Introduction to Electronics

Basic Components and Circuits

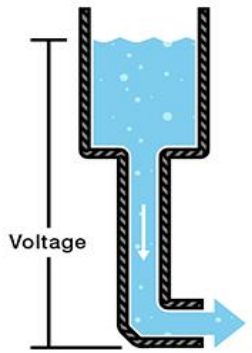
Contents

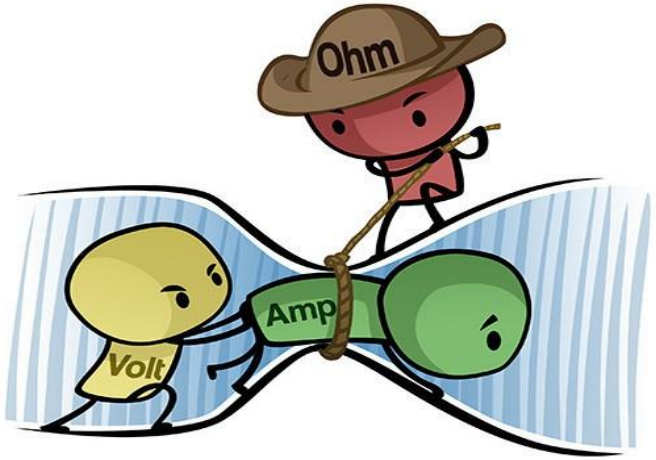
Objective

- To understand the basic elements of electronics engineering like voltage, current, resistance, capacitor.
- To get the knowledge of basic theorems like Ohm’s law, Kirchhoff's voltage & Current law, Thevinin’s & Norton’s theorem

What is voltage?

- **Voltage** makes electric charges to move .
- It is the 'push' that causes charges to move in a wire or other electrical conductor.
- The Unit of voltage is Volt(V).





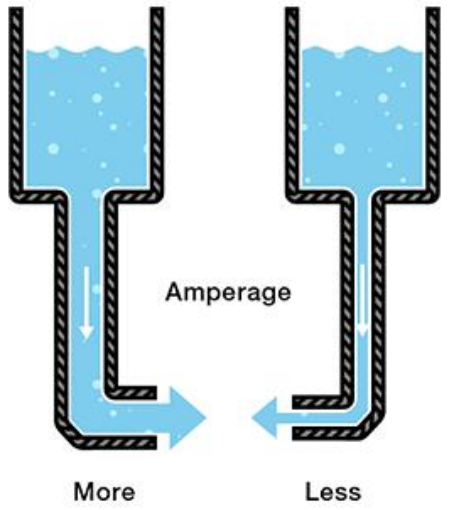
What is voltage?

The term voltage can be divided into different types they are

Voltage Classification:	
Terminology	**Values**
ELV- Extra low Voltage	**<25 V**
LV- Low Voltage	**≥25V - <1 KV**
MV-Medium Voltage	**≥1 KV - ≤ 33 KV**
HV-High Voltage	**>33 KV - ≤ 132 KV**
EHV-Extra High Voltage	**>132 KV**

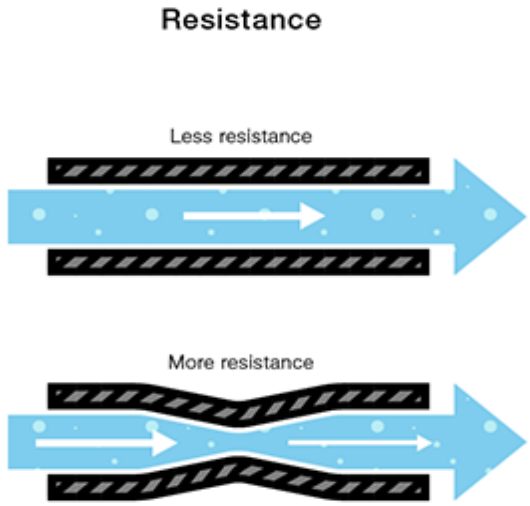
What is current?

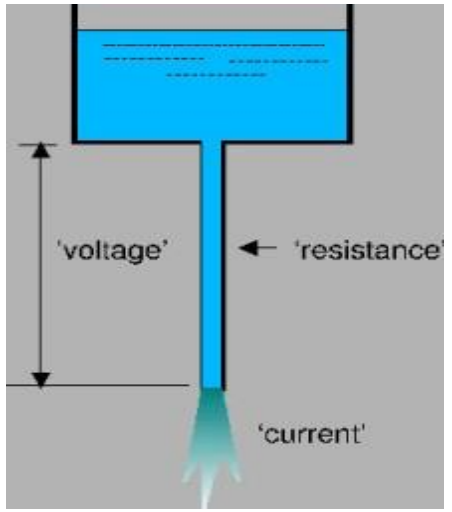
- Current is flow of electrons.
- Current is determined by the number of electrons passing through a cross-section of a conductor in one second.
- The unit of current is Ampere (Amps)



What is Resistance?

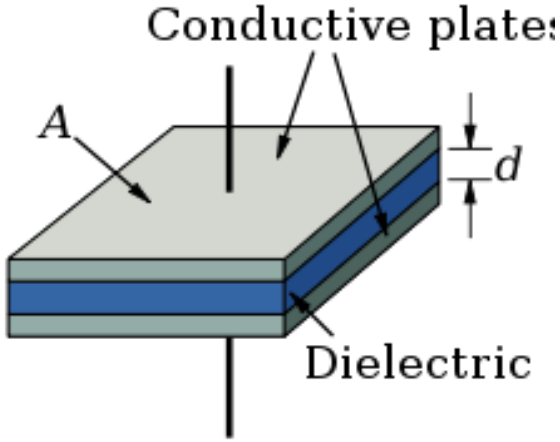
- Resistance to resist the flow of charge (current).
- When an electric current of one ampere passes through a component across which a potential difference (voltage) of one volt then the resistance of that component is one ohm.





What is Capacitor?

- Capacitors are components in an electrical circuit that can store a charge. The unit of capacitor is Farad
- A typical capacitor consists of two conducting surfaces (usually metal plates) separated by an insulating material like air, rubber, or paper. This insulating material is called a **dielectric**.

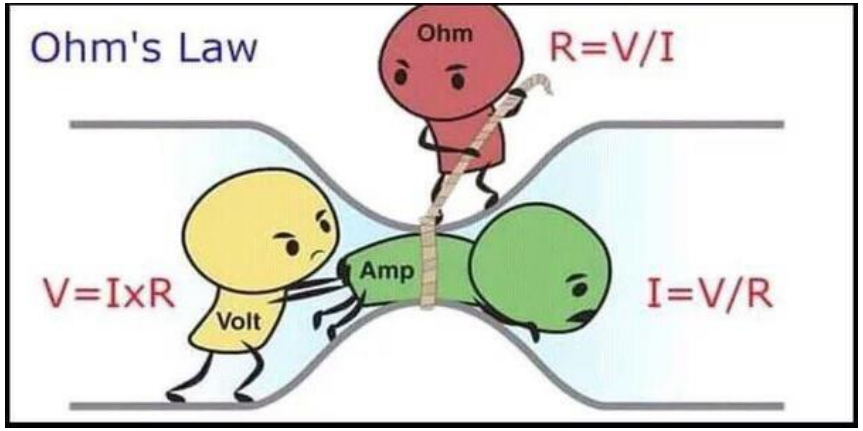


Ohm’s Law

Ohm’s law states that the voltage or potential difference between two points is directly proportional to the current or electricity.

Vis directly proportional to I V=IxR I=V/R R=V/I

Where V= voltage, I= current and R= resistance



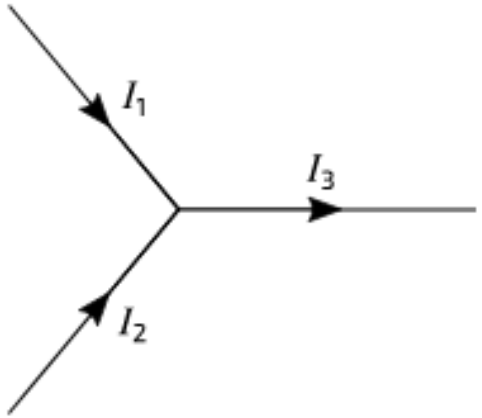
Kirchhoff's Laws

- Kirchhoff's laws are fundamental to circuit theory. They quantify how current flows through a circuit and how voltage varies around a loop in a circuit.

Kirchhoff's Laws

Kirchhoff's current law (1st Law)

It states that current flowing into a node (or a junction) must be equal to current flowing out of it. This is a consequence of charge conservation.

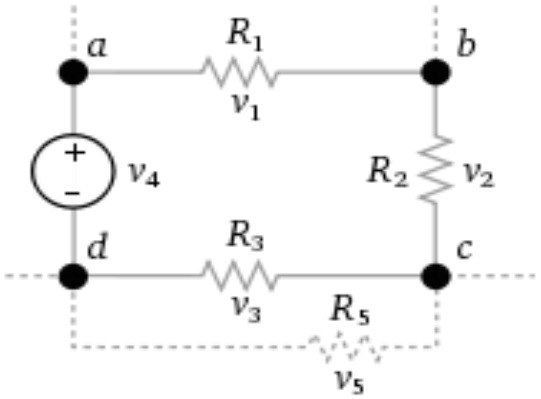


I1 + I2 = I3

Kirchhoff's Laws

Kirchhoff's voltage law (2nd Law)

It states that the sum of all voltages around any closed loop in a circuit must equal zero. This is a consequence of charge conservation and also conservation of energy.



$\Sigma V = 0.$

Atomic Structure

Conductors-Metals

- The conductivity of metals is based on the free electrons (so-called Fermi gas) due to the metal bonding.
- Already with low energy electrons become sufficiently detached from the atoms and a conductivity is achieved.
- If the temperature rises, the metal atoms swing ever stronger, so that the electrons are constrained in their movements.

Insulators

- Insulators possess no free charge carriers and thus are non-conductive.
- The atomic bond is based on shared electron pairs of nonmetals.
- The elements which behave like nonmetals have the desire to catch electrons, thus there are no free electrons which might serve as charge carriers.

Semiconductor

- Semiconductors are solids whose conductivity lies between the conductivity of conductors and insulators.
- Increasing temperatures leads to broken bonds and free electrons are generated.
- At the location at which the electron was placed, a so-called defect electron ("hole") remains.
- Due to exchange of electrons - to achieve the noble gas configuration - semiconductors arrange as lattice structure.

The band model

- The electronic band structure is an energy schema to describe the conductivity of conductors, insulators, and semiconductors.
- The schema consists of two energy bands (valence and conduction band) and the band gap.
- The valence electrons - which serve as charge carriers - are located in the valence band, in the ground state the conduction band is occupied with no electrons. Between the two energy bands there is the band gap, its width affects the conductivity of materials.

The energy band

- If we consider a single atom, there are according to the Bohr model of atoms sharply distinct energy levels, which may be occupied by electrons.
- If there are multiple atoms side by side they are interdependent, the discrete energy levels are fanned out.
- In a silicon crystal, there are approximately 10^{23} atoms per cubic centimeter, so that the individual energy levels are no longer distinguishable from each other and thus form broad energy ranges.

Band model

Conductors

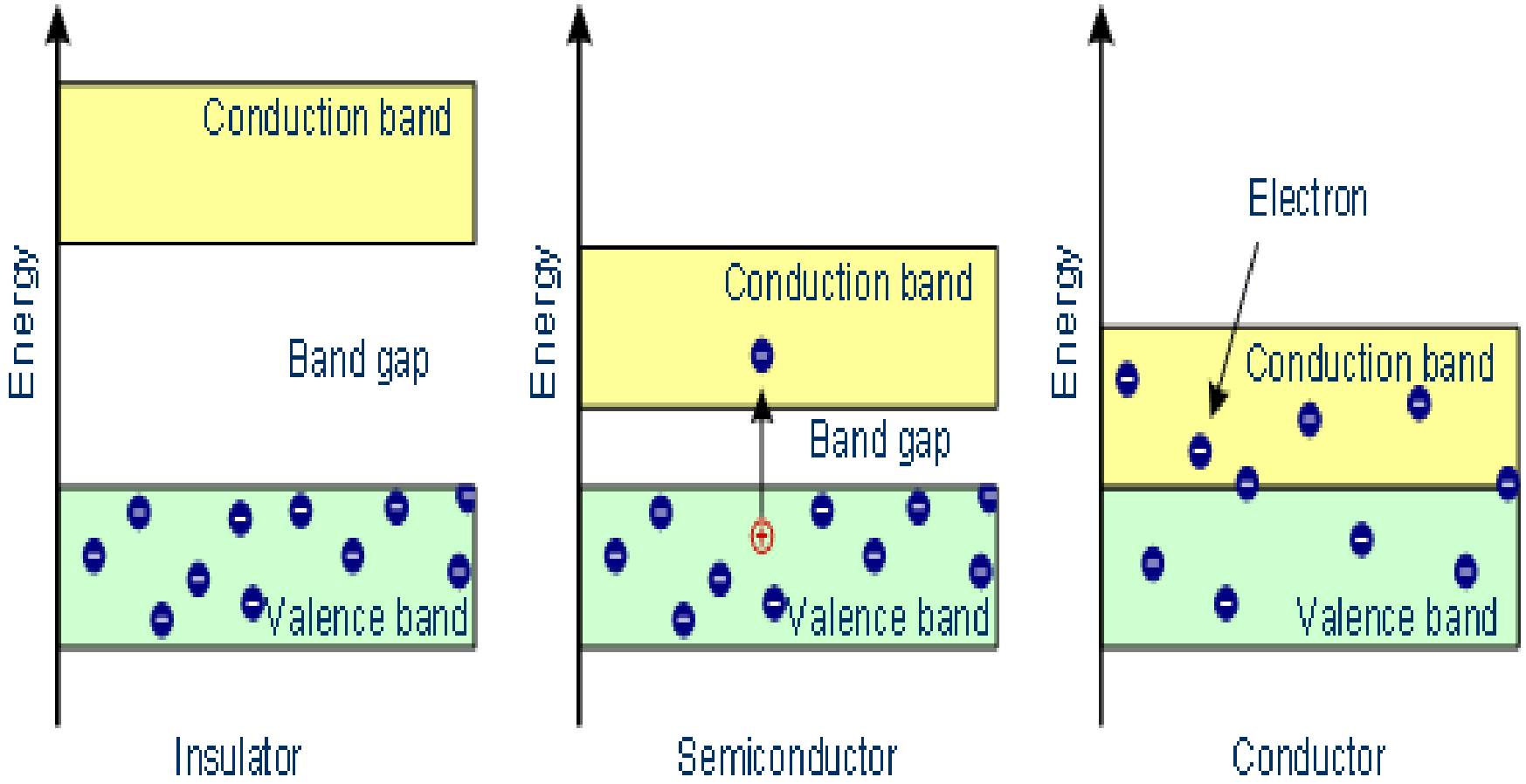
- In conductors there is no band gap between the valence band and conduction band.

Insulators

In insulators the valence band is fully occupied with electrons due to the covalent bonds. The electrons can not move because they're "locked up" between the atoms. To achieve a conductivity, electrons from the valence band have to move into the conduction band.

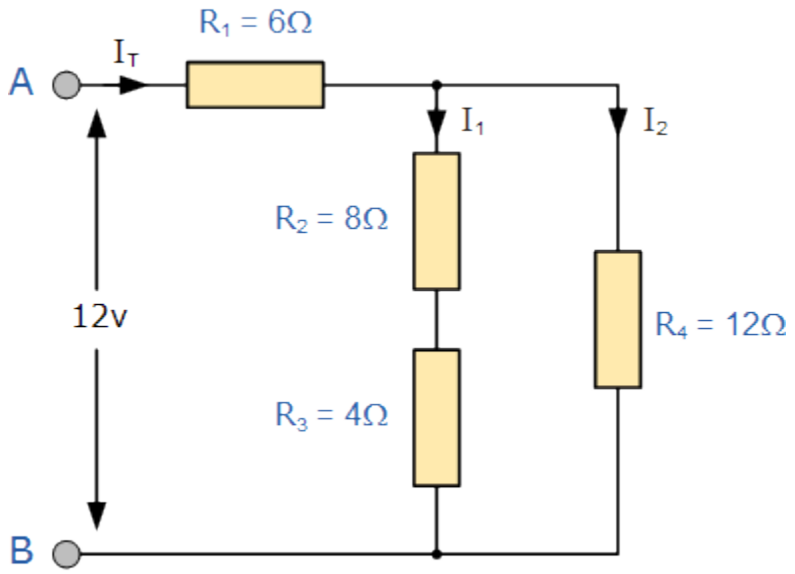
Semiconductors:

- Even in semiconductors, there is a band gap, but compared to insulators it is so small that even at room temperature electrons from the valence band can be lifted into the conduction band.
- A pure undoped semiconductor is known as intrinsic semiconductor.
- An **extrinsic semiconductor** is one that has been doped;


Energy
Conduction band
Band gap
Valence band
Insulator
Energy
Conduction band
Band gap
Valence band
Semiconductor
Energy
Electron
Conduction band
Valence band
Conductor

Problems

- Calculate Total resistance.



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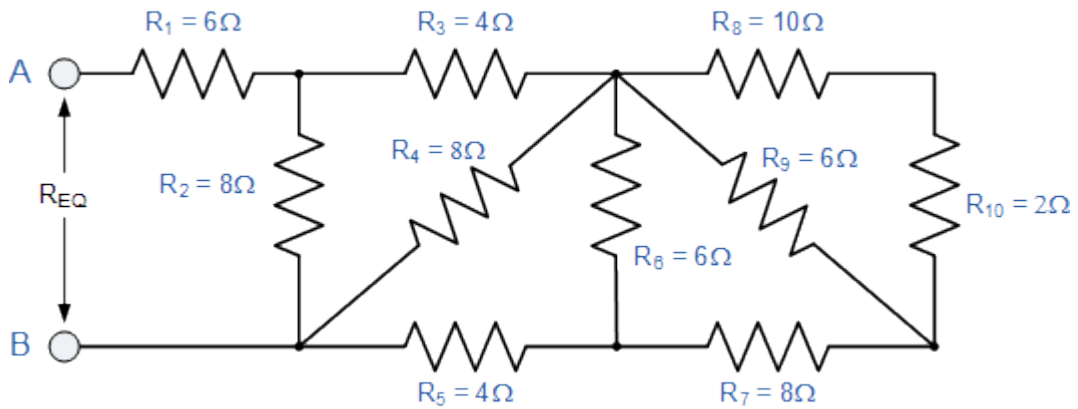

Conclusion

Voltage, Current, resistance, capacitor are the basic elements of Electronics.

The basic theorems are very much helpful to design basic electronic circuits.

Atomic structure of Conductors, Insulators, Semiconductors are discussed in detail.