Contents of course

EE-228-F **SIGNALS & SYSTEMS**

L T P		Class Work marks	: 50
3 - -		Theory marks	: 100
		Total marks	: 150
		Duration of Exam	: 3 hr

NOTE: For setting up the question paper, Question No. 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

SECTION-A

Signals: Definition, types of signals and their representations: continuous-time/discrete-time, periodic/non-periodic, even/odd, energy/power, deterministic/ random, one-dimensional/multi-dimensional; commonly used signals (in continuous-time as well as in discrete-time): unit impulse, unit step, unit ramp (and their inter-relationships), exponential, rectangular pulse, sinusoidal; operations on continuous-time and discrete-time signals (including transformations of independent variables).

SECTION-B

Fourier Transforms (FT):

(i) Definition, conditions of existence of FT, properties, magnitude and phase spectra, Some important FT theorems, Parseval's theorem, Inverse FT, relation between LT and FT

(ii) Discrete time Fourier transform (DTFT), inverse DTFT, convergence, properties and theorems, Comparison between continuous time FT and DTFT

SECTION-C

Time and frequency domain analysis of systems

Analysis of first order and second order systems, continuous-time (CT) system analysis using LT, system functions of CT systems, poles and zeros, block diagram representations; discrete-time system functions, block diagram representation, illustration of the concepts of system bandwidth and rise time through the analysis of a first order CT low pass filter

SECTION D

Laplace-Transform (LT) and Z-transform (ZT):

(i) One-sided LT of some common signals, important theorems and properties of LT, inverse LT, solutions of differential equations using LT, Bilateral LT, Regions of convergence (ROC) (ii) One sided and Bilateral Z-transforms, ZT of some common signals, ROC, Properties and theorems, solution of difference equations using one-sided ZT, s- to z-plane mapping .

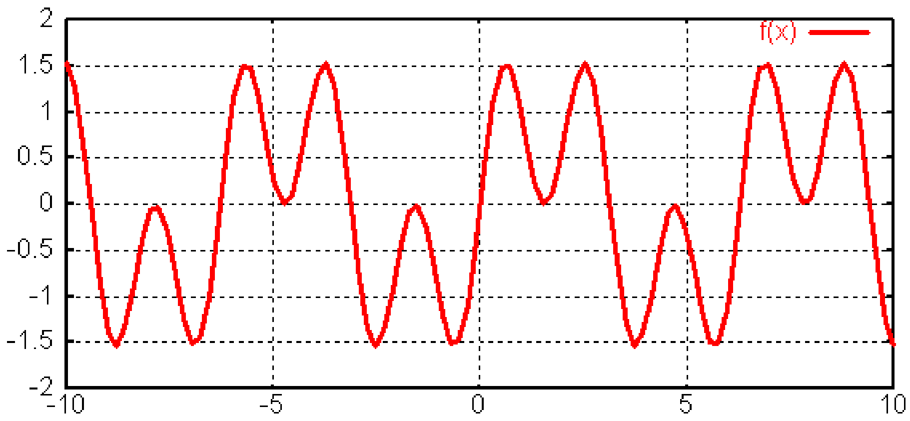
Text Books:

1. `Signal and Systems' I J NAGRATH, R. RANJAN & Sharan, 2009 Edn., TMH, New Delhi

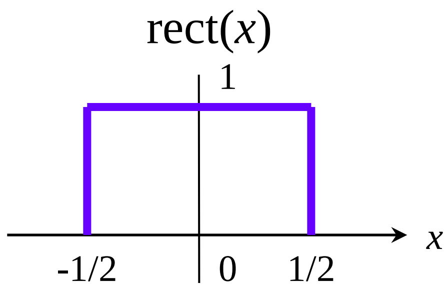
Reference Books:

1. V. Oppenheim, A.S. Willsky and S. Hamid Nawab, 'Signals & System',PEARSON Education, Second Edition, 2003.
2. Schaume Series on Signals & Systems, HSU & RANJAN, TMH,India

Signal is a set of data or information collected over time.

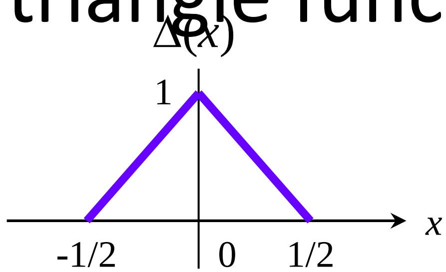


- Unit gate function (a.k.a. unit pulse function)



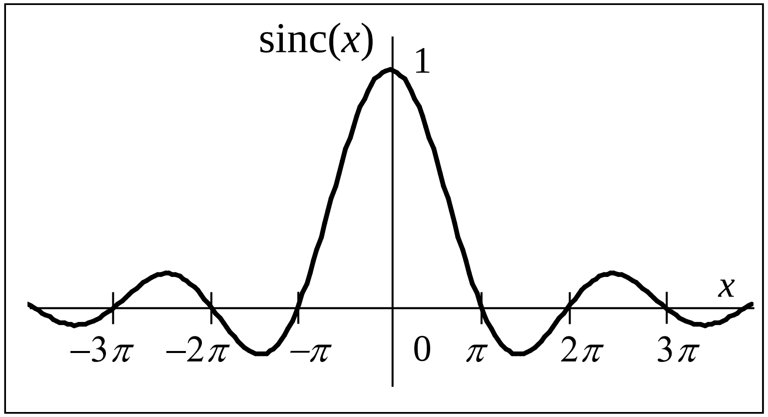
$$\mathrm{rect}(x)=\begin{cases}0 & |x|>\dfrac{1}{2}\\[4pt] \dfrac{1}{2} & |x|=\dfrac{1}{2}\\[4pt] 1 & |x|<\dfrac{1}{2}\end{cases}$$

- What does rect(x / a) look like?
- Unit triangle function



$$\Delta(x)=\begin{cases}0 & |x|>\dfrac{1}{2}\\[4pt] 1-2|x| & |x|<\dfrac{1}{2}\end{cases}$$

- Sinc function



$$\mathrm{sinc}(x) = \frac{\sin(x)}{x}$$

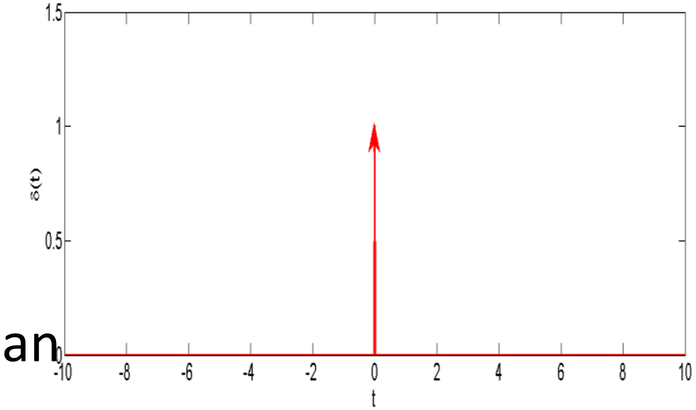
How to compute sinc(0)? As $x \to 0$, numerator and denominator are both going to 0. How to handle it?

  - Even function
  - Zero crossings at $x = \pm\pi, \pm 2\pi, \pm 3\pi, \ldots$
  - Amplitude decreases proportionally to 1/x

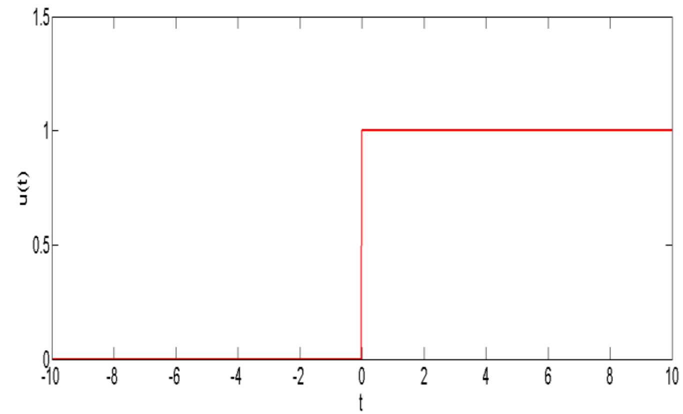
Continuous Unit Impulse and Step Signals

- The continuous **unit impulse signal** is defined:

$$x(t) = \delta(t) = \begin{cases} 0 & t \neq 0 \\ \infty & t = 0 \end{cases}$$



- Note that it is discontinuous at t=0
- The arrow is used to denote area, rather than actual value
- Again, useful for an infinite basis



- The continuous **unit step signal** is defined:

$$x(t) = u(t) = \int_{-\infty}^{t} \delta(\tau) d\tau$$

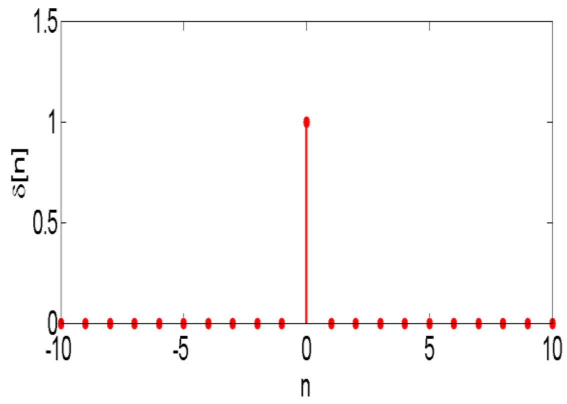
$$x(t) = u(t) = \begin{cases} 0 & t < 0 \\ 1 & t > 0 \end{cases}$$

Discrete Unit Impulse and Step Signals

- The discrete **unit impulse signal** is defined:

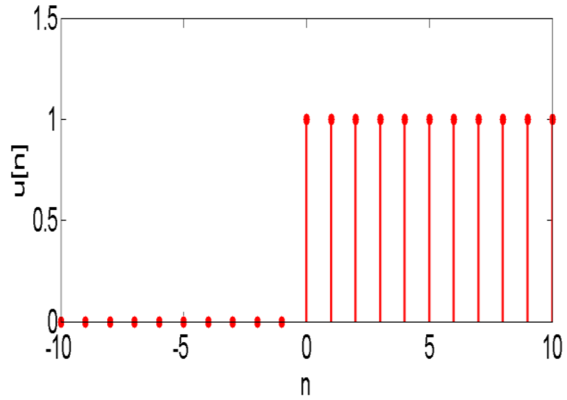
$$x[n] = \delta[n] = \begin{cases} 0 & n \neq 0 \\ 1 & n = 0 \end{cases}$$

- Useful as a **basis** for analyzing other signals



- The discrete **unit step signal** is defined:

$$x[n] = u[n] = \begin{cases} 0 & n < 0 \\ 1 & n \geq 0 \end{cases}$$



- Note that the unit impulse is the first difference (derivative) of the step signal

$$\delta[n] = u[n] - u[n-1]$$

- Similarly, the unit step is the running sum (integral) of the unit impulse.

Exponential and Sinusoidal Signals

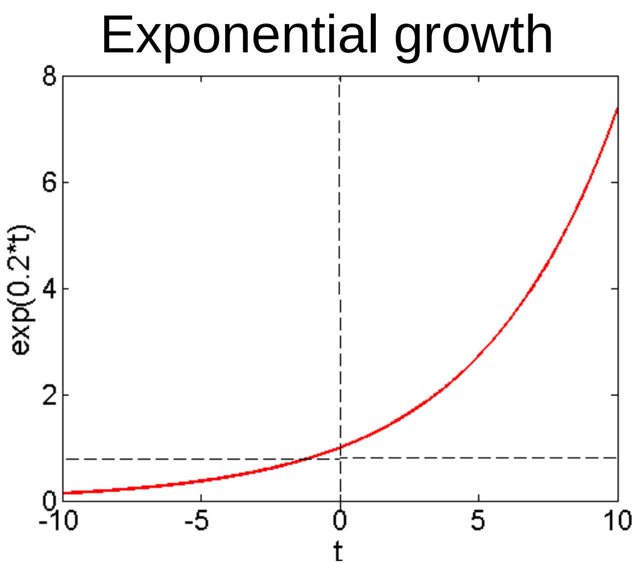
- Exponential and sinusoidal signals are characteristic of real-world signals and also from a basis (a building block) for other signals.
- A generic **complex exponential signal** is of the form:

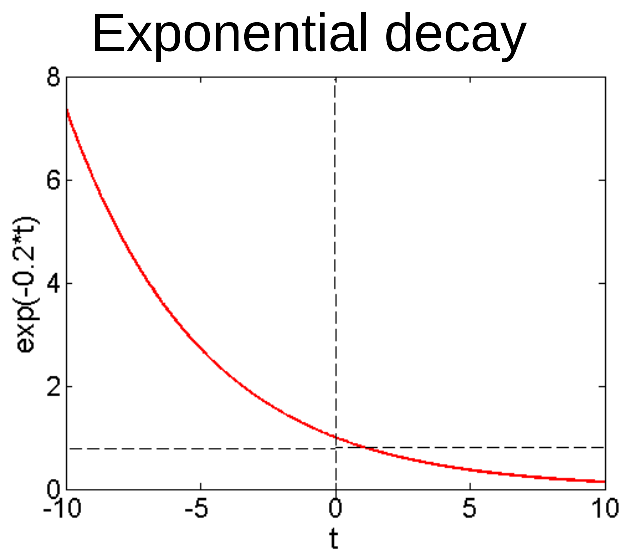
$$x(t) = Ce^{at}$$

- where *C* and *a* are, in general, complex numbers. Lets investigate some special cases of this signal
- **Real exponential signals**

$a > 0$

$C > 0$





$a < 0$

$C > 0$