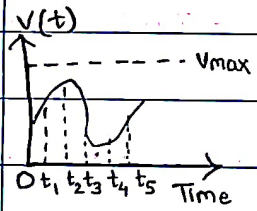
Digital Electronics

* Signal :- Variation of physical quantity with respect to any parameter.
- In electrical and electronics, signal is variation of an electrical quantity (i.e voltage (V) or Current (I)) as function of time
- Transducer :- It converts non-electrical signal to electrical signal.
- Two ways of representing numerical value of quantities :-

1) Analog (derived from the word analogous or real world signals)
2) Digital (derived from the word digit)

1) Analog Signal :- Can define any value within interval / limit



Signal varying continuously with respect to time
Discrete time signal :- defined for discrete interval of time
It is subset of analog signal
e.g. Automobile speedometer, Audio microphone

2) Digital Signal :- Discretized in time and amplitude / different quantized levels
e.g. Digital speedometer, Digital watch
Quantities are represented by symbols called digits.
[Finite no. of possibilities]

* Need of digital signal :-

1) All real time signals are analog, also some signals are weak
2) It is difficult to detect Analog signal in presence of noise as signal strength is highly deteriorated by noise
3) Digital circuits are less affected by noise, the spurious fluctuation in voltage (noise) are not as critical in digital systems. It is easy to detect digital signal as it is in 1 or 0 (binary / discrete values)

* Advantages of digital signal :-

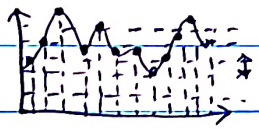
1. Easy to store and manipulate — 0 Volt → "0" → OFF, 1 Volt → "1" → ON
2. Accuracy & Precision are greater
3. Operation can be programmed, easy security of data (encryption)
4. Easier to design as circuits, high speed
5. Effect of noise is less compared to analog
6. Low bandwidth usage and high efficiency for long distance transmission.
7. Cost of digital is lower compared to analog.

* Digital System Example

System
↓
Subsystem
↓
Modules
↓
~~Functional Blocks~~
↓
Basic Unit (Logic Gate)
↓
Circuit (Transistors, Resistors, Capacitors)
↓
Device and Components

Analog Input → ADC → Digital System → DAC → Analog Output

Analog Signal (Continuous in time & amplitude) → Sampler (Discrete in time but continuous in amplitude) → Quantizer → Digital Signal (Discrete in time & amplitude)



Δ = Quantization error (Step size)

Max. error = $\Delta/2$

As Δ ↑, no. of level ↑, memory requirement ↑

* Increasing accuracy in digital system :- Increase the number of digits

If m = no. of switches / bits
n = no. of levels / possibilities
} $n = 2^m$

e.g. For 0 - 5 V (1 switch) ⇒ 0V, 5V
(2 switches) ⇒ 0V, 1.25V, 2.5V, 3.75V
} Thus if m ↑ accuracy increase.

* Combinational Circuit :- No memory

Sequential Circuit :- Circuits with memory.