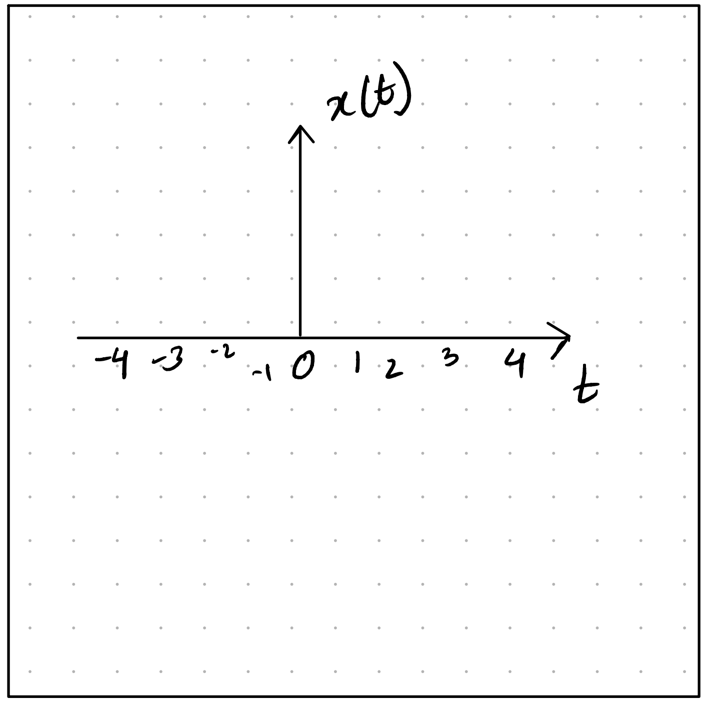
Classes of Signals.

Continuous Signals are represented as



Digital Signal

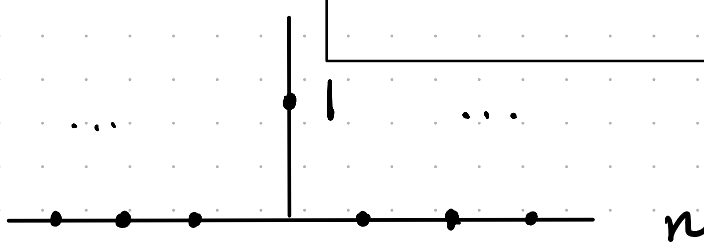
Digital signals are represented as.

$$x(n) = \begin{cases} 2^{-n}, & n \geq 0 \\ 0, & n < 0 \end{cases}$$

special DT signals

unit impulse

$$\delta(n) = \begin{cases} 1, & n = 0 \\ 0, & n \neq 0 \end{cases}$$

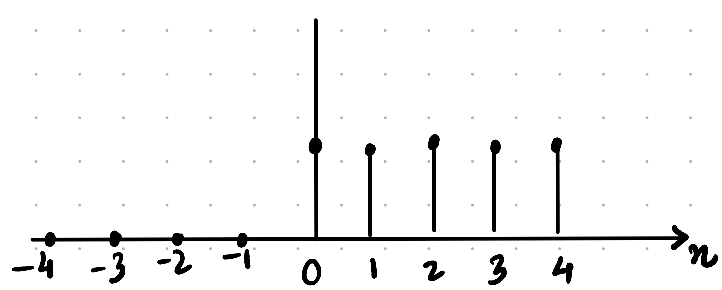


a function of two variables (usually non-negative integers)

The function is 1 if the variables are equal. Otherwise zero.

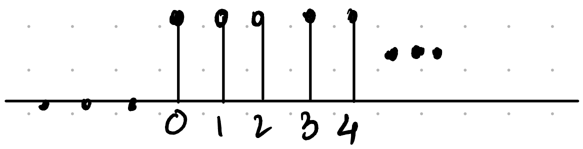
Unit step

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

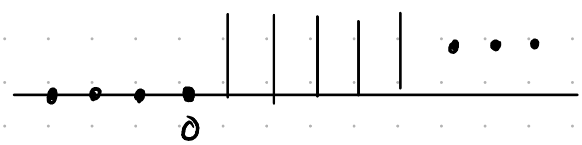


unit step and unit impulse are closely related.

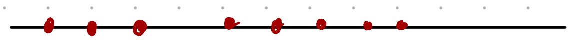
- The unit impulse sequence as the first backward difference of the unit step sequence



$\mu[n]$

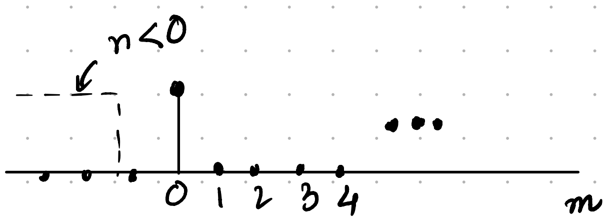


$\mu[n-1]$



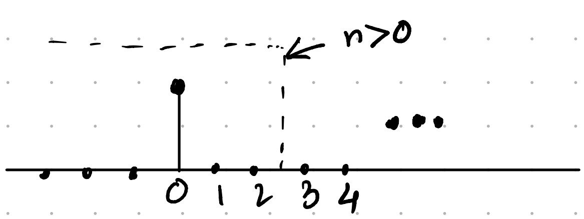
$\mu[n] - \mu[n-1]$

- The unit step sequence as a running sum of the unit impulse.



$\delta[m]$

$\mu[n] =$

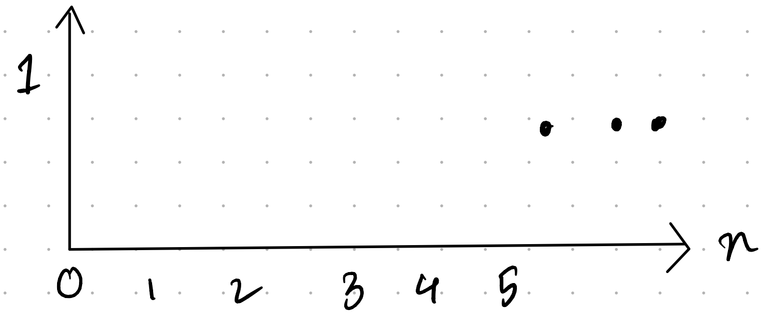


$\delta[m]$

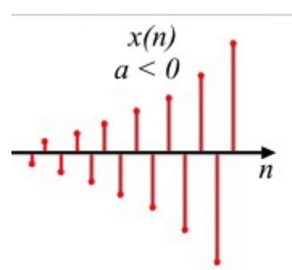
Real Exponential Sequence

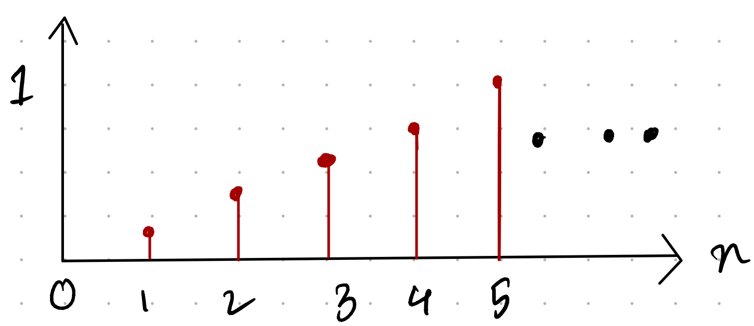
$x[n] =$

(a) $x[n]$, $n \geq 0$; $0 < a < 1$



(b) $x[n]$, $n \geq 0$ $a > 1$





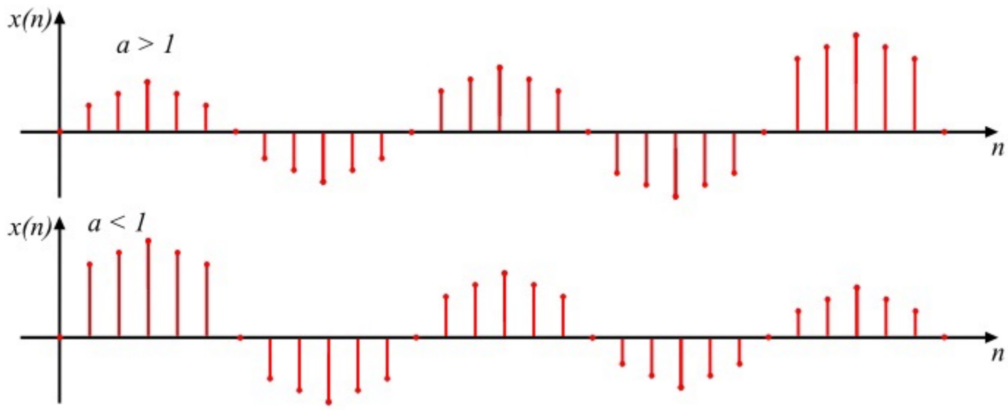
For $a < 0$ polarity alternates.

Complex exponential signal is defined by

$|a| = 1 \rightarrow$ both real & imaginary parts are sinusoidal

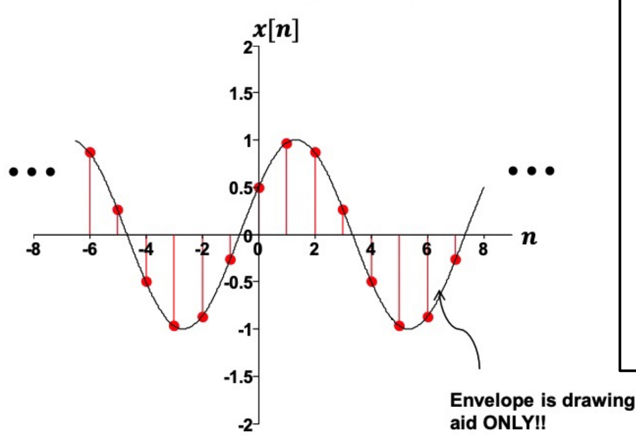
$|a| > 1 \rightarrow$ amplitude of the sinusoidal sequence increase exponentially

$|a| < 1 \rightarrow$ amplitude of the sinusoidal decreases exponentially



Sinusoidal Signal

$x[n] = A\cos(\omega_0 n + \varphi)$



> Complex exponential & Sinusoidal signals are used to determine dynamic response of a system

For continuous-time sinusoid $\cos(\omega t + \varphi)$

Periodic Signal

a discrete-time signal $x[n]$ is periodic

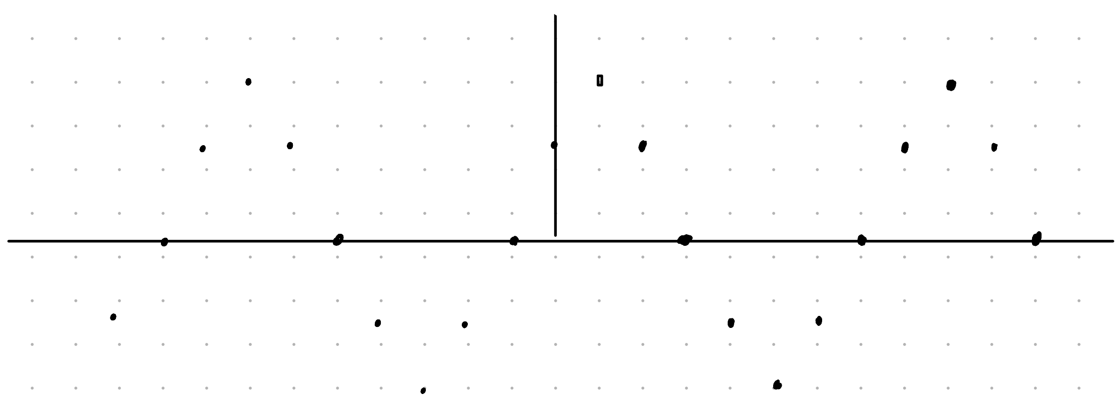
iff for $\forall n$ & smallest N

$\rightarrow N \quad 0,$

$\rightarrow N \rightarrow$

a sinusoidal signal is periodic

$$= A\cos\left[\omega_0 (n+N) + \phi\right]$$



Since $\cos(\,)$ invariant to $2\pi \cdot m$ phase shift (for m integer)

above cosine periodic iff

Thus

if $\rightarrow$ periodic otherwise not periodic

Let's check periodicity of the following signal.

- $x[n] = -7 \cos\left(0.6\pi n + \frac{\pi}{3}\right)$

$$f_0 = \frac{\omega}{2\pi} = \frac{0.6\pi}{2\pi}$$

- $x[n] = 1.6 \cos(0.7 n)$

$$f_0 = \frac{\omega}{2\pi} = \frac{0.7}{2\pi}$$

- $x[n] = 3\cos(7n)$

- $x[n] = 4.2 \sin(\pi n + 42^\circ)$

- $x[n] = \cos\left(\frac{3\pi}{5} n + \pi/2\right)$

Even & Odd Signals → we will come back after we learn some signal operations.

Signal Operations

Addition → $x_{sum}[n]$

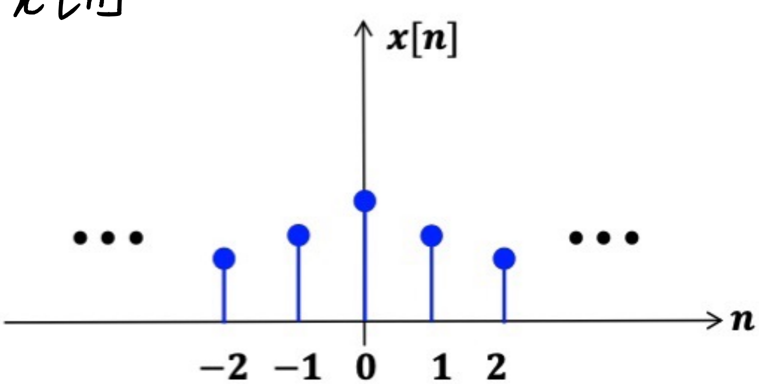
Subtraction → $x_{Dif}[n]$

Multiplication → $x_{mul}[n]$

Scaling → $x_{scale}[n]$, for a constant

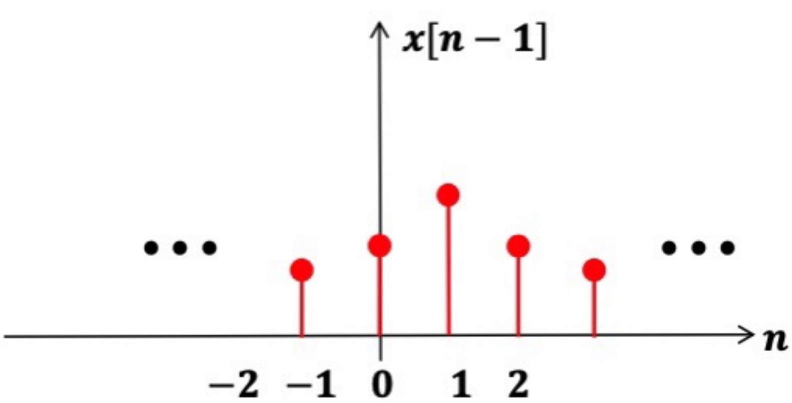
Time Shift → the shifting of signal in time

$x[n]$

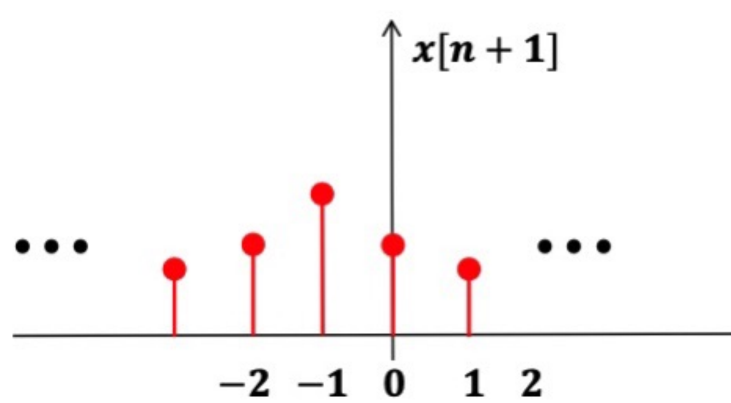


How to time shift in matlab.

$y[n] =$

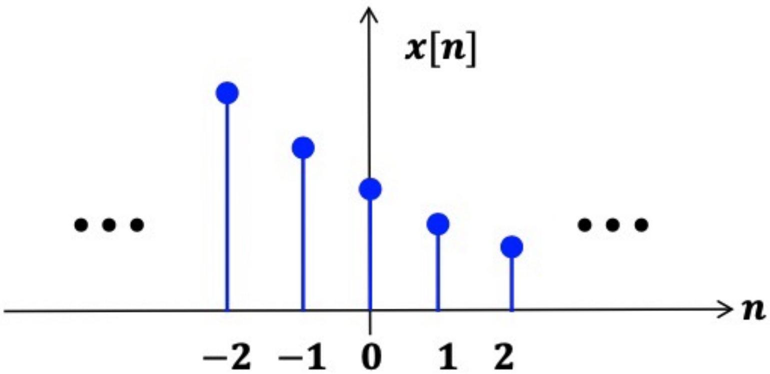


$y[n]$

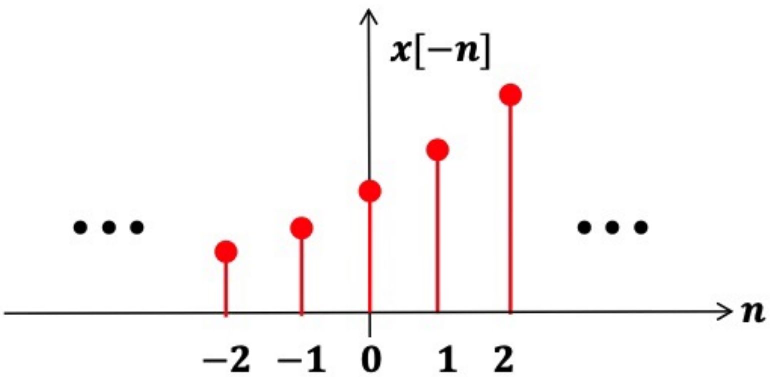


- Time Reversal

Reversing a signal in time



$x[n] = \{6 \quad 3 \quad 5 \quad -1 \quad 8]$



Reflection about $n = 0$

- Time Scale → multiplying a scalar (α) to time variable (n) in argument of function.

of time axis (n)

$y[n] = x[a \cdot n]$ "a" real

if a is positive integer

$a = -1$

$a =$ negative integer

a non integer

Even & Odd Signals

A discrete-time signal $x[n]$ is an signal if it is to its counterpart, i.e., with its about the origin

$$x[n] =$$

A discrete-time signal $x[n]$ is signal if

$$x[n] =$$

A general sequence $x[n]$ can be seperated into its odd symmetric & even-symmetric parts such that

$$x_n = x\ [n] + x\ [n]$$

where

$x_{odd}[n] =$ odd symmetric

$x_{even}[n] =$ even symmetric