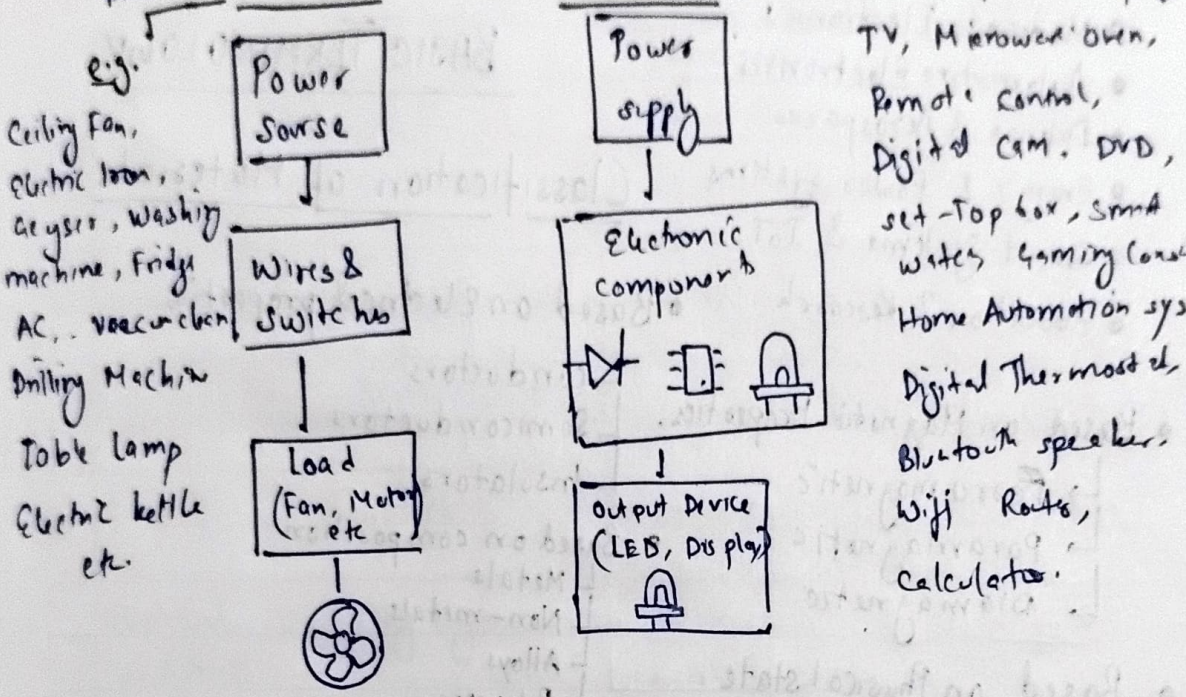
DAY 3 BRIDGE COURSE Dr. Vivek Upadyay

FUNDAMENTALS OF ELECTRICAL & ELECTRONICS ENGG

Difference b/w Electrical & Electronics



Feature	Electrical	Electronics
Definition	generation & transmission & distribution of electric power	control & processing of electrical signals
current Type	Mostly AC.	Mostly DC
Frequency	low freq (50/60 Hz)	high freq. (upto GHz range)
Power Level	High power (watts to mega watts)	Low power (milliwatts to watts)
Signal Type	Power signals	Information / control signals
Components	Generators, transformers, motors, switches.	Diodes, transistors, ICs, microcontrols
Applications	Power grids, home wiring, industrials motors.	Mobiles phones, computers, control system.
Control	Mechanical or electrochemical	Digital/analog signal processing
Example Devices	Ceiling fan, Pump, electric heater	Smartphone, LED TV, remote control

Application Areas of Electronics

- Consumer Electronics
- Communication System
- Computing & Info Technology
- Industrial Automation & Robotics
- Medical Electronics
- Automotive Electronics
- Defense & Aerospace
- Energy & Power systems
- Smart systems & IoT
- Education & Research

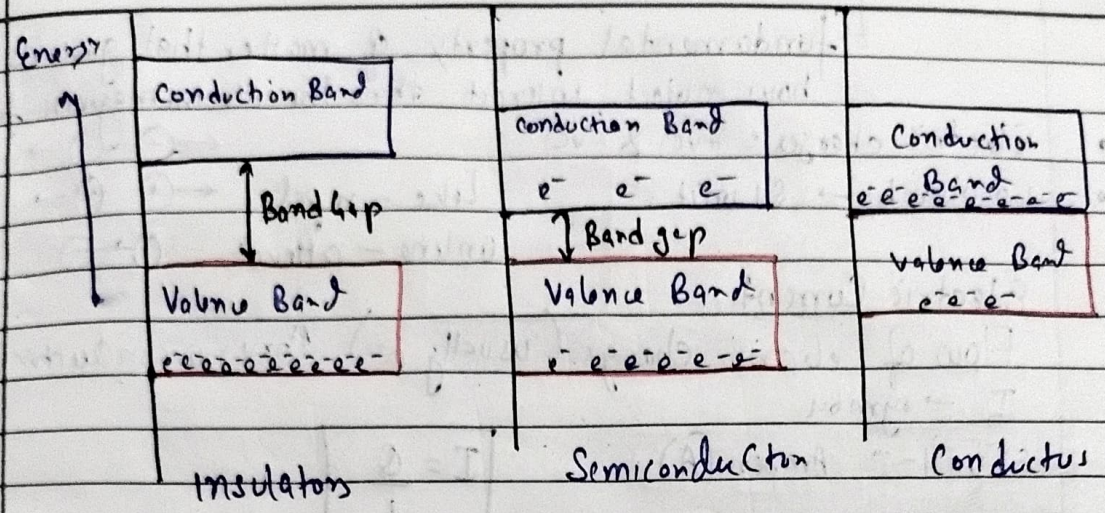
BASIC TERMINOLOGY

Classification of Materials

- Based on Magnetic Properties.
  - Ferromagnetic
  - Paramagnetic
  - Diamagnetic
- Based on Physical state
  - Crystaline
  - Amorphous
- Based on Mechanical Properties.
  - Ductile
  - Brittle
  - Malleable
  - Hard
  - Tough
- Based on Natural materials
  - synthetic
  - natural
- Based on electrical properties
  - conductors
  - Semiconductors
  - Insulators
- Based on composition
  - Metals
  - Non-metals
  - Alloys
  - Polymers
  - Ceramics
  - Composites
- Based on Physical state
  - solid
  - Liquid
  - Gases

Conductors, Semiconductors, and Insulators.

- Conductors: Materials that allow electric current to flow easily due to free electrons.
- Semiconductors: Materials with conductivity b/w conductors & insulators controllable by temperature or doping
- Insulators: Materials that resist the flow of electric current due to tightly bound electrons.



Conductos, Semiconduts & Insulators (Difference)

Property	Conductors	Semiconductor	Insulators
Electrical conductivity	very high.	Moderate (b/w conductors & Insulators)	very low
Band Gap	No or Negligible	Small band gap (~1 eV)	Large band gap (> 5 eV)
Examples	Cu, Ag, Al	Si, Germanium	Rubber, Glass, Plastic
Electrons Movement	Free electrons move easily	Electrons move under certain condition	Electrons are tightly bound.
Temp. Effect	Resistance inc. with temp	Conductivity inc. with temp	Almost no effect on conductivity
Use	Wires, cables, electrical parts	Diodes, transistors, IC's	Insulating coverings support materials

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* Electric Charge

└ fundamental property of matter that governs how objects interact thru the Electromagnetic force.

- Electric charges : +ve & -ve
- Coulomb → SI unit

Like - repel: ← ⊖ ⊖ → ← ⊕ ⊕ →

unlike - attract: ⊕ → ← ⊖

Electric Current

Flow of electric charge (usually e^-) thru a conductor

I → symbol

SI unit → Ampere (A)

$$I = \frac{Q}{t}$$

Types of Current :-

- DC : one direction (e.g. batteries)
- AC : charges dir^n periodically (e.g. household supply)

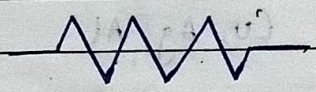
Example : A current of 1 ampere means 1 coulomb charge passes thru a pt. in 1 sec

→ Resistance / Resistor

└ opposition offered by a material to the flow of electric current

└ symbol = R

└ unit : ohm (Ω)



Factors affecting Resistance:

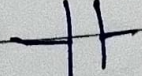
- Material
- Length ($R \propto L$)
- cross-sectional Area ($R \propto \frac{1}{A}$)
- Temp.

Capacitance (C) → store electric charge

Symbol : C

unit : farad (F)

Formula : $C = \frac{Q}{V}$



Here :

C = capacitance, Q = charge, V = Potential diff.

Used in filtering, energy storage, & tuning circuits

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INDUCTANCE (L)

Inductance is the property of a conductor, by which a change in current induces an electromotive force (EMF)

symbol : L

unit : Henry (H)

Formula : $V = L\left(\frac{dI}{dt}\right)$

used in transformers, motors & filters

Series & Parallel Comb^n of R, L, C

Resistance (R)

		Current	Voltage
Series	$R_{eq} = R_1 + R_2$	Same thru all Resistors	Divided
Parallel	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$	Divided	Same across all resistors

Capacitance (C)

		Voltage	Charge
series	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$	Divided	same on all capacitors
Parallel	$C_{eq} = C_1 + C_2 \ldots$	same across all Capacitors	Divided

Inductance (L)

		Current	Voltage
series	$L_{eq} = L_1 + L_2 + \cdots + L_n$	Same thru all inductors	Additive
parallel	$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \cdots + \frac{1}{L_n}$	Divided	Same across all inductors

Key Points

- Resistance adds in series, conductance adds in parallel
- Capacitance adds in parallel, inverse adds in series
- Inductance adds in series, inverse adds in parallel (like resistance)

Potential & Potential Difference

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Electric potential is amt. of electric potential energy per unit charge at a point.
Potential diff is the work done to move a unit charge b/w two points

Unit: Volt (V)

Formula:	Here:
$V = \frac{W}{Q}$	V = potential diff, Q = charge, W = Work don

Voltage: measure of electric potential diff b/w two points
symbol: V
unit: Volt (V)
It drives the electric current thro a circuit
sources: Batteries, generators, power supplies

POWER: Rate at which electrical energy is consumed or generated

symbol: P
unit: Watt

$P = VI$
$P = I^2R$
$P = \frac{V^2}{R}$

ENERGY: total work done by an electric current in a given time

symbol: E
unit: Joule (J)
or
Kilowatt-hour (kWh)

$E = P \times t$

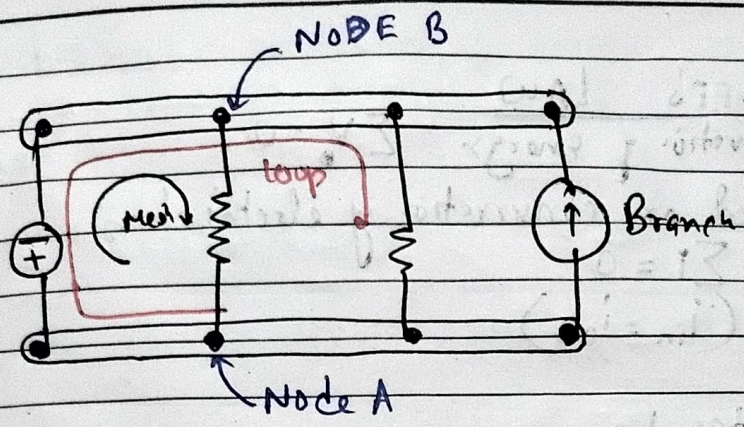
used in measuring electricity consumption in household and industries

Electric Circuit

→ A loop → close path; start-end → same node
  ↳ contain multiple meshes
  ↳ every mesh is a loop but not every loop is mesh

→ mesh → special type of loop → smallest possible loop → does not enclose any other loop
  ↳ Mesh Analysis (KVL)
  ↳ signify complex circuits into solvable eqn

→ Node → two or more circuit connection pt.
  ↳ Node voltage Analysis (KCL)
  ↳ junction point.



Classification of Circuits Components

Feature	Active Components	Passive Components
Power Requirement →	Need ext. power	No ext. power needed
Signal Amplification →	Yes	No
Energy Control →	Controls e⁻ flow	cant control the flow
Function →	Amplify, switch, generate	Store, resist, filter
Example →	Transistor, IC, Diode	Resistor, Capacitor, Inductor

Ohm's Law → Discovered in 1825
→ 3 quantities ka relation
→ Volt, Current, Result

$V = IR$

Volt = current × Resistance
volt = Ampere × Ohms

$$\frac{V}{R} = \frac{IR}{R} = I$$

$$\boxed{\frac{V}{R} = I}$$

- KCL
- KVL