Lab # 02: Functions and Signal Operations

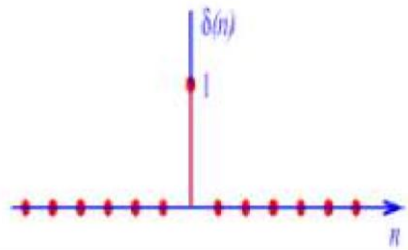
Objective:

Generating and operating basic sequences. In this lab we will learn to:

- Generate Delta (Impulse) Function.
- Generate Unit Step Function.
- Generate Exponential Function.
- Generate sinusoidal function.
- Perform operations (scaling, shifting) on above functions.

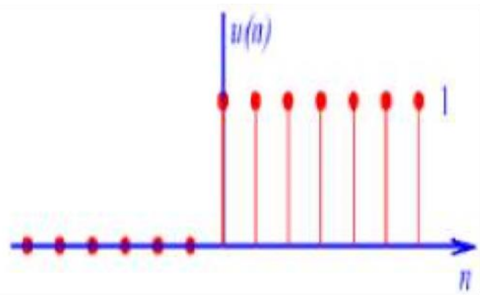
The Unit Delta (Impulse) function: often called the discrete time impulse or the unit impulse. It is denoted by δ[n].

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



The Unit Step function: The unit step, denoted by u(n), is defined by

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



Creation of Unit Impulse and Unit Step sequences: A unit impulse sequence I[n] of length N can be generated using the MATLAB command

I= [1 zeros (1, N-1)];

Similarly, a unit step sequence S[n] of length N can be generated using the MATLAB command

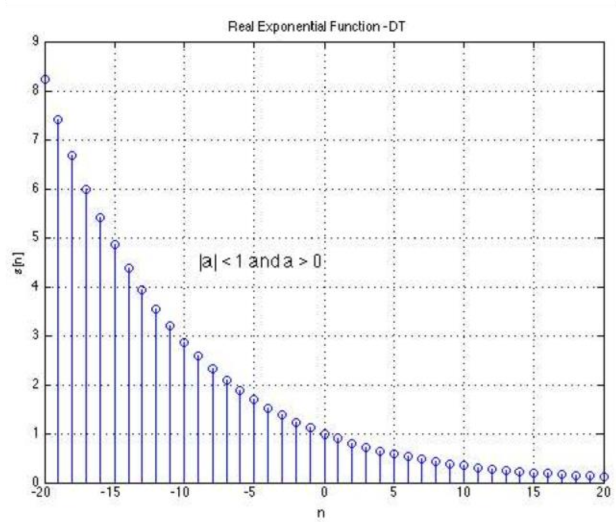
S= [ones (1, N)]

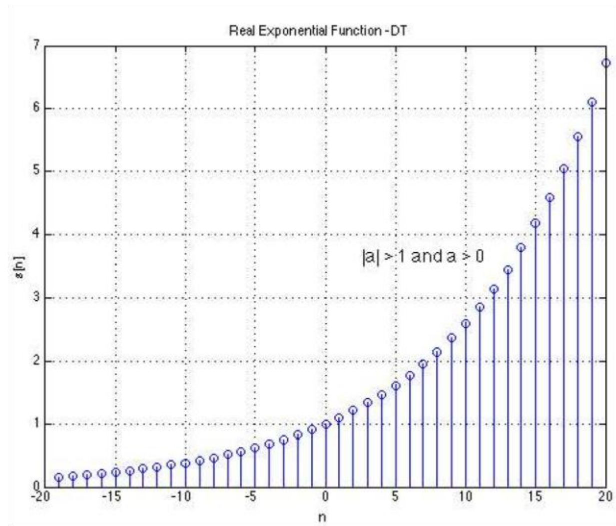
The Exponential Function: Finally, an exponential sequence is defined by

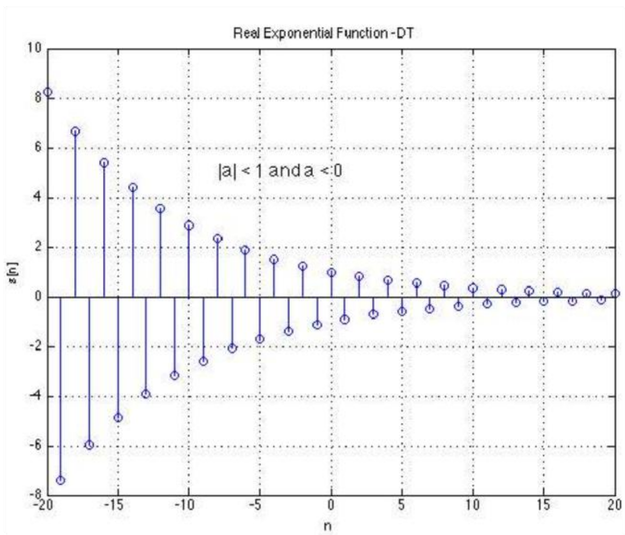
$$\text{Exponential signal} = A\alpha^n$$

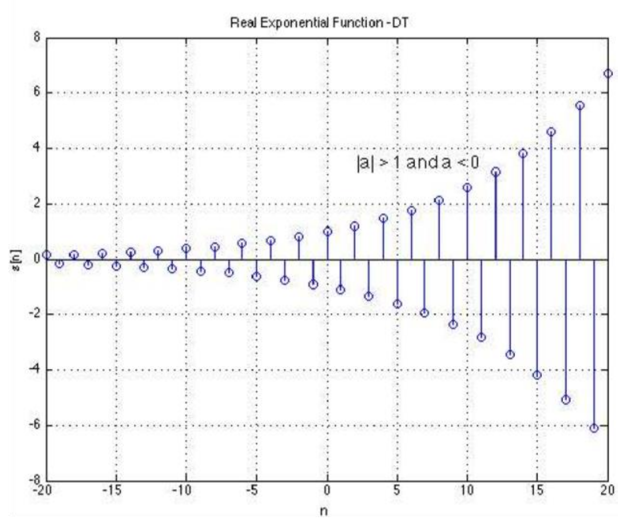
The sign of α does not affect the rising or falling of the signal; instead, it affects its oscillatory behavior. Negative alphas cause the signal to alternate between negative and positive values.

The *magnitude* of α affects the rising and falling behavior: $|\alpha|<1$ results in falling signals, whereas $|\alpha|>1$ results in rising signals.





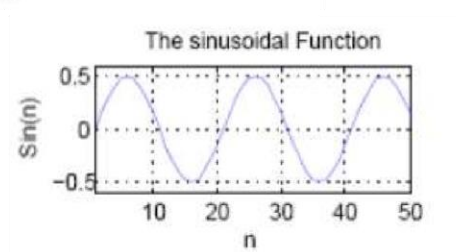




The sinusoidal function:

$Y(n) = A \sin(W_c n + \varphi)$

A=Amplitude, W_c= Angular frequency, phi (φ) = phase shift
$W_c = 2\pi f$ where f =frequency
$f = 1/T$ where T = Time Period.



Basic Operations:

Signal Adding: This is a sample-by-sample addition given by

$$\{x_1(n)\} + \{x_2(n)\} = \{x_1(n) + x_2(n)\}$$

and the length of x1(n) and x2(n) must be the same.

Signal Multiplication: This is a sample-by-sample multiplication (or "dot" multiplication) given by

$$\{x_1(n)\} \bullet \{x_2(n)\} = \{x_1(n)x_2(n)\}$$

and the length of x1(n) and x2(n) must be the same.

Shifting: In this operation each sample of x(n) is shifted by an amount k to obtain a shifted sequence

$$y(n) = \{x(n-k)\}$$

Folding: In this operation each sample of x(n) is flipped around n = 0 to obtain a folded sequence y(n).

$$y(n) = \{x(-n)\}$$

LAB TASK # 01:

a) Write a generic MATLAB code to generate a unit impulse and unit step
b) Plot the exponential signal by taking the value of A=2 and taking the value of "α" equal to -4, -0.5, 0.5, 4. Plot all the sequences in a single figure using "subplot" command. Give your interpretation about the sequences.
c) Write a generic MATLAB code to generate a sinusoidal range -50:50, frequency 0.08, amplitude 2.5 and phase shift 90 degrees and display it.

LAB TASK # 02:

x1($\boldsymbol{n}$) = [$\mathbf{11\ -13\ 15}\ 7\ \mathbf{-9}$] -2 ≤ n ≤ 2
x2($\boldsymbol{n}$) = [$\mathbf{-12\ 14\ 6\ -8\ 5}$] 0 ≤ n ≤ 4

a) Write a MATLAB function for signal shifting, and shift given signals by 5 i.e. (x[n-5]) and by 6 i.e. (x[n+6]) respectively.
b) Write a MATLAB function for signal flipping and flip above signals. **(Do not use MATLAB built in function for flipping)**
c) Generate and plot the following sequences:
$x[n] = 3 * \delta[n-10] + 15 * \delta[n+7]$ -15 ≤ n ≤ 15
x[n] = n * u[n] + u[n-10] + u[n-20] + $10\alpha^{-0.8[n-5]}$[u[n-20]-u[n-30]] -30 ≤ n ≤ 30
Where a=2.

Note: Plot signals using stem. Give title to resultant signal and label x-axis and y-axis properly.