Digital Logic

Introduction

Unit 1

Working principle of generic digital computer:

- Memory stores programs as well as input, output and intermediate data.
- The data path performs arithmetic and other data-processing operations as specified by the program.
- The control unit supervises the flow of information between the various units.
- A data path, when combined with the control unit, forms a component referred to as a *central processing unit,* or CPU.
- The program and data prepared by the user are transferred into memory by means of an input device such as a keyboard.
- An output device, such as a CRT (cathode-ray tube) monitor, displays the results of the computations and presents them to the user.

Advantages of digital system:

- Have made possible many scientific, industrial, and commercial advances that would have been unattainable otherwise.
- Less expensive
- More reliable
- Easy to manipulate
- Flexibility and Compatibility
- Information storage can be easier in digital computer systems than in analog ones. New features can often be added to a digital system more easily too.

Disadvantages of digital system:

- Use more energy than analog circuits to accomplish the same tasks, thus producing more heat as well.
- Digital circuits are often fragile, in that if a single piece of digital data is lost or misinterpreted, the meaning of large blocks of related data can completely change.
- Digital computer manipulates discrete elements of information by means of a binary code.
- Quantization error during analog signal sampling.

Information Representation

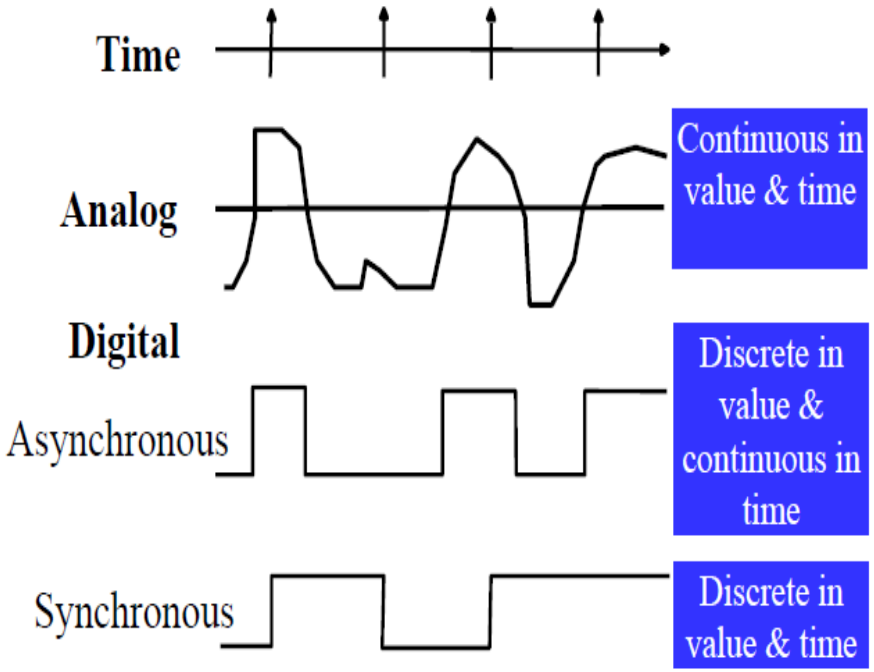
Signals

- Information variables represented by physical quantities.
- For digital systems, the variables take on discrete values.
- Two level or binary values are the most prevalent values in digital systems.

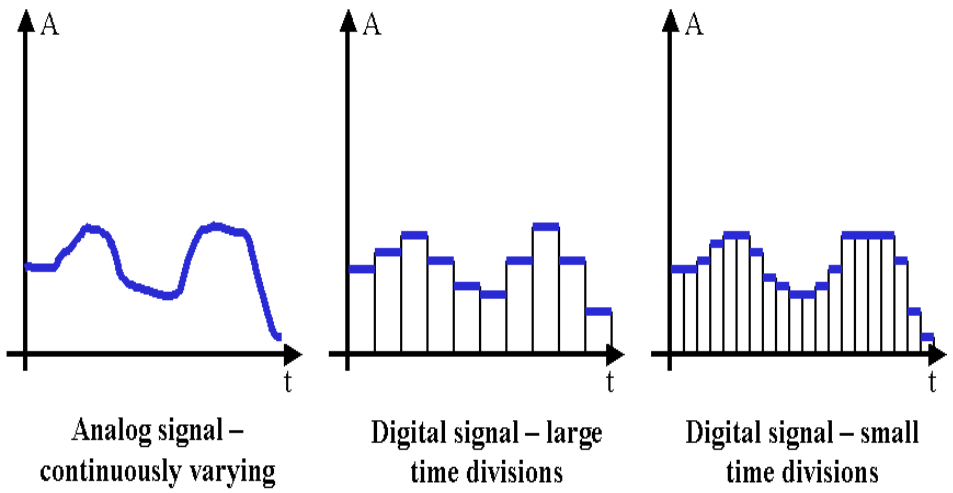
- Binary values are represented abstractly by:
  - digits 0 and 1
  - words (symbols) False (F) and True (T)
  - words (symbols) Low (L) and High (H)

  - and words On and Off.
- Binary values are represented by values or ranges of values of physical quantities

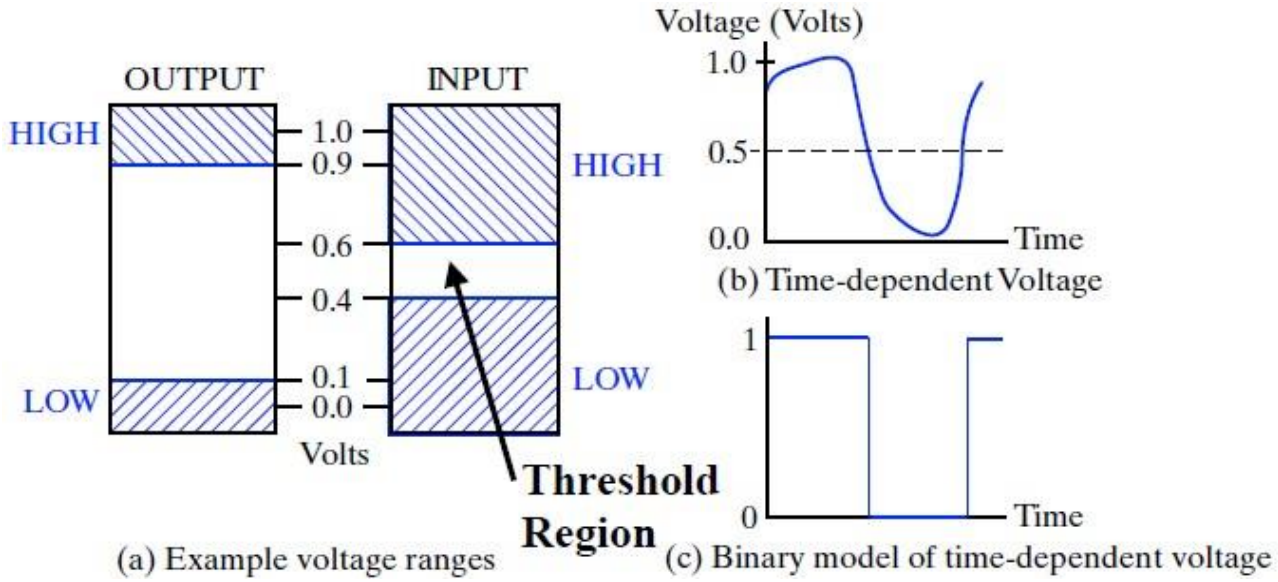
- **Signal Examples over time**



Here is an example waveform of a quantized signal. Notice how the magnitude of the wave can only take certain values, and that creates a step-like appearance. This image is discrete in magnitude, but is continuous in time (asynchronous):



Signal Example – physical quantity: Voltage



(a) Example voltage ranges

(b) Time-dependent Voltage

(c) Binary model of time-dependent voltage

- **What are other physical quantities representing 0 and 1?**

CPU: Voltage
Disk: Magnetic Field Direction
CD: Surface Pits/Light
Dynamic RAM: Electrical Charge

Questions:

1. What are Analog and Digital signals.
2. Differentiate between Analog System and Digital System.

Previously Used Analog Systems

- Cameras
- Audio Recording
- Video Recording
- Telephone Systems
- Special Effect in Advertisement and Movies

Examples of Digital Systems

- In communication systems
- Business Transactions
- Traffic Control
- Medical Treatment
- Industrial Applications
- Digital Telephones
- Digital TV
- Digital Cameras
- Weather Monitoring

Various Basic Digital Devices

- Logic Gates:

✓ Basic elements that make up a digital system.

✓An electronic gate is a circuit which is able to operate on a number of binary inputs.

✓AND, NOT and OR are the basic gates.

- Combinational Circuits:

➢Produces output for a certain specified combination of inputs.

➢Doesn’t contains memory

➢Eg. Adder, Subtractor, Multiplexer etc.

- Sequential Logic Circuits:

➢ A combinational circuit combines with memory produces Sequential logic circuits.

➢Eg Flip Flops, Counter etc.

Performance Comparison of Digital And Analog Signals:

Parameter	Analog Signal	Digital Signal
Number of values	Infinite	Finite
Number of Signlas	Continuous time	Discrete time
Nature of signal	Signal generator, transducer	Computers A to D convertr
Examples	Sine wave, triangular wave	Binary signal

Analog and Digital Systems (Comparison):

Parameter	Analog System	Digital System
Type of signal	Analog signal	Digital Signal
Type of Display	Analog meter	Digital Display
Accuracy	Small	High
Design complexity	Difficult to Design	Easy to Design
Memory Attached	No memory	Have memory
Storage	Not possible	possible
Distortion	High	Small
Communication between systems	Not easy	Easy
Noise Effect	High	Low

Clock Signal:

- A clock signal (historically also known as logic beat) **oscillates between a high and a low state .**
- A clock signal is produced by a clock generator.

Clocks

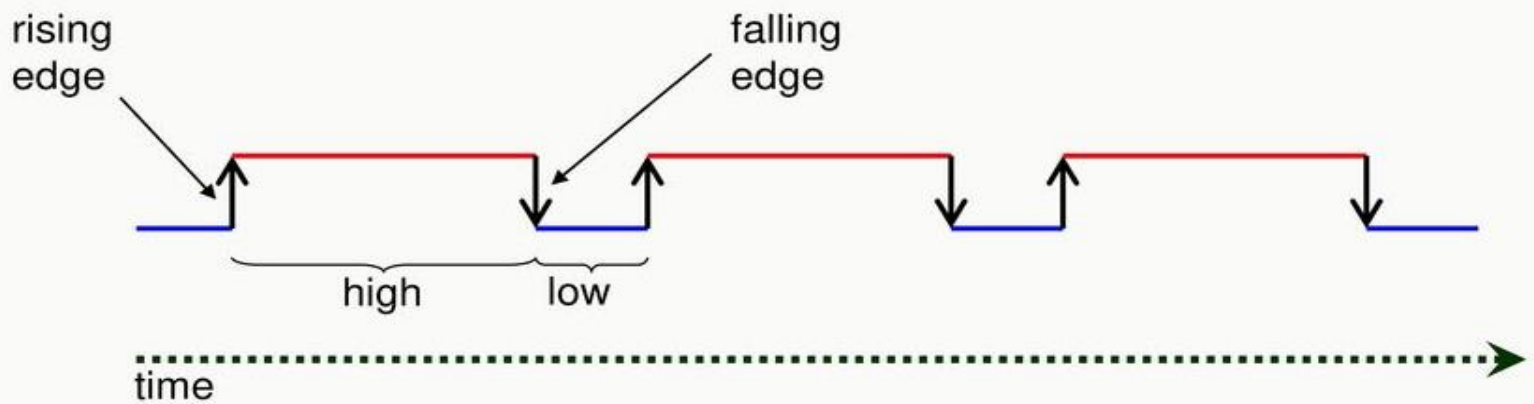
A *clock* is a free-running signal with a cycle time.

A clock may be either *high* or *low*, and alternates between the two states.

The length of time the clock is high before changing states is its *high duration*; the *low duration* is defined similarly.

The *cycle time* of a clock is the sum of its high duration and its low duration.

The *frequency* of the clock is the reciprocal of the cycle time.



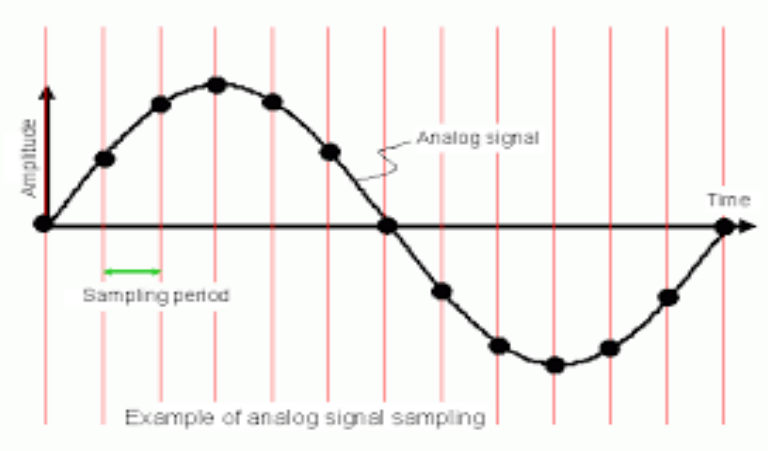
Analog to Digital Conversion:

Analog-to-digital conversion involves four major steps:

- Sampling.
- Quantization.
- Encoding.
- Compression (optional)

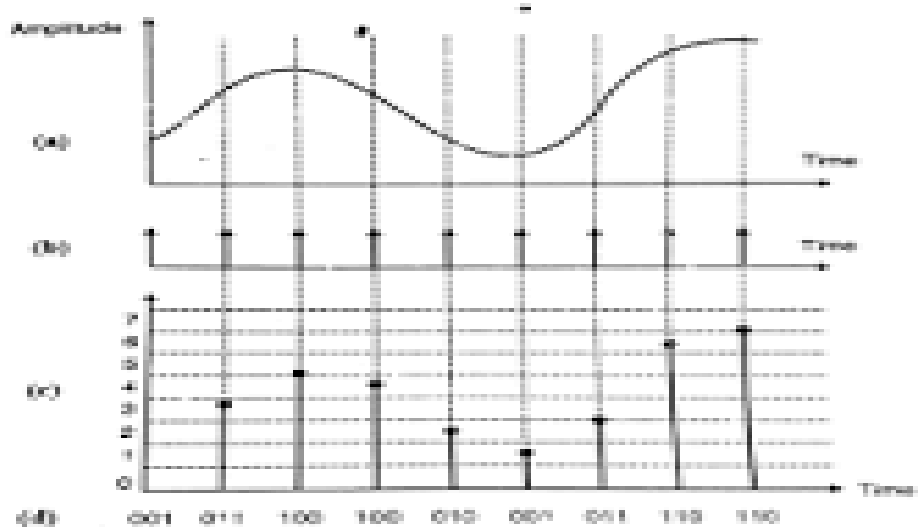
• Sampling

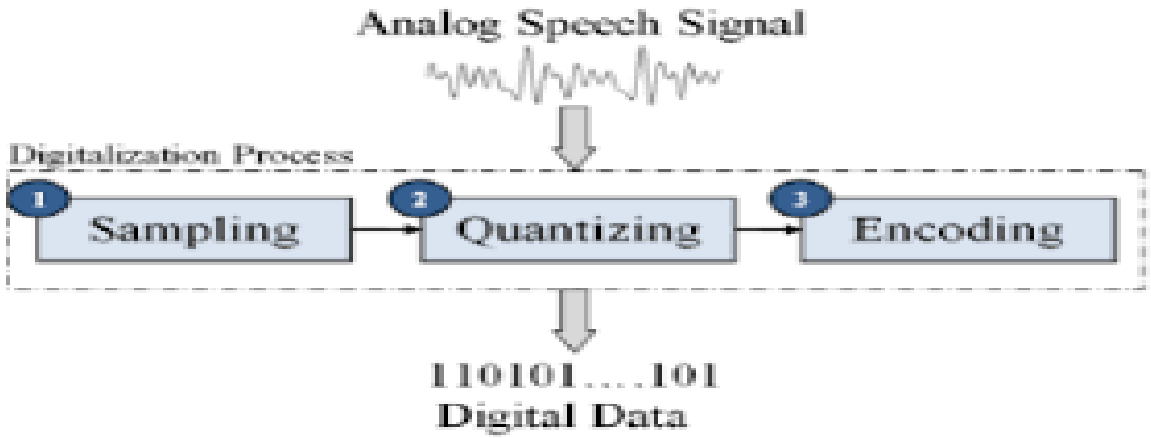
- The A/D converter **captures analog signals at fixed time intervals along the time axis**.
- This process is known as sampling, and the fixed time interval is known as the sampling period (the inverse of the sampling period is called the sampling frequency)



• Quantization:

- The process of converting continuous sample values into discrete values i quantization.
- In this process we divide the signal range into a fixed number of intervals.
- Each intervals is of same size and is assigned a number.





Encoding is the process of mapping the quantized value to the digital word.