INTRODUCTION TO SIGNALS AND SYSSTEMS

1.1 SIGNAL

A signal is an abstraction of any measurable quantity that is a function of one or more independent variables such as time or space.

Example: The alternating current is a signal because current varies with time. DC is not a signal because current is constant with time.

NB

A signal could be:

A single variable signal: f(x), f(t) depends on a single variable

Multi-variable signal: Depends on two or more variables f(x\_1, x\_2)

1.1.1 CLASSIFICATION OF SIGNALS

1. Coninuous time signals

2. Discrete time signals

1.1.1.1 CONTINUOUS TIME SIGNALS

These are signals that are present for all instances of time e.g. sinusoidal, cosinusoidal, triangular wave form, rectangular wave form.

1.1.1.2 DISCRETE TIME SIGNALS

Signals that are usually present at discrete points in time

1.2 SYSTEM

A system is an abstraction of anything that takes an input signal, operates on it and produces an output signal e.g. a human being.

A system will be meaningless without a signal to operate upon

i/p --- [system] --- o/p

o/p is dependent on the nature of the system

1.2.1 TYPES OF SYSTEMS

1. Continuous time systems: These operate on continuous time signals

2. Discrete time systems: These operate on discrete time signals

1.3 LTI systems (Linear Time Invariant)

Operates on two fundamental principles

An LTI system combines the properties of linearity and time-invariance

Linearity

Given that x\_1(t) --- [system] ----- y\_1(t) and x\_2(t) ---- [system]----y\_2[t]

Shoul we super impose them

x\_1(t) + x\_2(t) ----- [system] ------- y\_1(t)+y\_2(t)

Specific input produces a specific output

Time Invariance

Given that x(t) --- [system] ---- y(t)

Should there be a shift in time, (%tau)

x(t-{%tau}) ----- [system] ----- y(t-{%tau})

- Opposite to LTI is the LTV(linear time variant) system e.g. human beings

- Properties of the signal in an LTI system does not change with time

- LTI provides sufficient approximation during system analysis.

Therefore an LTI system is described as

x(t) ---- [LTI system h(t)] ---- y(t)

y(t) = x(t) \* h(t)

x(t) --- applied input signal or excitation

y(t) --- expected output signal/response

h(t) --- Impulse response of the system

h(t) --- is the parameter that characterizes the system

\* is the convolution operator (a tool for the time domain analysis of the system)

1.4 WHAT WE CONSIDER IN SIGNALS AND SYSTEMS

The basic concept under consideration in the study of signals and systems are:

1. The description of signals as functions of frequency

NB: z-transform is the discrete equivalent of fourrier transform

2. Investigating how systems respond to input of different frequencies

3. Providing tools for switching between time domain and frequency domain representation e.g. Laplace, Fourrier transform, Z-transform

4. Determination of which domain is suitable for a particular problem

1.5 PROBLEMS IN SIGNALS AND SYSTEMS

There are two major categories of problems

1. Analysis Problem: Here we are trying to figure out the expected response in a system.

2. Synthesis Problem: Here we have an idea about the input its properties and what the output should be but we want to figure out how do we design a system to give that output