# Fundamentals of Electric Circuit

## Lecture1

Introduction Units , Definition  and Simple Circuits

# References

1- Robert L. Boylestad, Introductory Circuit Analysis.

2- U. A. Bakshi, Basic Electrical Engineering.

3-S. Kumar, A Text Book of Electrical Engineering.

4- U. A. Bakshi, Basic of Electrical Engineering.

5- P. S. Subramanyam, Basic Concepts of Electrical Engineering.

6- S. K. Sahdev, Basic Electrical Engineering.

7-R. Prasad, Fundamentals of Electrical Engineering.

- All figures are taken from the reference

(Robert L. Boylestad, Introductory Circuit Analysis, Tenth Edition)

# International System of Units(SI)

The table below illustrates the most important units that are related to our subject.

| Quantity | Symbol | Units |
|---|---|---|
| Time | t | Second(s) |
| Length | l | Meter(m) |
| Temperature | T | Kelvin(K) |
| Charge | Q | Coulomb(C) |
| Current | I | Ampere (A) |
| Voltage | V | Volt(V) |
| Force | F | Newton(N) |
| Power | P | Watts(W) |
| Energy | W | Joules(J) |

# Scientific Notation

| Power of 10 | Prefix | Abbreviation |
|---|---|---|
| $10^{12}$ | Tera | T |
| $10^{9}$ | Giga | G |
| $10^{6}$ | Mega | M |
| $10^{3}$ | Kilo | k |
| $10^{-3}$ | Milli | M |
| $10^{-6}$ | Micro | μ |
| $10^{-9}$ | Nano | n |
| $10^{12}$ | Pico | p |

# Structure of Atoms

- To understand the concepts of current and voltage, it is necessary to know the atoms and their structure.

- Generally, the atom includes three particles; the neutron, the proton, and the electron. The table below gives the information about each particle.

| Fundamental Particles of Matter | Symbol | Charge | Mass in Kg |
|---|---|---|---|
| Neutron | n | 0 | $1.6 \times 10^{-}$ |
| Proton | $P^{+}$ | Positive | $1.6 \times 10^{-}$ |
| Electron | $e^{-}$ | negative | $9.107 \times 1$ |

# Current

- The current can be defined as the flow of electric charge through the material per unit time.

  The mathematical formula of current is as follows:

$$I = \frac{Q}{t} \quad (Ampere(A))$$

  where $Q$ (coulomb) is the charge and $t$ (sec) is the time.

**EX:** The charge flowing through the conductor is 0.16 C every 64 ms. Determine the current in ampere.

Solution:

$$I = \frac{Q}{t} = \frac{0.16}{64 \times 10^{-3}} = 2.5\ A$$

**Current:** flow of charge (electrons) within a conductor or how fast charge is moving. Charge will only flow if there is a voltage source (potential difference).

**Symbol for Current** = I

**Unit for Current** = Amps (A)

# Electric Current

- Electric current is the continuous flow of electric charge
- Two types of current are direct and alternating
- Direct current (DC) is when the charge flows in one direction

- Alternating current (AC) is when the flow of electric charge regularly reverses direction
- An example of a direct current is a flashlight and most battery-operated devices
- Alternating current is in your home and school
- Current is defined as the direction in which the positive charges would flow

| Current in Amps | Effect on A Person |
| --- | --- |
| 0.001 Amps | Can be felt |
| 0.005 Amps | Painful |
| 0.010 Amps | Involuntary muscle spasms |
| 0.015 Amps | Loss of muscle control |
| 0.070 Amps | If through heart, serious injury, likely fatal if it lasts more than 1 second |

# Voltage

- In order for a charge to flow in a conducting wire, the wire must be connected in a complete loop that includes a source of electrical energy
- A flashlight will not work if there is no battery

**Voltage:** the charge (electron) "pusher." Voltage *causes* current to flow/move.

Voltage sources:

Battery

Generator

Outlets

**Symbol for voltage** = V

**Unit for voltage** = Volts (V)

# Voltage

- The potential difference between two points is the work that has to be done to move a unit charge from one point to other. It is measured in volts.

$$V = \frac{W}{Q} \quad (Volts(V))$$

where $W$ is the work done (Joules) and Q is the charge.

$$W = V.Q\ (Joules)$$

**EX:** Find the potential difference between the two points in an electrical system if 60 Joules of energy are expended by charge of 20 C between these two points.

**Solution:**

$$V = \frac{W}{Q} = \frac{60}{20} = 3\ V$$

# Voltage Sources

- Three common voltage sources are batteries, solar cells and generators
- A battery is a device that converts chemical energy to electrical energy
- In a 9-volt battery the voltage drop is about 9 volts

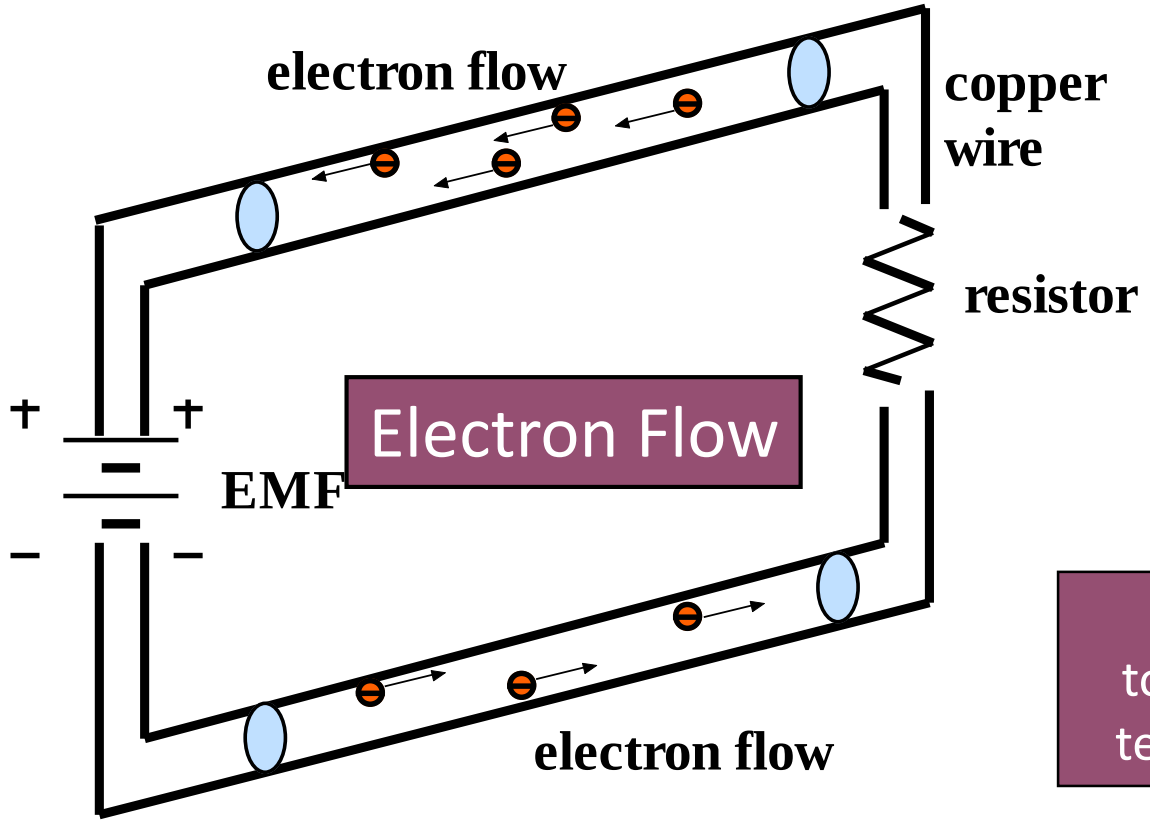
# Potential Difference

- Reminder potential energy is related to position
- Charges flow from a high to low potential energy
- Potential difference is the difference in electrical potential energy between two places in an electric field

# Basic Laws of Circuits

## Current

Under the influence of an electromotive force, the one valence electron of each copper atom is pulled from the outer orbit and moves through the copper space toward a positive potential.




electrons move toward the positive terminal of the EMF

# Basic Laws of Circuits

Ohm's Law: Current

Conventional current flow assumes positive charges move toward the negative side of the circuit EMF.