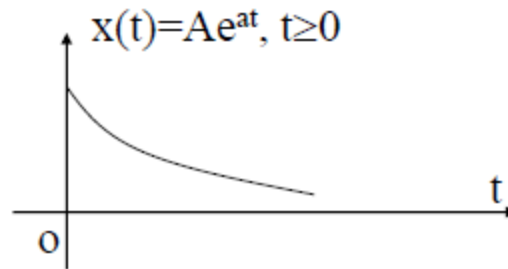


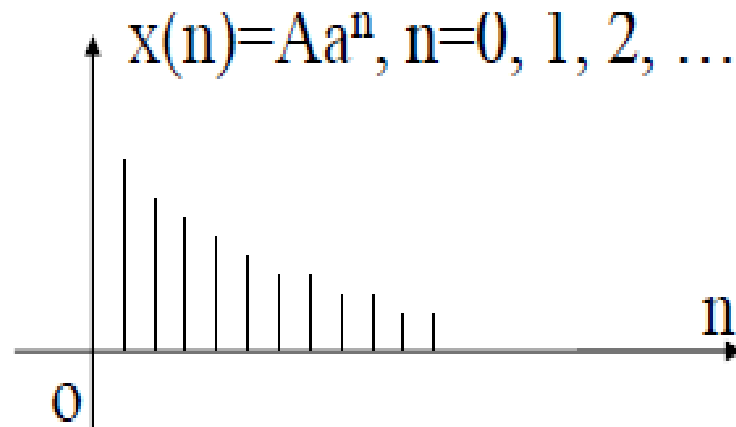
Definition, types of signals and their representations

Introduction to Signals

- A Signal is the function of one or more independent variables that **carries some information** to represent a physical phenomenon.
- A continuous-time signal, also called an analog signal, is defined along a continuum of time.



A discrete-time signal is defined at discrete times.



Elementary Signals

Sinusoidal & Exponential Signals

- Sinusoids and exponentials are important in signal and system analysis because they arise naturally in the solutions of the differential equations.

- Sinusoidal Signals can be expressed in either of two ways :

cyclic frequency form- $A \sin 2\pi f_o t = A \sin(2\pi/T_o)t$

radian frequency form- $A \sin \omega_o t$

$$\omega_o = 2\pi f_o = 2\pi/T_o$$

T_o = Time Period of the Sinusoidal Wave

Sinusoidal & Exponential Signals Contd.

$$\left. \begin{aligned} x(t) &= A \sin (2\pi f_o t + \theta) \\ &= A \sin (\omega_o t + \theta) \end{aligned} \right\} \text{Sinusoidal signal}$$

$$x(t) = Ae^{at} \quad \text{Real Exponential}$$

$$= Ae^{j\omega_o t} = A[\cos (\omega_o t) + j \sin (\omega_o t)] \quad \text{Complex Exponential}$$

θ = Phase of sinusoidal wave

A = amplitude of a sinusoidal or exponential signal

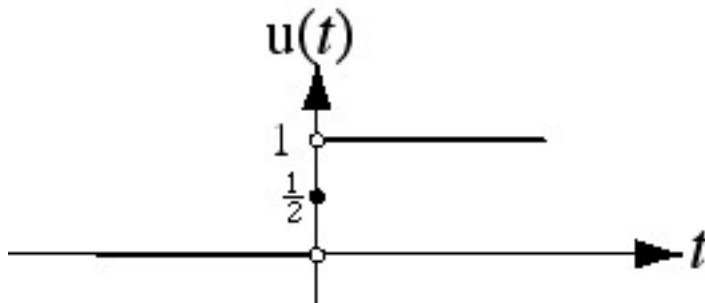
f_o = fundamental cyclic frequency of sinusoidal signal

ω_o = radian frequency

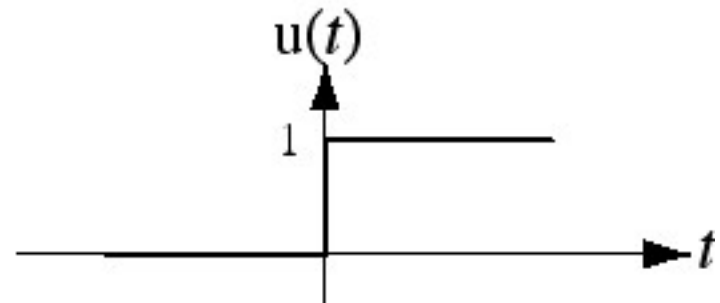
Unit Step Function

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

Precise Graph



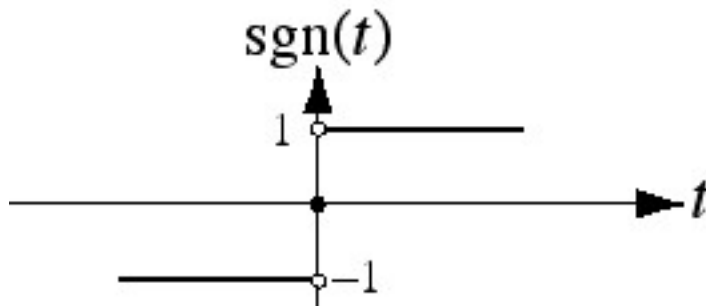
Commonly-Used Graph



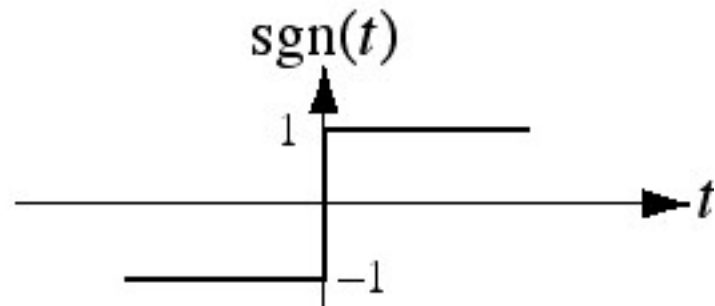
Signum Function

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

Precise Graph

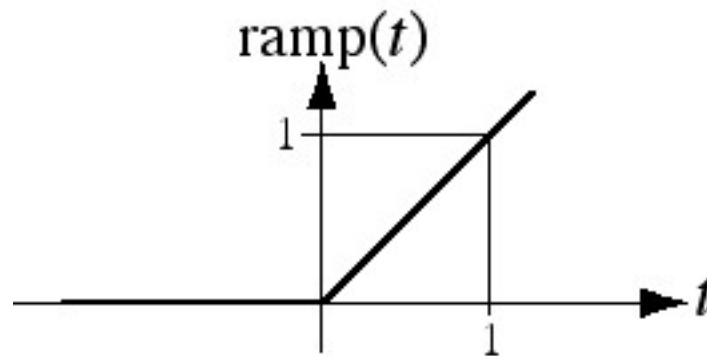


Commonly-Used Graph



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,

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

