

UNIT-1

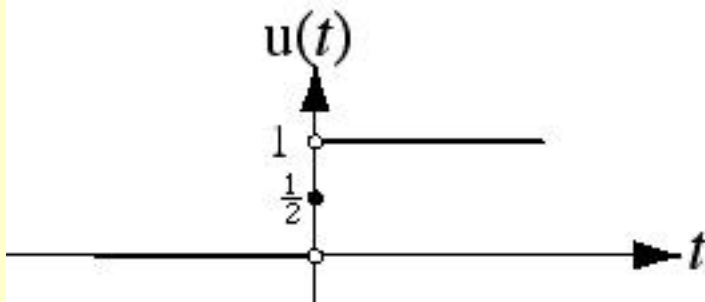
(Lecture-6)

Descriptions of signals

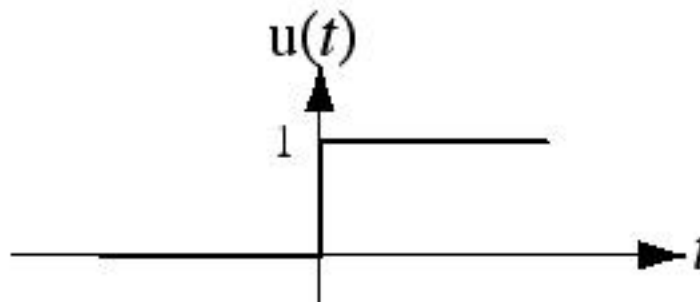
Unit Step Function

$$u(t) = \begin{cases} 1 & , t > 0 \\ 1/2 & , t = 0 \\ 0 & , t < 0 \end{cases}$$

Precise Graph



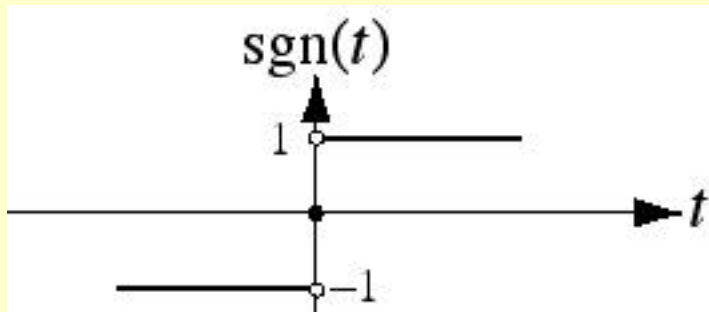
Commonly-Used Graph



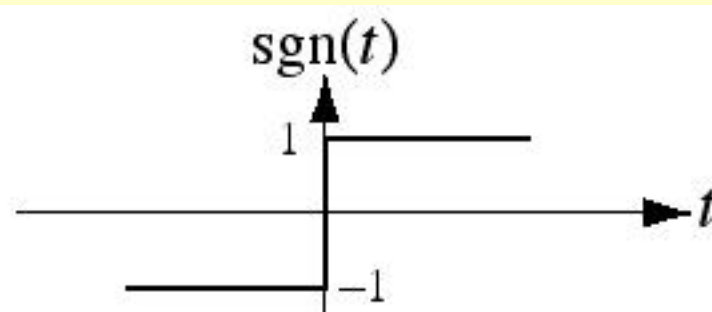
Signum Function

$$\text{sgn}(t) = \begin{cases} 1 & , t > 0 \\ 0 & , t = 0 \\ -1 & , t < 0 \end{cases} = 2u(t) - 1$$

Precise Graph

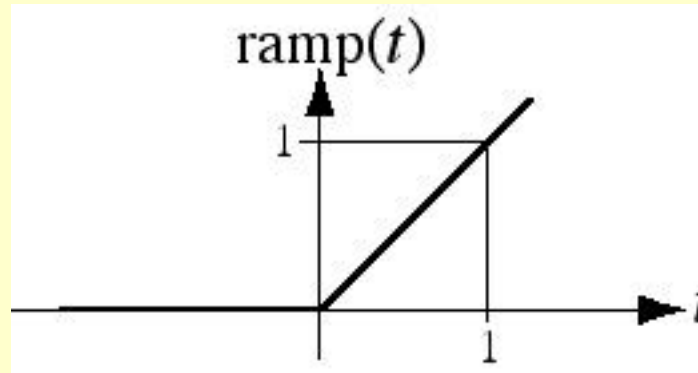


Commonly-Used Graph



The signum function, is closely related to the unit-step function.

Unit Ramp Function

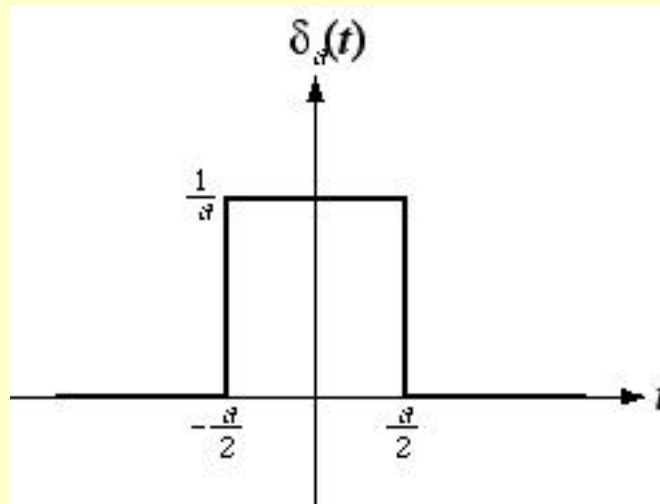


$$\text{ramp}(t) = \begin{cases} t & , t > 0 \\ 0 & , t \leq 0 \end{cases} = \int_{-\infty}^t u(\lambda) d\lambda = t u(t)$$

- **The unit ramp function is the integral of the unit step function.**
- **It is called the unit ramp function because for positive t , its slope is one amplitude unit per time.**

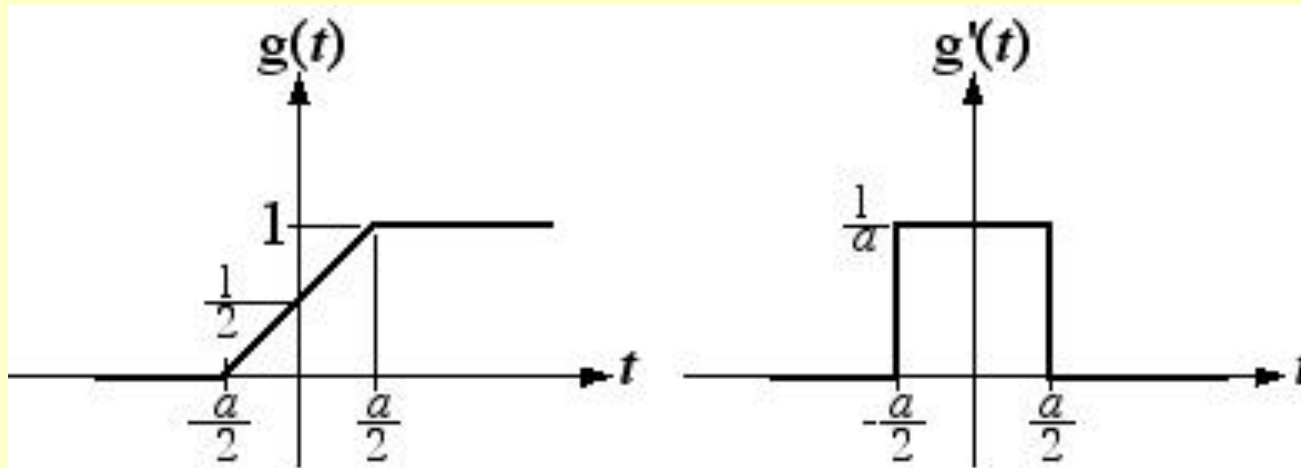
Rectangular Pulse or Gate Function

Rectangular pulse,
$$\delta_a(t) = \begin{cases} 1/a & , |t| < a/2 \\ 0 & , |t| > a/2 \end{cases}$$



Unit Impulse Function

As a approaches zero, $g(t)$ approaches a unit step and $g'(t)$ approaches a unit impulse

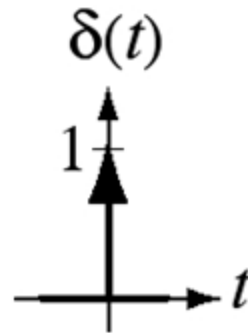


Functions that approach unit step and unit impulse

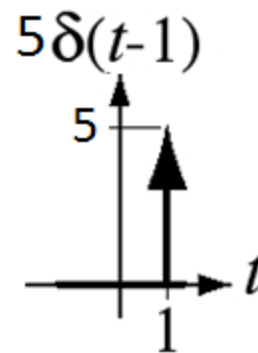
So unit impulse function is the derivative of the unit step function or unit step is the integral of the unit impulse function

Representation of Impulse Function

The **area under an impulse** is called its **strength or weight**. It is represented graphically by a **vertical arrow**. An impulse with a strength of one is called **a unit impulse**.



Representation of Unit Impulse

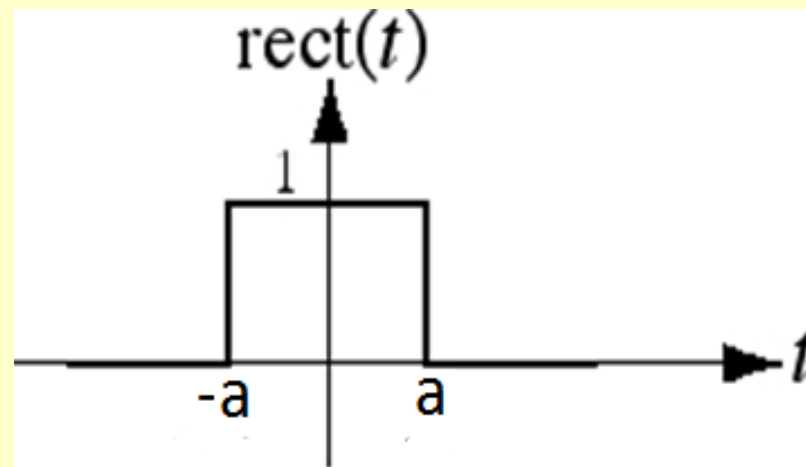


Shifted Impulse of Amplitude 5

The Unit Rectangle Function

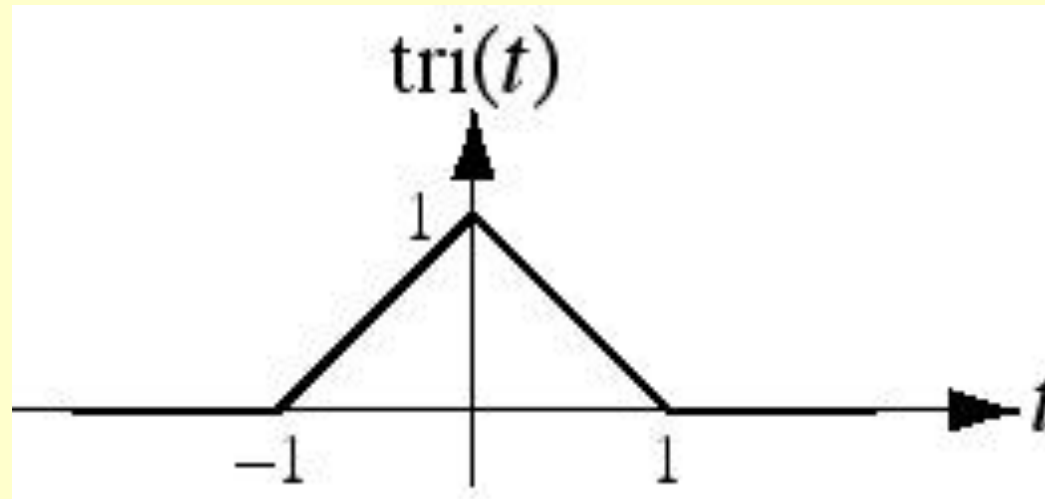
The unit rectangle or gate signal can be represented as combination of two shifted unit step signals as shown

$$\text{rect}(t) = u(t+a) - u(t-a)$$



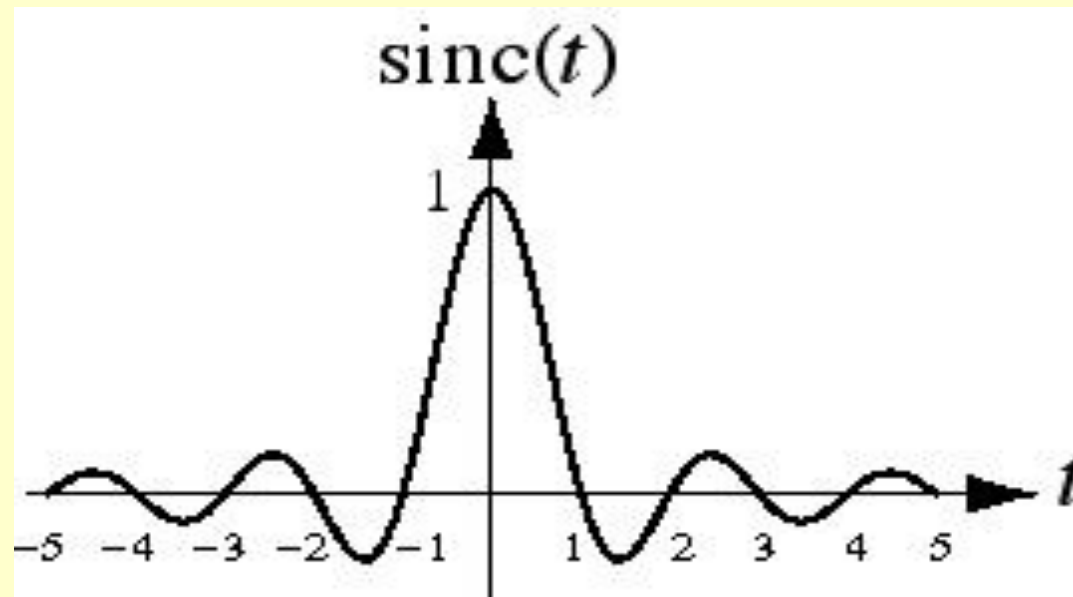
The Unit Triangle Function

A triangular pulse whose height and area are both one but its base width is not, is called unit triangle function. The unit triangle is related to the unit rectangle through an operation called convolution.



Sinc Function

$$\text{sinc}(t) = \frac{\sin(\pi t)}{\pi t}$$



Discrete-Time Signals

- **Sampling** is the acquisition of the values of a continuous-time signal at discrete points in time
- $x(t)$ is a continuous-time signal, $x[n]$ is a discrete-time signal

$$x[n] = x(nT_s) \text{ where } T_s \text{ is the time between samples}$$

Discrete Time Exponential and Sinusoidal Signals

- DT signals can be defined in a manner analogous to their continuous-time counterpart

$$x[n] = A \sin (2\Pi n/N_0 + \theta) \quad \text{Discrete Time Sinusoidal Signal}$$

$$= A \sin (2\Pi F_0 n + \theta)$$

$$x[n] = a^n \quad \text{Discrete Time Exponential Signal}$$

n = the discrete time

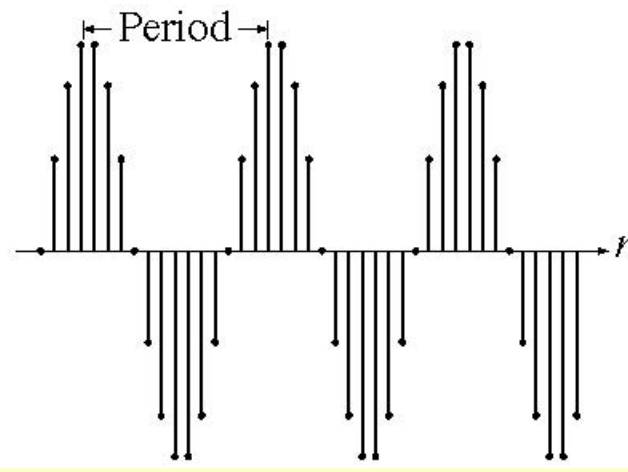
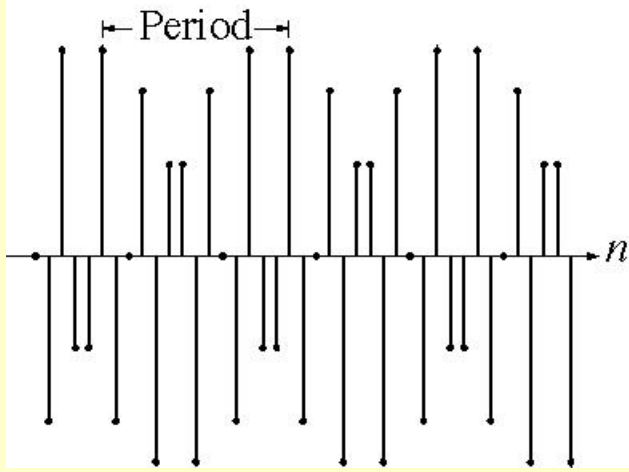
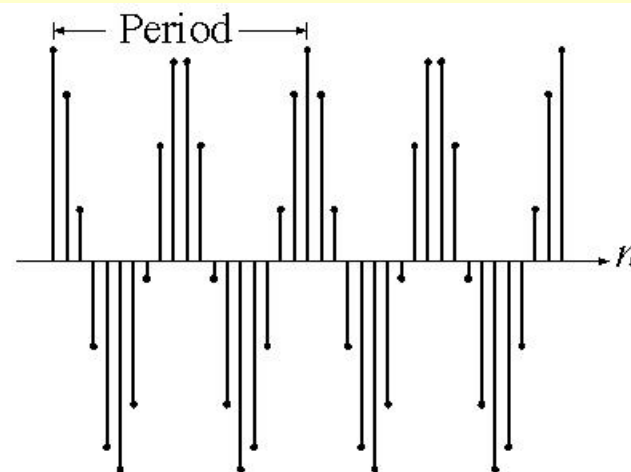
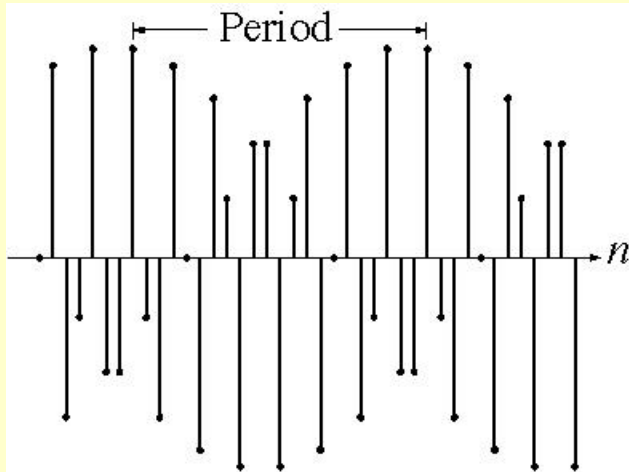
A = amplitude

θ = phase shifting radians,

N_0 = Discrete Period of the wave

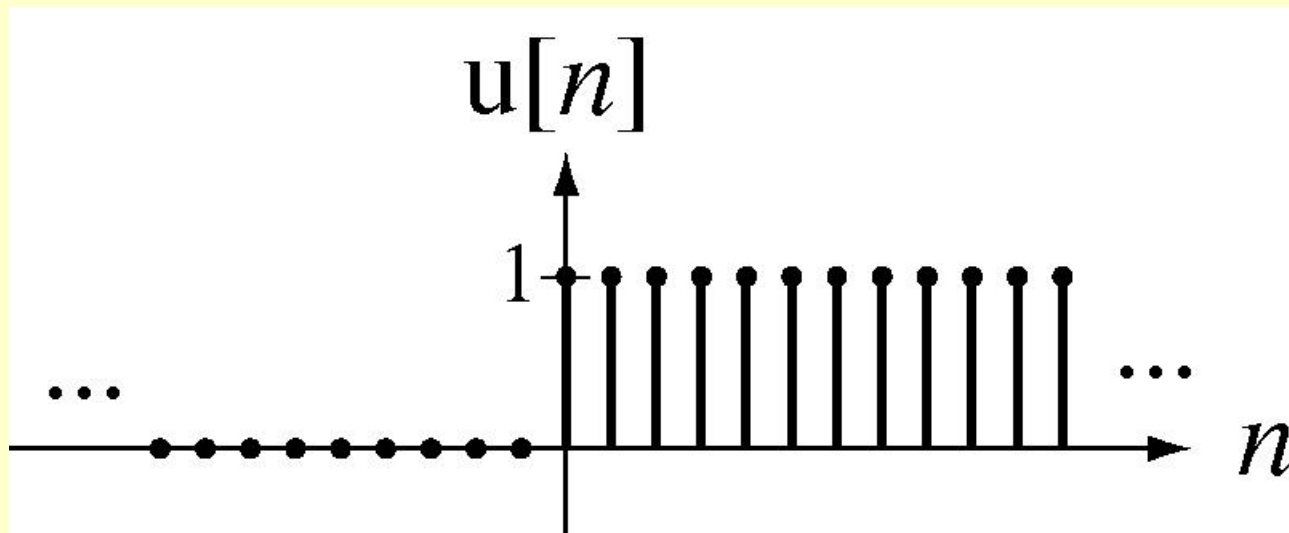
$1/N_0 = F_0 = \Omega_0/2 \Pi$ = Discrete Frequency

Discrete Time Sinusoidal Signals



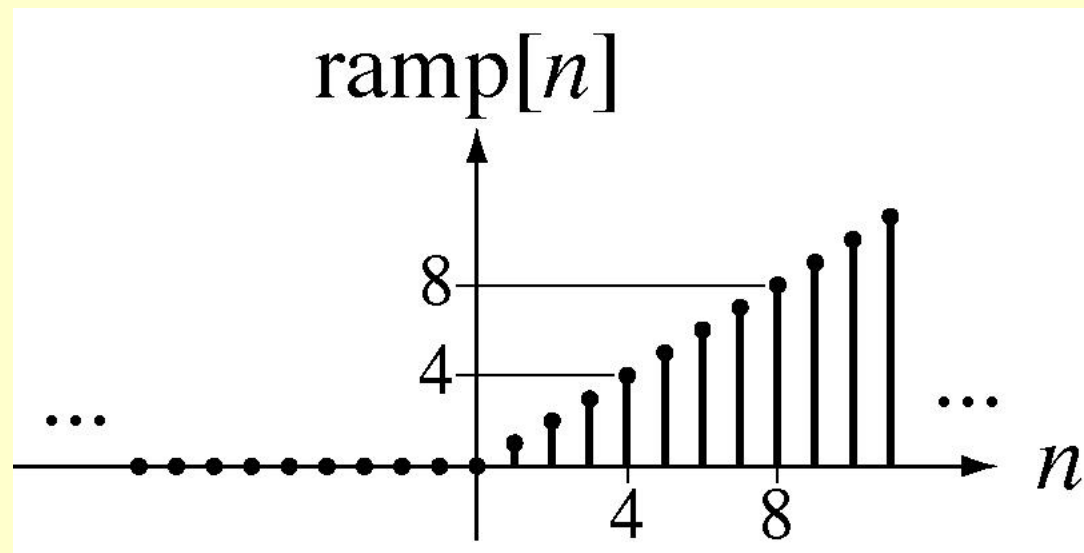
Discrete Time Unit Step Function or Unit Sequence Function

$$u[n] = \begin{cases} 1, & n \geq 0 \\ 0, & n < 0 \end{cases}$$



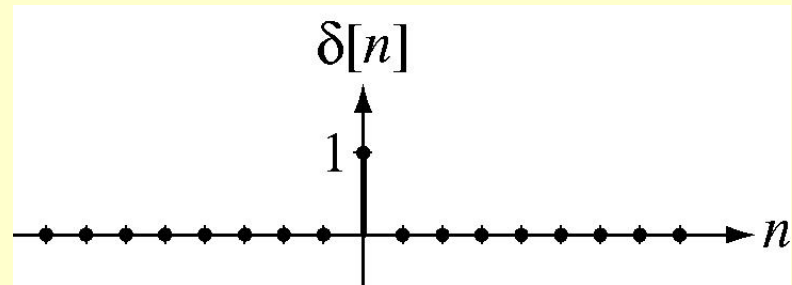
Discrete Time Unit Ramp Function

$$\text{ramp}[n] = \begin{cases} n & , n \geq 0 \\ 0 & , n < 0 \end{cases} = \sum_{m=-\infty}^n u[m-1]$$



Discrete Time Unit Impulse Function or Unit Pulse Sequence

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



$$\delta[n] = \delta[an] \text{ for any non-zero, finite integer } a.$$

Unit Pulse Sequence Contd.

- The discrete-time unit impulse is a function in the ordinary sense in contrast with the continuous-time unit impulse.
- It has a sampling property.
- It has no scaling property i.e.
$$\delta[n] = \delta[an]$$
 for any non-zero finite integer 'a'