Al-Mustaqbal University / College of Engineering & Technology
Communication Technical Engineering Department
Class (Second)
Signal and System / Code (UOMU0207032)
Lecturer (Prof.Dr.Haider jabber Abd)
1st term – Lecture 1. (introduction to Signal and System)

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1-5	Signals and Systems, spectrum, and filters; Singularity functions; periodic signals and Fourier series; nonperiodic signals and Fourier transform. convolution and impulses system response and filters; correlation and spectral density; Parseval's theorem for energy signals
Week 6-8	Noise: Band-limited white noise; thermal noise; noise figure.
Week 9	Mid-term Exam
Week 10-12	Sampling: sampling theory and practice, aliasing.
Week 13-15	Transmission lines: characteristic impedance, reflection coefficient and standing waves
Week 16	**Final exam**

Required Texts	"Introduction to Communication Systems" By F. G. Strelmer
Recommended Texts	Sanjay Sharma: "Communication Systems (Analog and Digital) T. R. Ganesh Babu, and G. Srinivasan: " Communication Theory and systems", 2006

Email: haider.jabber@uomus.edu.iq

Definitions

Signal : A signal describes a time varying physical phenomenon which is intended to convey information. (or) Signal is a function of time or any other variable of interest. (or) Signal is a function of one or more independent variables, which contain some information.

Example: voice signal, video signal, signals on telephone wires, EEG, ECG etc.

Signals may be of continuous time or discrete time signals.

System : System is a device or combination of devices, which can operate on signals and produces corresponding response. Input to a system is called as excitation and output from it is called as response. (or) System is a combination of sub units which will interact with each other to achieve a common interest.

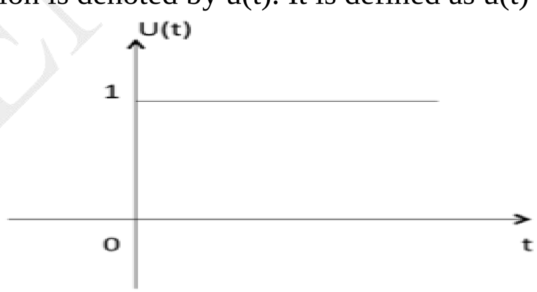
For one or more inputs, the system can have one or more outputs.

Example: Communication System

Elementary Signals or Basic Signals:

Unit Step Function

Unit step function is denoted by u(t). It is defined as u(t) = 1 when $t \geq 0$ and
0 when $t < 0$



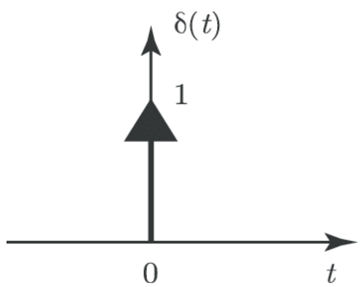
Email: haider.jabber@uomus.edu.iq

- It is used as best testsignal.
- Area under unit step function isunity.

Unit Impulse Function

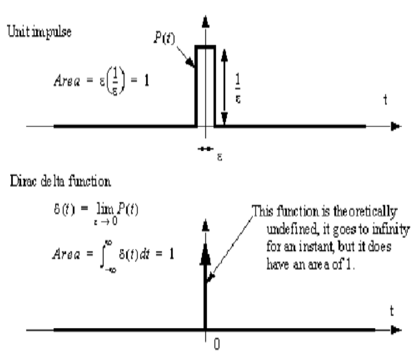
Impulsefunctionisdenotedbyδ(t).anditisdefinedasδ(t)= $\begin{cases} 0; & t \neq 0 \\ \infty; & t = 0 \end{cases}$

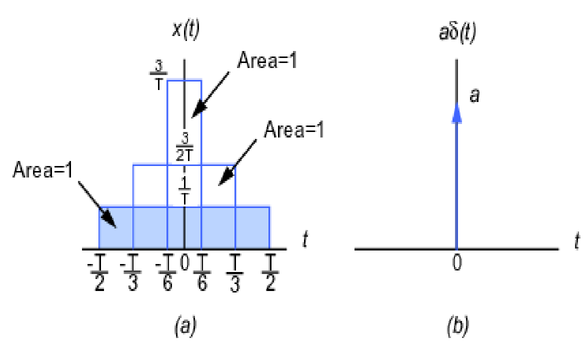
$$\int_{-\infty}^{\infty} \delta(t)\,dt = 1$$

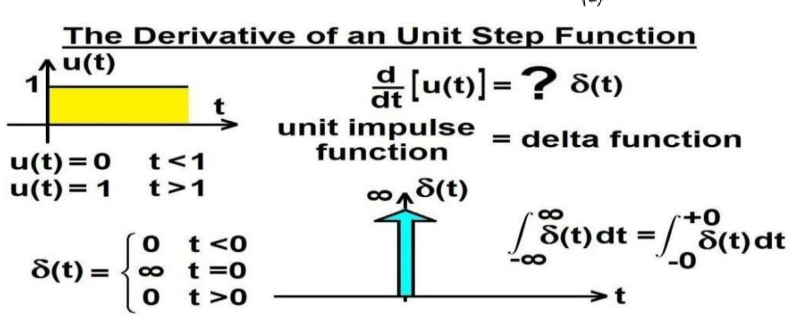


$$\int_{-\infty}^{\infty} \delta(t)dt = u(t)$$

$$\delta(t) = \frac{du(t)}{dt}$$

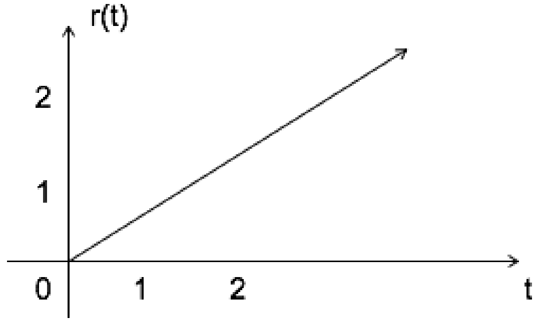






Ramp Signal

Ramp signal is denoted by r(t), and it is defined as r(t) = $\begin{cases} t & t \geqslant 0 \\ 0 & t < 0 \end{cases}$



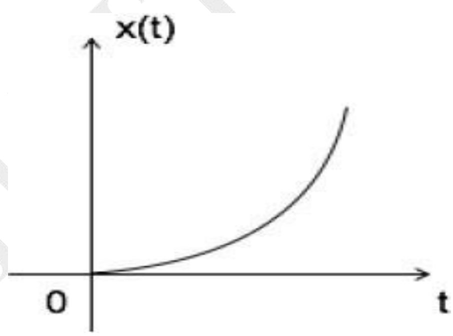
$$\int u(t) = \int 1 = t = r(t)$$

$$u(t) = \frac{dr(t)}{dt}$$

Area under unit ramp is unity.

Parabolic Signal

Parabolic signal can be defined as x(t)= $\begin{cases} t^2/2 & t \geqslant 0 \\ 0 & t < 0 \end{cases}$

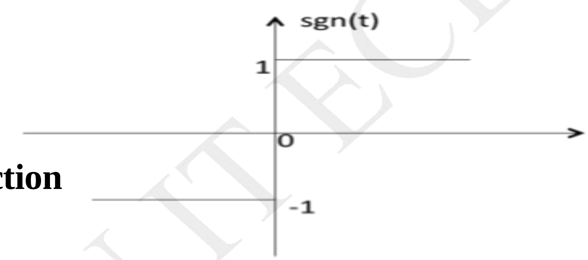


$$\iint u(t)dt = \int r(t)dt = \int t dt = \frac{t^2}{2} = parabolic signal$$

$$\Rightarrow u(t) = \frac{d^2x(t)}{dt^2}$$

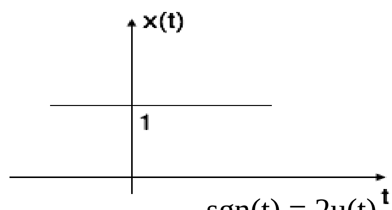
$$\Rightarrow r(t) = \frac{dx(t)}{dt}$$

Signum Function



Signum function is denoted as sgn(t). It is defined as sgn(t) =

$$\begin{cases} 1 & t > 0 \\ 0 & t = 0 \\ -1 & t < 0 \end{cases}$$



sgn(t) = 2u(t) – 1

Exponential Signal

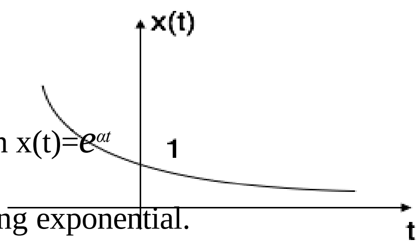
Exponentialsignalisin theformof x(t) =$e^{\alpha t}$

.The shape of exponential can be defined by α

Casei: if $\alpha = 0 \longrightarrow x(t) = e^{0} = 1$

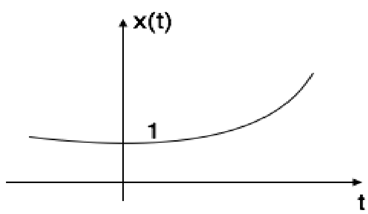
Caseii: if $\alpha < 0$ i.e.-vethen $x(t) = e^{-\alpha t}$

. The shape is called decaying exponential.



Caseiii: if $\alpha > 0$ i.e.+vethen $x(t) = e^{\alpha t}$

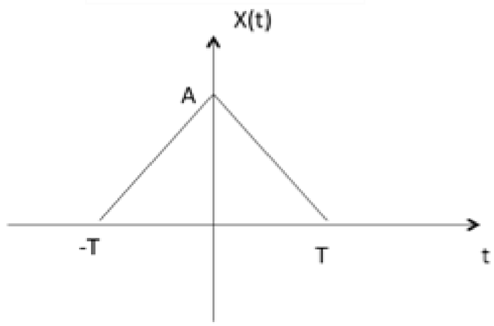
. The shape is called raising exponential.



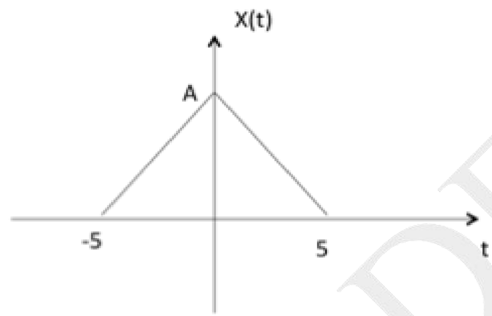
Triangular Signal

Let it be denoted as x(t)

$$x(t) = A\left[1 - \frac{|t|}{T}\right]$$

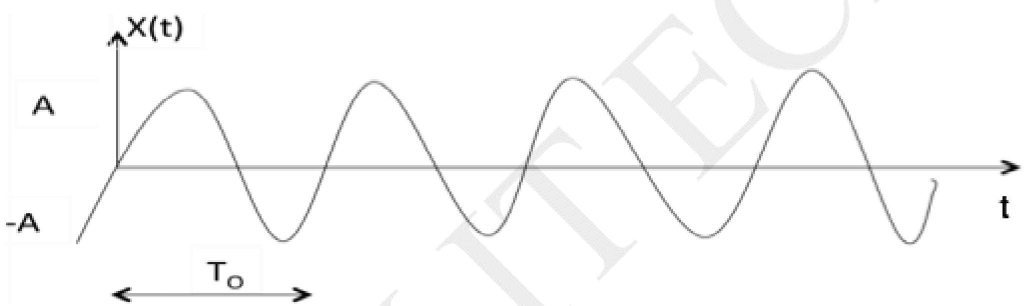


$$\text{ex}: x(t) = A\left[1 - \frac{|t|}{5}\right]$$



Sinusoidal Signal

Sinusoidalsignalisin theformof $x(t)=A\cos(w_0 \pm \varphi)$ or $A\sin(w_0 \pm \varphi)$



Where $T_0 = 2\pi/w_0$

<u>Classification of Signals:</u>

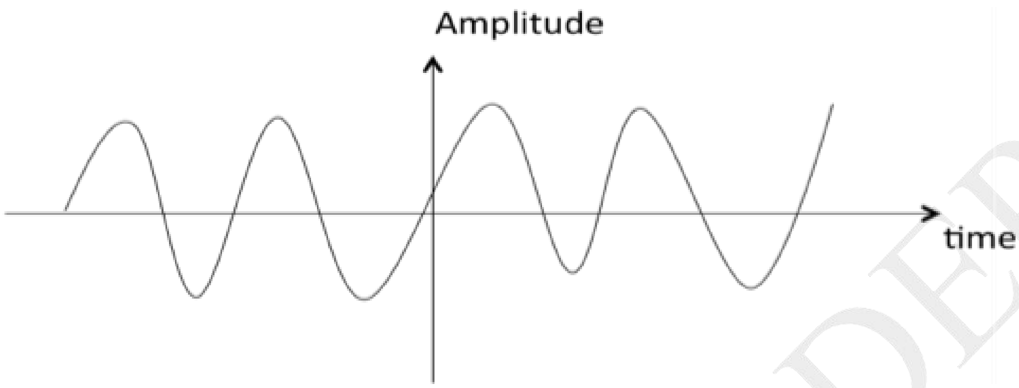
Signals are classified into the following categories:

- Continuous Time and Discrete TimeSignals
- Deterministic and Non-deterministicSignals
- Even and Odd Signals
- Periodic and AperiodicSignals
- Energy and PowerSignals

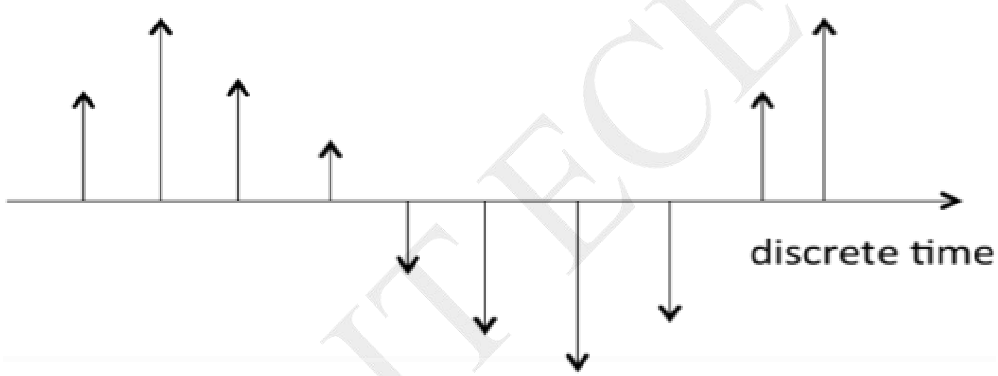
Al-Mustaqbal University / College of Engineering & Technology
Communication Technical Engineering Department
Class (Second)
Signal and System / Code (UOMU0207032)
Lecturer (Prof.Dr.Haider jabber Abd)
1st term – Lecture 1. (introduction to Signal and System)

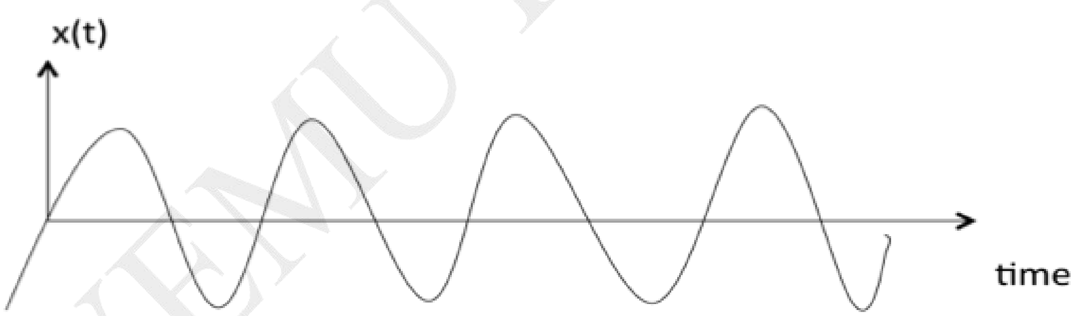
Continuous Time and Discrete Time Signals

A signal is said to be continuous when it is defined for all instants of time.



A signal is said to be discrete when it is defined at only discrete instants of time/

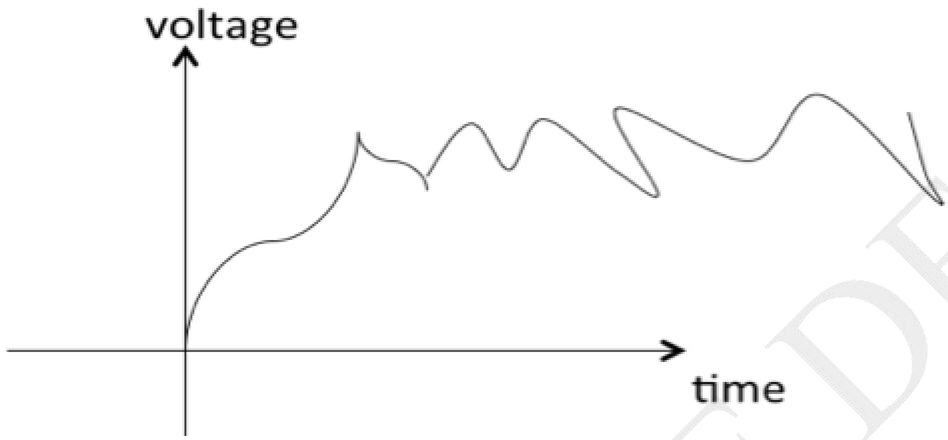




Deterministic and Non-deterministic Signals

A signal is said to be deterministic if there is no uncertainty with respect to its value at any instant of time. Or, signals which can be defined exactly by a mathematical formula are known as deterministicsignals.

A signal is said to be non-deterministic if there is uncertainty with respect to its value at some instant of time. Non-deterministic signals are random in nature hence they are called random signals. Random signals cannot be described by a mathematical equation. They are modelled in probabilistic terms.



Even and Odd Signals

A signal is said to be even when it satisfies the condition $x(t) = x(-t)$

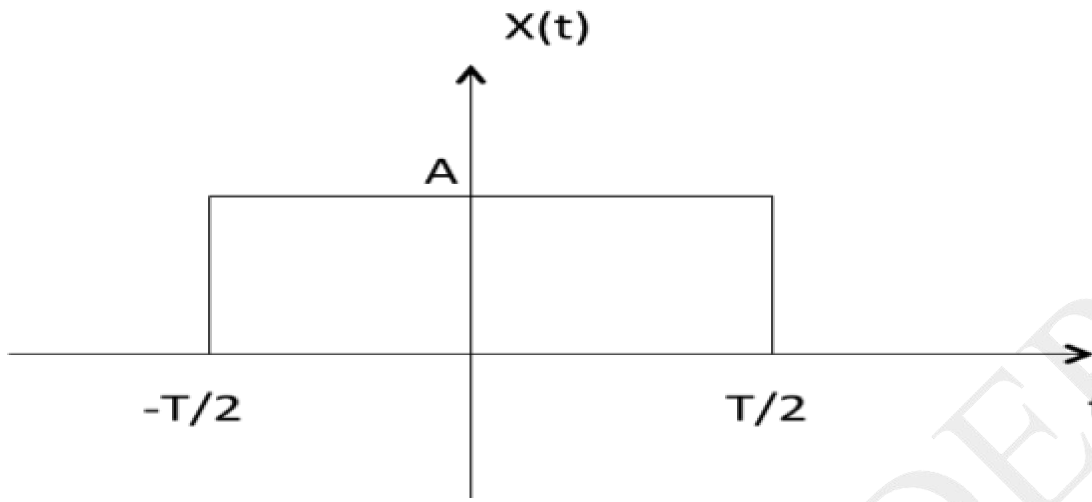
Example 1: t^2, t^4… cost etc.

Let $x(t) = t^2$

$x(-t) = (-t)^2 = t^2 = x(t)$

$\therefore$ $t^2$is evenfunction

Example 2: As shown in the following diagram, rectangle function x(t) = x(-t) so it is also even function.



A signal is said to be odd when it satisfies the condition x(t) = -x(-t)

Example: t, t^3 ... And sin t

Let x(t) = sin t

x(-t) = sin(-t) = -sin t = -x(t)

∴ sin t is odd function.

Any function $f(t)$ can be expressed as the sum of its even function $f_e(t)$ and odd function $f_o(t)$.

$f(t) = f_e(t) + f_0(t)$

where

$f_e(t) = ½[f(t) + f(-t)]$

Periodic and Aperiodic Signals

A signal is said to be periodic if it satisfies the condition $x(t) = x(t + T)$ or $x(n) = x(n + N)$.

Where

T = fundamental time period,

1/T = f = fundamentalfrequency.

The above signal will repeat for every time interval T_0 hence it is periodic with period T_0.

Energy and Power Signals

A signal is said to be energy signal when it has finite energy.

A signal is said to be power signal when it has finite power.

NOTE:A signal cannot be both, energy and power simultaneously. Also, a signal may be neither energy nor power signal.

Power of energy signal = 0
Energy of power signal = ∞

Real and Imaginary Signals

A signal is said to be real when it satisfies the condition $x(t) = x^*(t)$
A signal is said to be odd when it satisfies the condition $x(t) = -x^*(t)$
Example:

If $x(t)= 3$ then $x^*(t)=3^*=3$ here x(t) is a real signal.
If $x(t)= 3j$ then $x^*(t)=3j^* = -3j = -x(t)$ hence x(t) is a odd signal.

Note: For a real signal, imaginary part should be zero. Similarly for an imaginary signal, real part should be zero.