Chapter-1

Introduction:

The fundamentals and implementation of digital electronics are essential to understanding the design and working of consumer/industrial electronics, communications, embedded systems, computers, security and military equipment.

The applications such as programmable logic devices, microprocessors, microcontrollers, **digital** troubleshooting and **digital** instrumentation

Analogue electronics (also spelled **analog electronics**) are electronic systems with a continuously variable signal, in contrast to digital electronics where signals usually take only two levels.

The term "analogue" describes the proportional relationship between a signal and a voltage or current that represents the signal. The word analogue is derived from the Greek word (analogos) meaning "proportional"

Diode:

A semiconductor device with two terminals, they allowing the flow of current in one direction only.

Digital electronics circuits are **electronics** that handle **digital** signals (discrete bands of analog levels) rather than by continuous ranges as used in analog **electronics**.

The **definition** of a **diode** is an electronic device with two transmitting terminals that allows electric current to flow in one direction while blocking current in the opposite direction. An example of a **diode** is a light-emitting **diode**, an LED.

Resistor

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element.

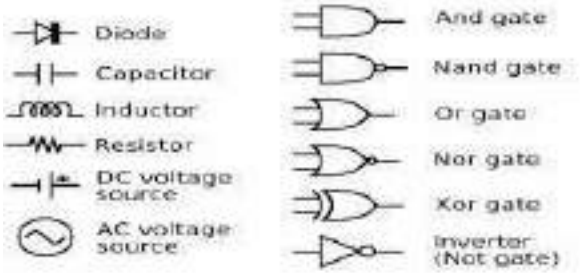
A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit.

In electronic circuits, **resistors** are used to Electronic symbols and notation ·

Transistors

A semiconductor device with three connections, capable of amplification in addition to rectification.

A **transistor** is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals



Capacitor

A device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator.

A **capacitor** is a passive two-terminal electrical component that stores electrical energy in an electric field. The effect of a **capacitor** is known as capacitance.

IC Logic Families

The following are the factors depends on the IC Logic families

a) Speed
b) Power description
c) Noise immunity
d) Input/output interface compatibility
e) Cost

Waveform

It is the shape of curve obtained by plotting the instantaneous values of voltage or current along **Y** axis (ordinate) against time along **X** axis (abscissa).

History of IC's Family's

The Semiconductor industry has evolved from the first IC's of the early 1970's.

Scale of Integration/ Classification of Integrated Circuits

The number of gates that can be put in a single chip,

a) **Small Scale Integration (SSI):**
   - ❖ It contains several Independent gates in a Single Package.
   - ❖ The Number of gates in these usually less than 10 pins available in the IC.
   - ❖ The I/O's of the gates are directly to the pins in the Package

b) **Medium Scale of Integration(MSI):**
   - ❖ It has 10 to 200 gates I a single package
   - ❖ They perform specific elementary digital functions such as decoders, adders' registers.

c) **Large Scale Integration(LSI):**
   - ❖ It contains between 200 to a few thousand gates in single package.
   - ❖ They include digital systems such as processors, Memory chips & Programmable modules.

d) **Very Large Scale Integration:**
   - ❖ They contains more than thousands gates in a single package
   - ❖ They include large.meory arrays & complex microcomputer chips.

e) **Super large Scale Integration (SLSI)**
   - ❖ It contains between 10,000 to 1 lakh transistors within a single package.
   - ❖ It performs computational operations such as microprocessor chips, micro controllers, basic Calculators.

f) **Ultra Large Scale Integration:**
   - ❖ It has more than 1 million transistors & used in Computers, CPUs, Video processors etc.

Digital Integrated circuits

The advantages of IC's being used in Digital Systems are..

- ➢ Small Size
- ➢ High Reliability
- ➢ Low Cost
- ➢ Low Power Consumption

There are two broad Categories of digital IC's

a) **Fixed Function Logic:**-In this logic functions of the IC's are set by the manufacturer & cannot be altered.

b) **Programmable Logic:** - In this logic functions of IC's can be altered.

Characteristics of IC family gates

There are five basic characteristics are……

- Power dissipation
- Propagation delay
- Fan in
- Fan out
- Noise Margin

Power dissipation: It means **power** Consumed by the gate & it is the product of dc voltage & current.

Propagation delay:-The term propagation delay refers to the average time it takes the input signal to propagate to the output.

Fan in:-Fan in is the number of input terminals for ex an AND gate has a 2 inputs.

Fan out:-The number of gates that each gate can drive while providing voltage levels in the guarantied range called fan out/standard load.
The fan out depends on the amount of electric current of a gate

Noise Margin: It refers to the maximum voltage that can be added to the generated signal in a digital circuit.

Classification of IC's

There are two basic techniques for manufacturing IC's classification is

1) **Bipolar technique/family:** It fabricates Bipolar transistors on a chip, it is preferd for SSI & MSI
2) **Metal oxide Semiconductors technique/family(MOS):-**It fabricates metal oxide on a chip, it is preferred LSI & VLSI

The Basic families in the bipolar category are

1) Resistors Transistors Logic(RTL)
2) Diode Transistors Logic (DTL)
3) Transistor Transistor Logic(TTL)
4) Emitter Coupled Logic (ECL)

The Basic families in the MOS category are..

1) P-Channel MOSFET(Metal Oxide Semiconductor Field Effect)
2) N-Channel MOSFET
3) CMOS(Complementary Metal oxide semiconductor Field Effect)

Diode Transistor Logic:-It is a class of digital circuits built from bipolar function Transistor (BJT), diodes & Transistors.

- Increased in Fan in,
- Propagation delay is relatively large

Transistor Transistor Logic:- In this technology the diodes are replaced by Transistors to improve the circuits operations ,

- It is a class of digital circuits build from bipolar function transistors & resistors,
- Computers, Industrial ,Control test equipment etc,
- TTL IC's are examples of SSI to LSI

Emitter Coupled Logic: It is a logic family in which current is steered trough bipolar transistors to compute logical function.

- It can change the state very rapidly,
- It is sometimes called "Current Mode Logic"
- It operates at very high speed
- The propagation time can be less than a nanosecond
- The circuit require a lot of power & some power is wasted due to more consume of heat
- They are used in systems such as super computers & signal processors

MOS (Metal oxide Semiconductor)

The metal oxide semiconductor is a unipolor transistor that depends on the flow of only one type of carrier which may be electrons (n-channel) or hole (p-channel)

The triple compound "metal oxide semiconductor" reference to the nature of the physical structure of the field effect & transistors.

CMOS (Complementary Metal Oxide Semiconductor)

CMOS is sometimes explained as complementary symmetry metal oxide semiconductors.

The word "Complementary symmetry" refer to the fact of that the typical digital design style with CMOS user complementary & symmetrical pairs of electronic devices p-type & N-type MOSFET's logic functions.

- They have a very high input resistance
- They are compatible with one another
- It leads to more noise immunity
- Heat dissipation is low
- It is used in chips such as microprocessors RAM, IBM mainframe use CMOS, digital wrist watches, portable computers etc.
- Operation speed is high & manufacturing costs are low