Lab # 5
Some Basic Signals
Unit Impulse, Unit Step, Exponential Signals, Unit Ramp, Rectangular Pulse (Rect Signals).

Objective:

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Unit Impulse

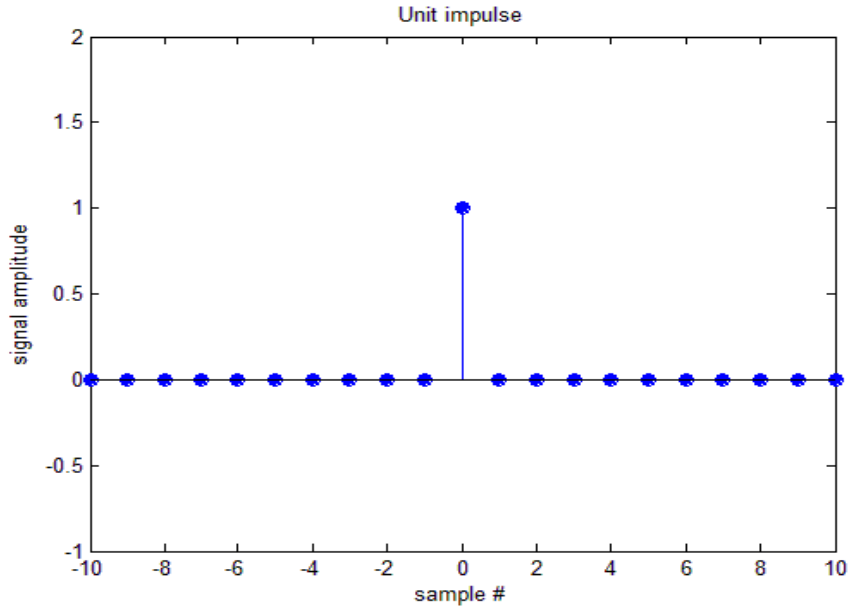
Unit Impulse is defined as follow

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

The impulse exists only on the origin point (zeroth index) and is zero elsewhere. In Matlab we implement the sequence as follows.

Example:

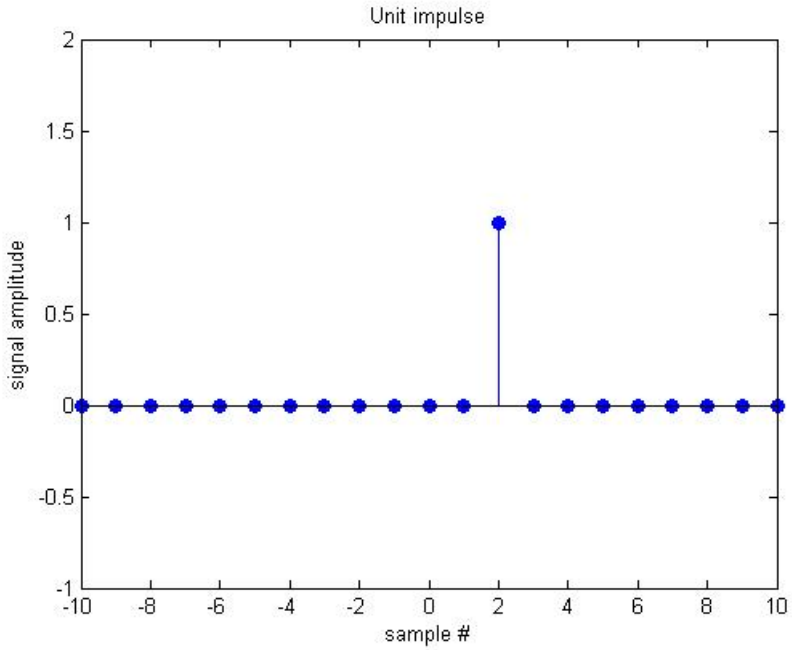
```
n=-10:10
x1=[zeros(1,10) 1 zeros(1,10)];
stem(n,x1,'filled');
```



Example:

Generate an impulse sequence δ[n-2], for -10=> n <=10

```
n=-10:1:10;
x=[zeros(1,12) 1 zeros(1,8)];
stem(n,x,'filled');
```



Unit Step Sequence

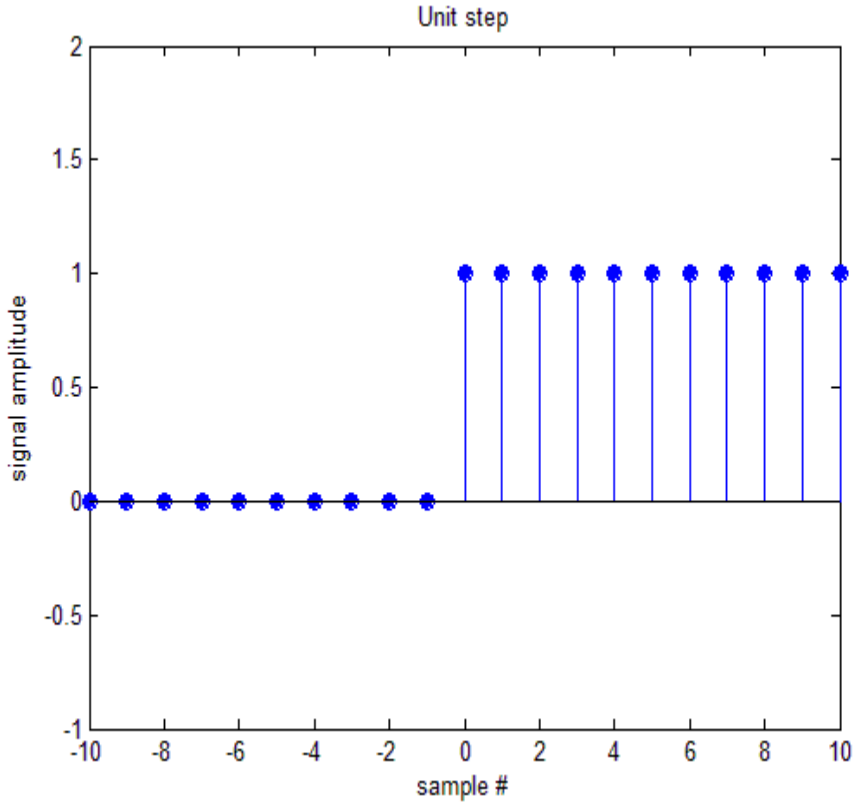
Unit Step signal is defined as follows

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

The signal has one amplitude on positive axis starting from zeroth index. Matlab code for the said signal is given below.

Example:

```
x1=[zeros(1,10) ones(1,11)];
stem(n,x1,'filled');
```



The built-in function Heaviside can also be used.

Exponential Signals

Exponential signal vary with respect to some exponent that may be real or imaginary. Two types of exponential signals are there.

1. Real exponential signal

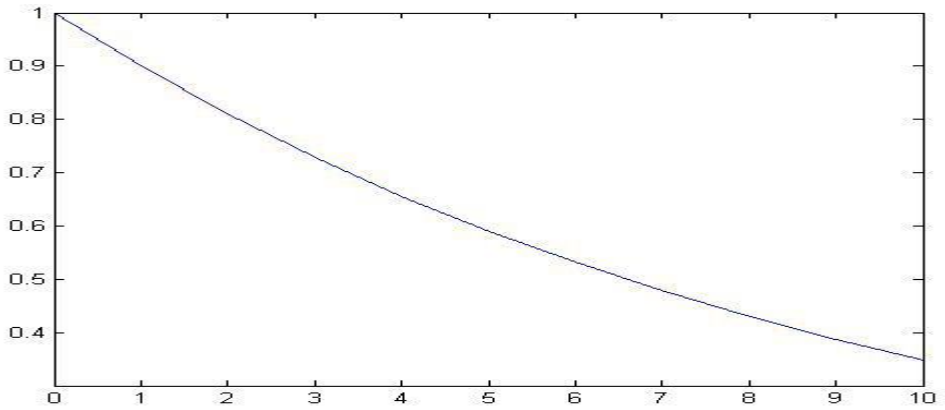
A real exponential is defined as follows.

$$X(n)=a^{n}$$

Example: $X(n)=0.9^{n}$

We do it in Matlab as

```
n=0:10;
x=0.9.^(n);
plot(n,x)
```



The shape of the real exponential varies as decaying or rising exponentials. Depending upon the real constant, signal decays or rises.

2. Complex Exponential signals

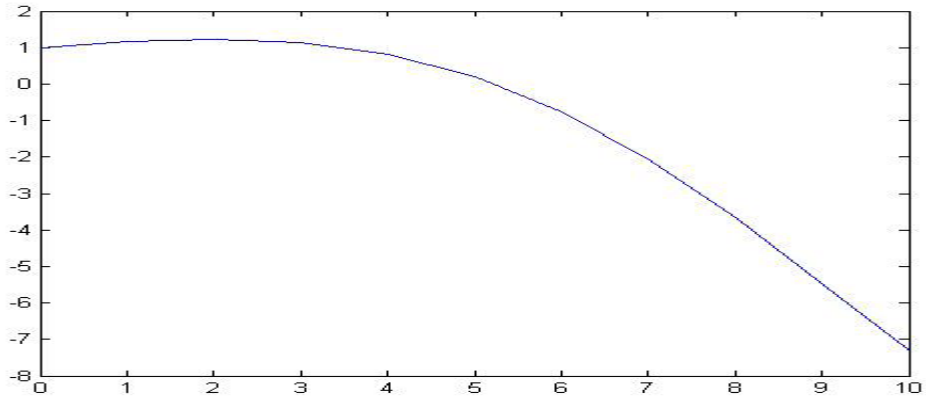
Complex valued exponential signal is defined as

$$X(n)=e^{(\alpha)n}$$

Matlab function for plotting the complex valued exponential is given below.

Example: $x(n)=\mathbf{e}^{\mathbf{an}}$

```
a=0.2+0.3j
n=0:10;
a=0.2+0.3j;
x=exp(a*n);
plot(n,x)
```



- The purpose of the command real is – to extract the real part of a Matlab vector.

Real (x)

- The purpose of the command imag is – to extract the imaginary part of a Matlab vector.

Imag(x)

Unit Ramp:

Ramp signal is defined as

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

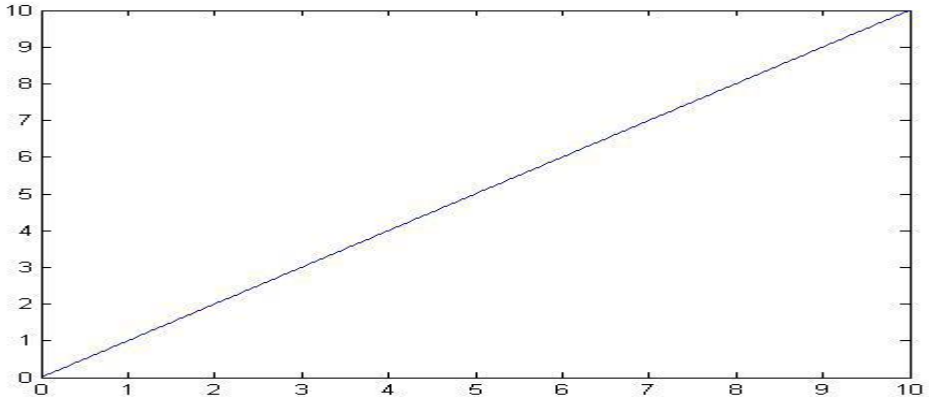
The amplitude values vary as domain increases. Ramp signals exists on positive side only.

Matlab Code for Unit ramp is given below.

Example:

```
t=0:0.01:10;
x=t;
plot(t,x)
```

Output signal is given below.



Another approach is to generate a ramp signal on shifted point or interval. Function for the shifted ramp is given below.

Rectangular Pulse:

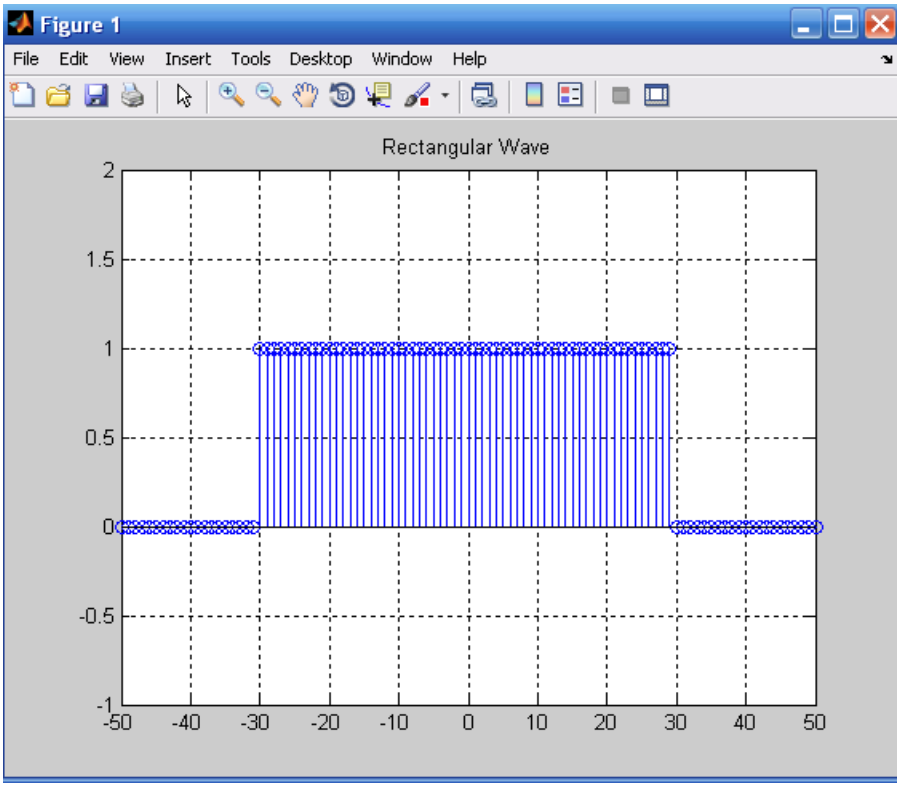
Rect signal is defined as

$$rect = \begin{cases} 1 & -1/2 \le t \le 1/2 \\ 0 & t = otherwise \end{cases}$$

Rect signal produces a rectangular pulse of the width equal to the time interval with half of the width lying on negative side and half on positive side.

Matlab code is given below.

```
n=-50:50;
Rect=[zeros(1,20) ones(1,60) zeros(1,21)];
stem(n,Rect);
axis([-50 50 -1 2]);
grid on;
title('Rectangular Wave')
```



Post Lab Questions

a) What is a ramp signal?

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b) Differentiate between Unit impulse and Unit step.

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c) What is Dirac used for ?

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d) Write the following equation as you would write in Matlab.

$$f(x) = \begin{cases} a.\, exp(-\pi a^2 t^2), & x \leq t \leq Ts \\ 0, & else \end{cases}$$

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Lab Tasks

Task 1

a) Use the impulse function to implement the following :

x[n] = 2δ[n] + 5δ[n-1] + 8δ[n-2] + 4δ[n-3] + 3δ[n-4]

b) Generate a unit step sequence.(other than the one done in Lab)

Task 2

a) Plot continuous and discrete signal of the following unit exponential signal

$$x(t)= e^{at}$$

b) Use the functions Heaviside and dirac to plot unit step and impluse respectively.

Task 3

a) Plot a ramp and a time reversed ramp function.

b) Plot the real part and imaginary part of the following complex exponential signal.

$$x(n)=e^{(-0.1+0.3j)n}$$