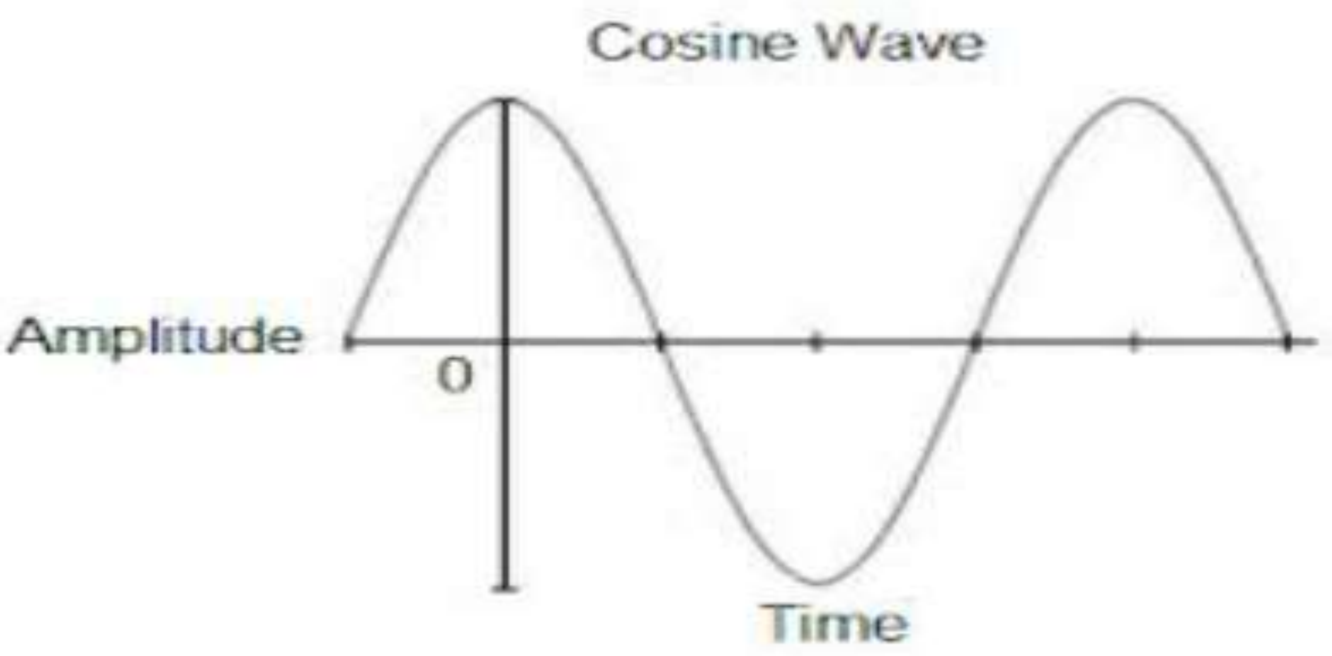
Sin Signal



$$x(t) = A \sin(\omega_0 t + \theta)$$

$$x(t) = A \sin(2\pi f_0 t + \theta)$$

Cos Signal



$$x(t) = A \cos(\omega_0 t + \theta)$$

$$x(t) = A \cos(2\pi f_0 t + \theta)$$

Sinusoidal Signal

Where

A : is the amplitude (real),

w_o : is the radian frequency in radians per second, and

θ : is the phase angle in radians.

Sinusoidal Signal

Where wo is called the fundamental angular frequency.

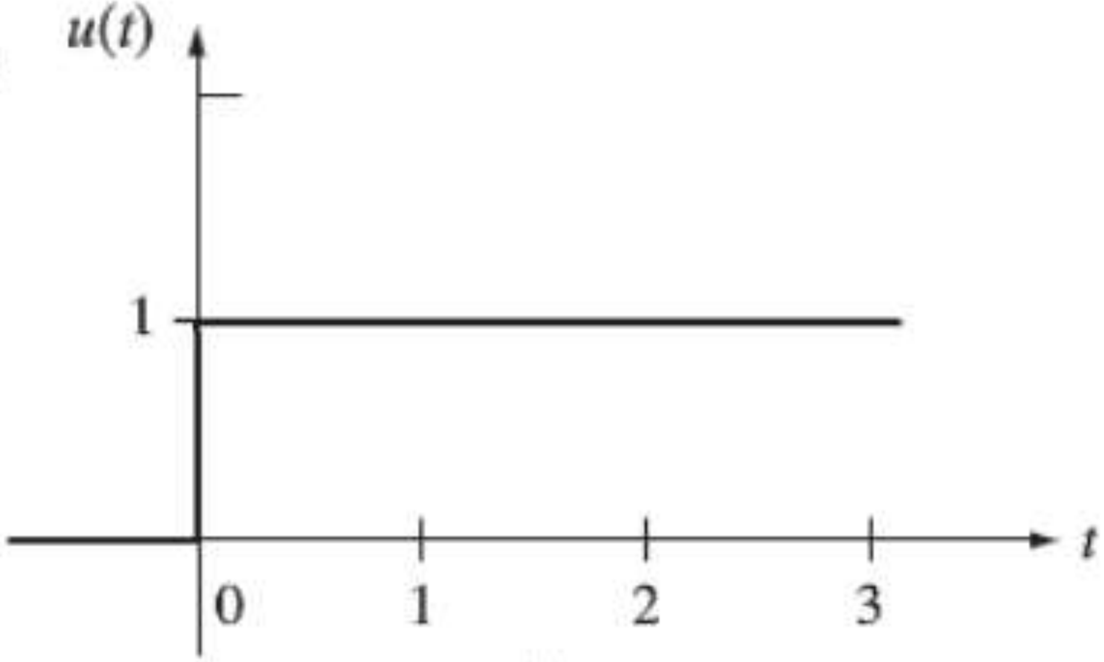
$$\omega_0 = 2\pi f_0$$

The reciprocal of the fundamental period To is called the fundamental frequency fo:

$$f_0 = \frac{1}{T_0} \quad \text{hertz (Hz)}$$

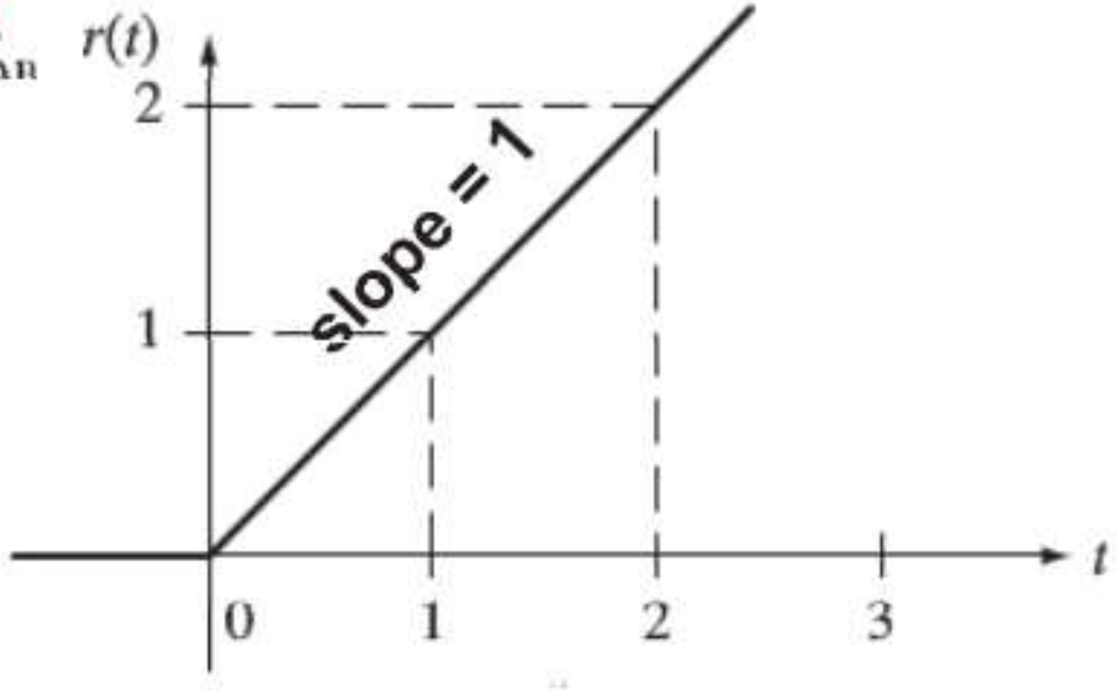
$$T_0 = \frac{2\pi}{\omega_0}$$

Unit-step function u(t)



$$u(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$$

Unit-ramp function r(t)

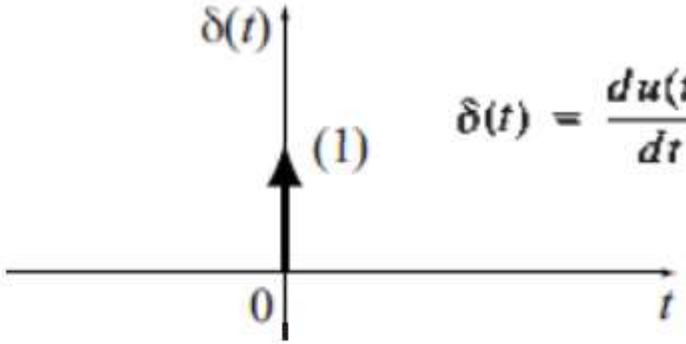


$$r(t) = \begin{cases} t, & t \geq 0 \\ 0, & t < 0 \end{cases}$$

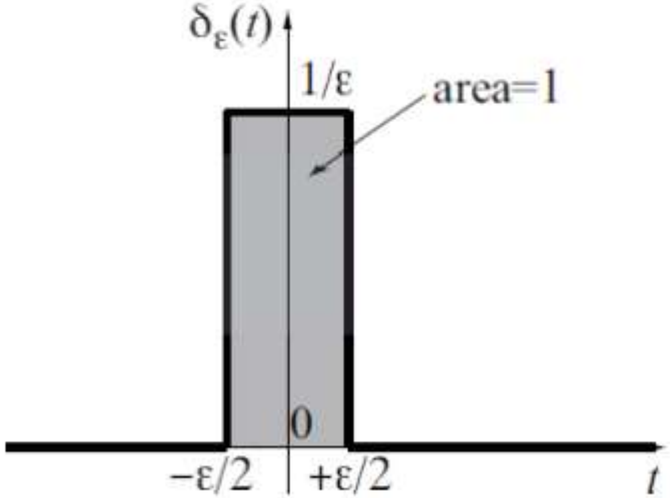
Unit Impulse Function

The unit impulse also called the delta function or the Dirac distribution, is defined by

$$\delta(t) = 0 \text{ for } t \neq 0$$



$$\delta(t) = \frac{du(t)}{dt}$$



$$\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$

$$\delta(t) = \lim_{\varepsilon \to 0} \delta_\varepsilon(t),$$

where

$$\delta_\varepsilon(t) = \begin{cases} 1/\varepsilon, & -\varepsilon/2 \le t \le \varepsilon/2 \\ 0, & |t| > \varepsilon/2 \end{cases}$$

Unit Impulse Function

If x(t) is a signal that is continuous at t = 0, then

$$x(t)\delta(t) = x(0)\delta(t)$$

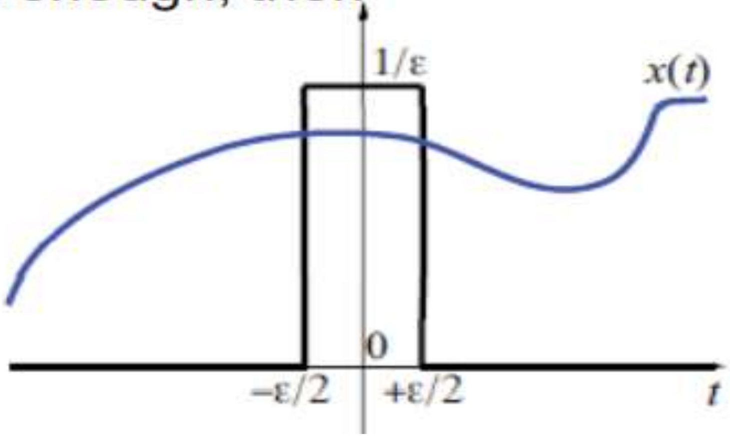
In particular,

$$\int_{-a}^{a} x(t)\delta(t)dt = x(0) \qquad \text{for any } 0 < a \leq +\infty.$$

You can convince yourselves of this by approximating ð(t) with a pulse,

such as $ð_s(t)$, and using the fact that, if s is small enough, then

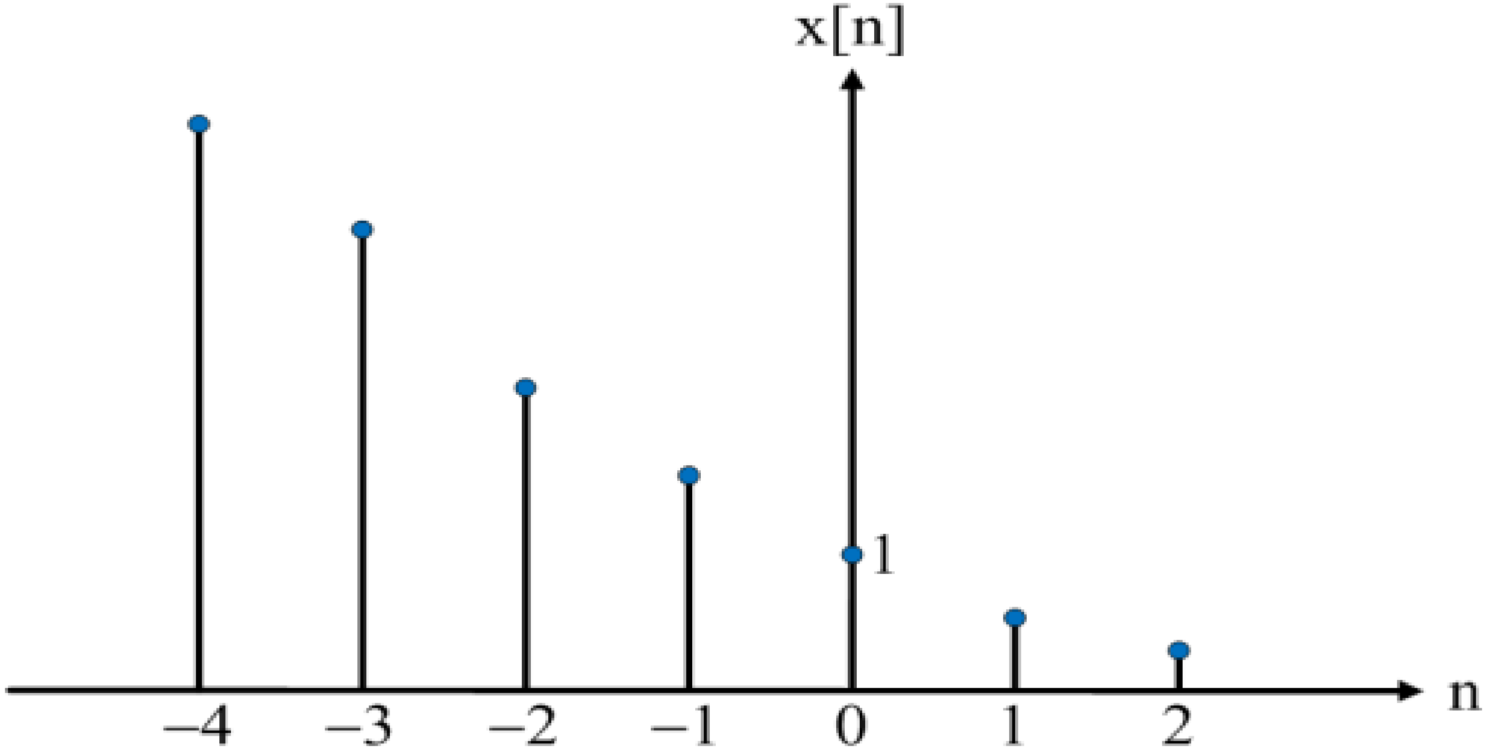
$$x(t) \approx x(0) \qquad \text{for } -\varepsilon/2 \leq t \leq \varepsilon/2.$$



Real Exponential Sequence

$$x[n] = a^n$$

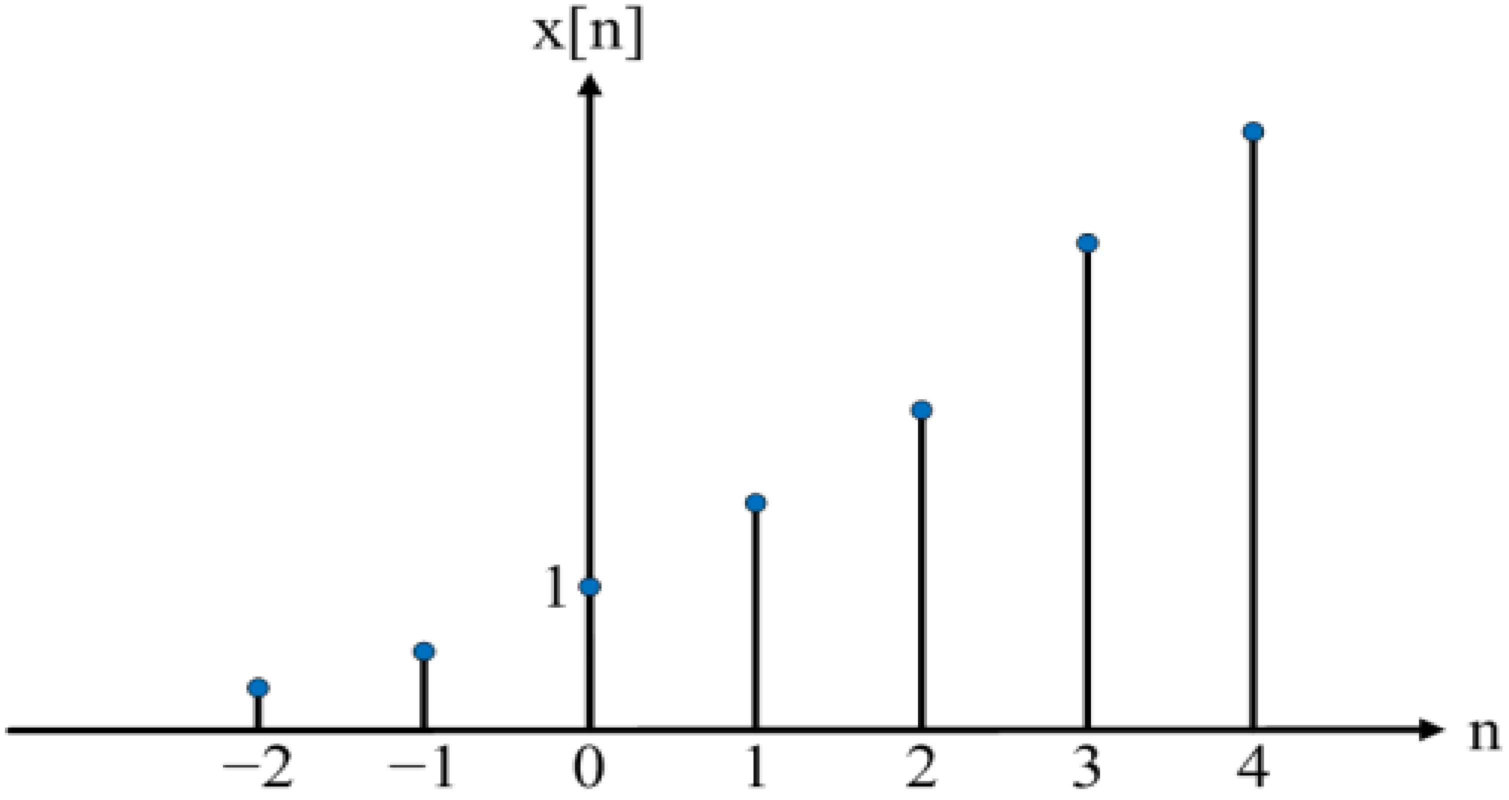
$n < 0$



Real Exponential Sequence

$$x[n] = a^n$$

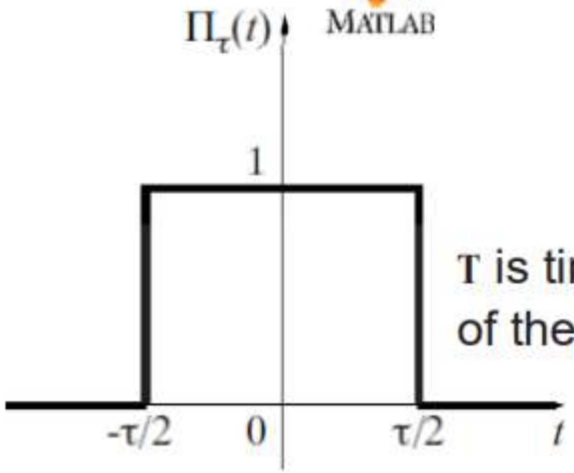
$n > 0$



Rectangular pulse function

$$p_\tau(t) = \begin{cases} 1, & \frac{-\tau}{2} \le t < \frac{\tau}{2} \\ 0, & t < \frac{-\tau}{2}, t \ge \frac{\tau}{2} \end{cases}$$

$p_\tau(t)$



τ is time duration of the pulse

$p_\tau(t)$ can be expressed in the form $\Pi_\tau(t) = u\left(t + \frac{\tau}{2}\right) - u\left(t - \frac{\tau}{2}\right)$

Triangular pulse function

$$\text{tri}(t) = \begin{cases} 1 - |t| &, \quad |t| < 1 \\ 0 &, \quad |t| \geq 1 \end{cases}$$