National University

Int. to Electrical Eng.

Introduction to Electricity

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Definition of Electricity:

- is the movement of charge, which is from positive to negative no matter how the charge is created, chemically (like in batteries) or physically (friction from socks and carpet).

1- Charge:

Symbol: (q) **Unit: Coulomb (C)**

The fundamental electric quantity is charge

- Atoms are composed of charge carrying particles: electrons and protons, and neutral particles, neutrons.
- The smallest amount of charge that exists is carried by an electron and a proton.
- Charge in an electron: qe = -1.602x10-19 C
- Charge in a proton: qp = 1.602x10-19 C

2- Current:

- **Symbol: I** •**Unit: Ampere**
- Current is rate of flow of negatively-charged electrons, through a predetermined area.
- There are two types of current, direct current (DC) and alternating current (AC). DC is current that flows in one direction with a constant voltage
- AC is current that changes direction periodically along with its voltage.

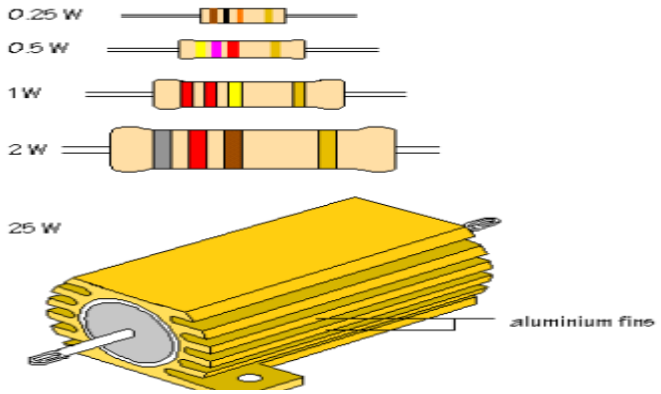
3- Voltage :

- **Symbol: V** •**Unit: Volt**

- voltage across two points (A and B) is the cost in energy required to move a unit of positive charge from A to B

4- Resistor:

- Flow of electric current through a conductor
- Expressed in ohms Ω (named after George ohm), kilo-ohms (k Ω[1000]), or mega-ohms (M Ω [10^6 Ω])
- Ω is a measure of how much a resistor resists the flow of electricity



Symbol for resistor

Uses of Resistors:

- Limiting current in electric circuits.
- Lowering voltage levels in electric circuits (using voltage divider).
- As a sensor (thermistor detects temperature condition)

5- Capacitor:

- is an energy storage element. It can store electrical pressure (voltage) for periods of time.
- When a capacitor has a difference in voltage, it is said to be charged.
- A capacitor is charged by having a one-way current flow through it for a period of time.
- It can be discharged by letting a current flow in the opposite direction out of the capacitor.

Capacitor Symbols:

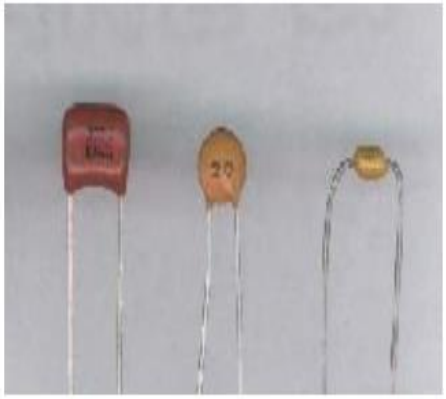
Fixed capacitor

Polarized capacitor

Variable capacitor

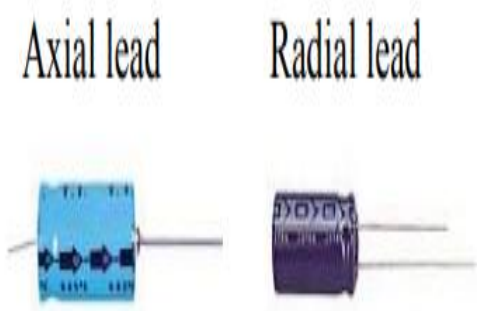
Capacitor Variations

Ceramic capacitors



small, inexpensive, but poor temperature stability and poor accuracy
often used for coupling applications

Electrolytic



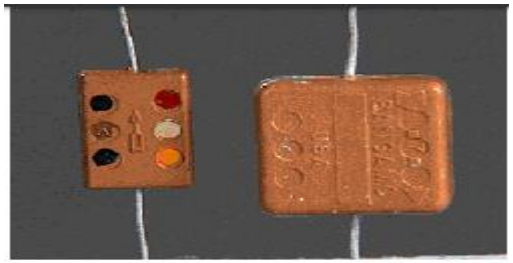
Made of Aluminum
Also has Bad temperature stability and short lives

Capacitor Variations

Mylar

Inexpensive
And has poor
temperature stability

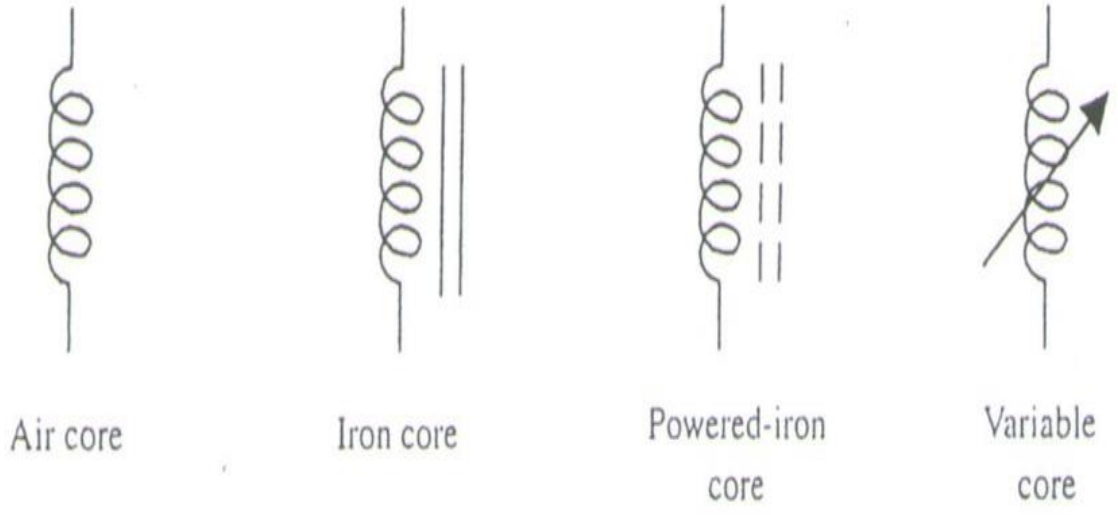
Mica



extremely accurate,
constructed with alternate layers of metal foil and mica insulation
often used in high-frequency circuits

6- Inductor:

- is a passive energy storage element that stores energy in the form of magnetic field.



Inductor Variations

Antenna coil

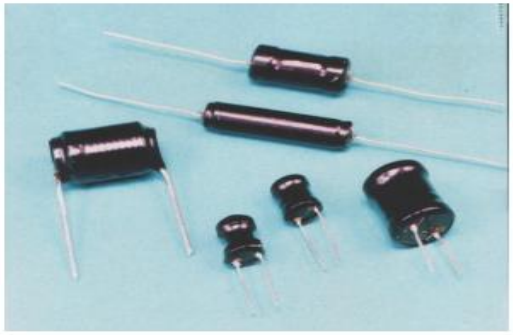
used to tune in ultrahigh-frequency signals

Tuning coil

used in radio receivers to select a desired frequency.

Inductor Variations

Chokes



general-purpose inductors that act to limit fluctuating current.

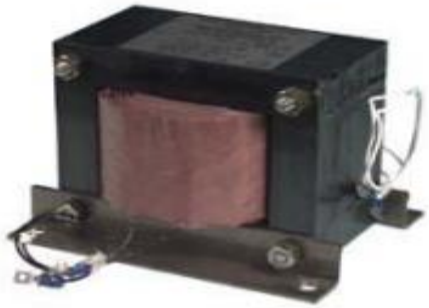
Toroidal coil

high quality can be operated at extremely high frequencies

7- Transformer:

- Isolation

acts as an isolation device; does not increase or decrease the secondary voltage



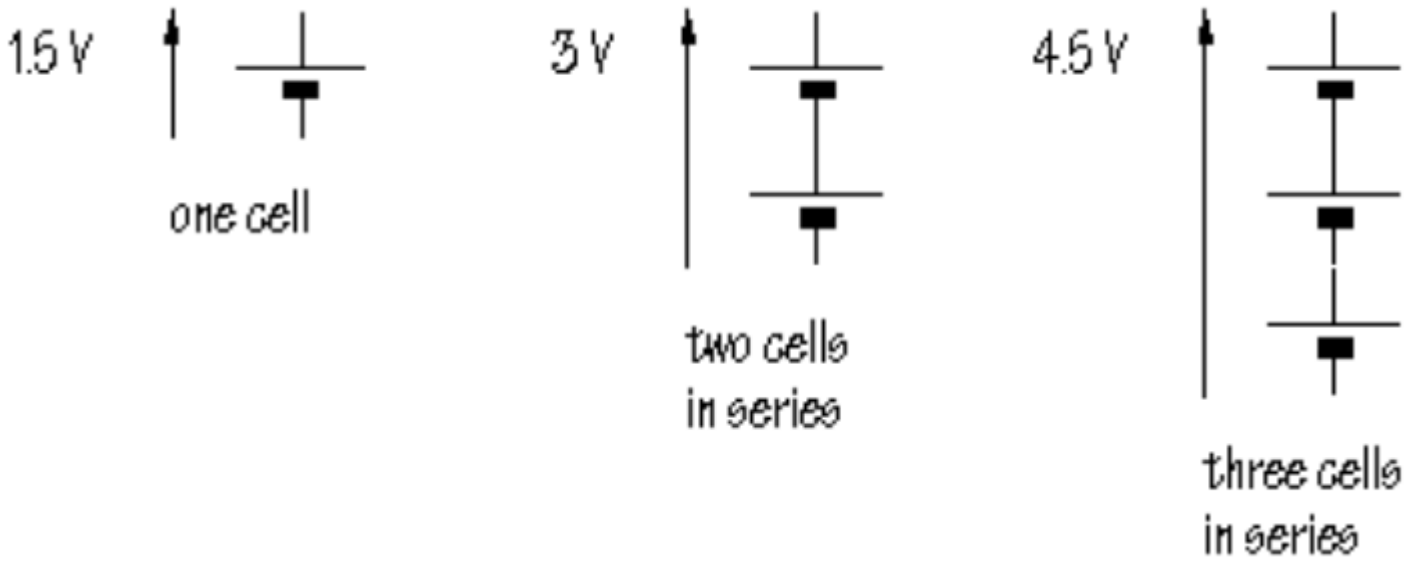
- High Frequency

used for high frequency applications, i.e. matching RF transmission lines to other devices (transmission line to antenna)

- **Audio**

- used to match impedances between audio devices
- work best at audio frequencies from 150Hz to 12kHz

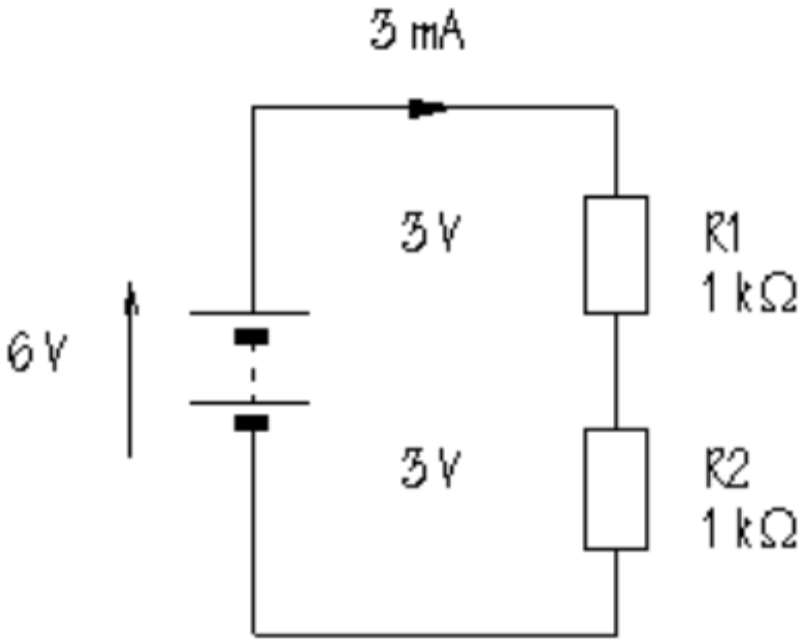
Series Connection of Cells



Connection which circuits are connected in-line with the power source.
The current in series circuits is constant throughout but the voltage may vary

Example:

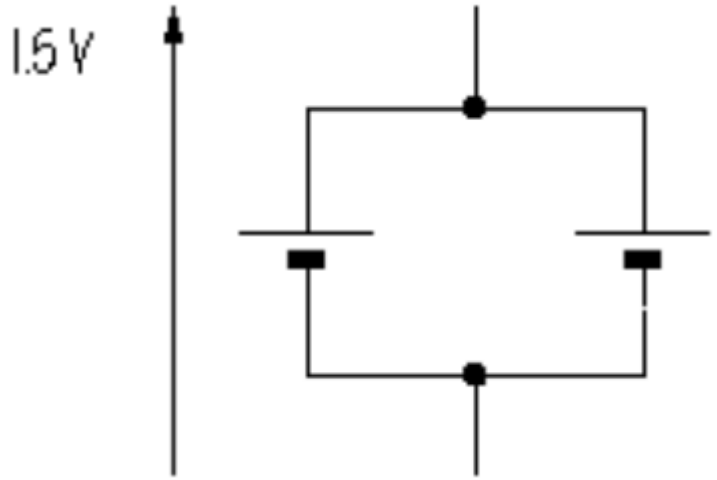
- Resistors in Series:



$$R_{total}=R_1+R_2$$

$$R_{total}=1+1=2k\Omega$$

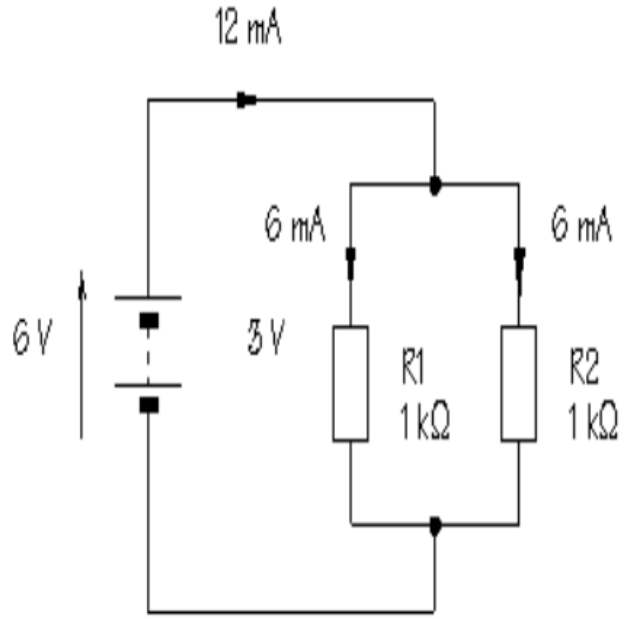
Parallel Connection of Cells



Connection which cells branch off from the power supply.
The total current supplied from the power source is divided among each of the branches but voltage is common throughout.

Example:

- Resistors in Parallel:



$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$R_{total} = \frac{1 \times 1}{1+1} = \frac{1}{2} = 0.5k\Omega$$

Metric Units and Conversions

Abbreviation	Means	Multiply unit by	Or
p	pico	.000000000001	10^{-12}
n	nano	.000000001	10^{-9}
μ	micro	.000001	10^{-6}
m	milli	.001	10^{-3}
.	Unit	1	10^{0}
k	kilo	1,000	10^{3}
M	mega	1,000,000	10^{6}
G	giga	1,000,000,000	10^{9}

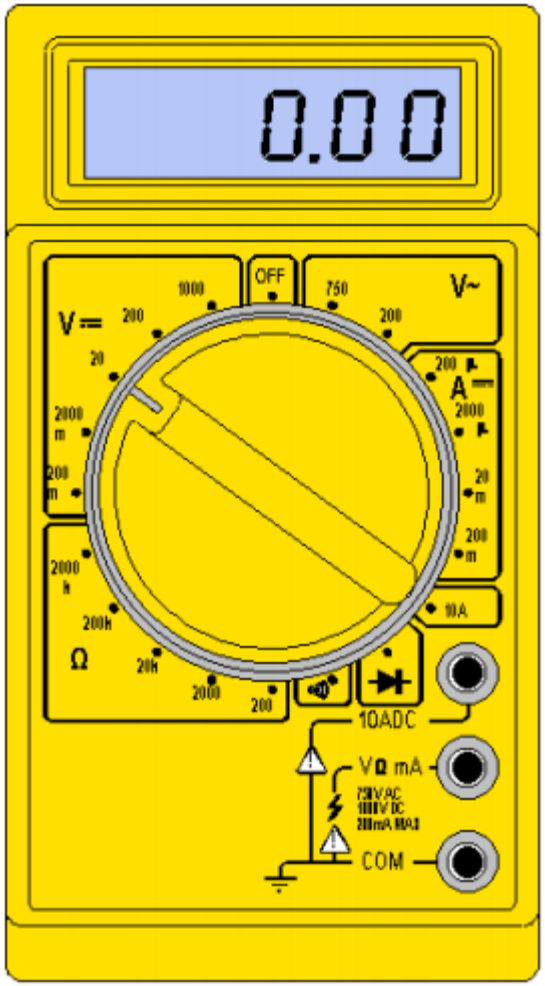
Digital Multimeter

DMM is a measuring instrument:

1- ammeter measures current, connected in series. All the current flowing in the circuit must pass through the ammeter

2- A voltmeter measures the potential (voltage) between two points, connected in parallel between two points of circuit

3- An ohmmeter measures resistance ,does not function with a circuit connected to a power supply



Classwork

- Find total resistant in figure below: