Mass of proton - 1.67×10^{-27} kg.
— 11 — electron - 9.1×10^{-31} kg
— 11 — electron - $\frac{1}{1836}$ of proton

MAHESH KENDRE

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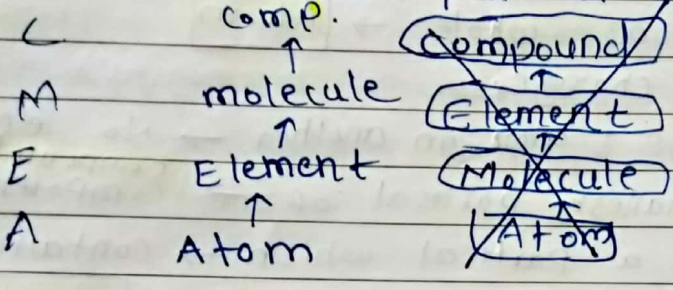
Date

ELECTRON THEORY (2-3)

Matter - Anything has mass & volume.

Compound :- Chemical combi^{n} of 2 or more element

Molecule :- Smallest partical of matter.



~~Trick~~ :- AMEC
↓
~~Aircraft Maintanance Engg. course~~

* Protons → +ve charge
* neutron has same mass as proton.
* Protons mass is 1.837 times greater than electron.
* No. of proton & neutron in necleus determine weight of atom.
* electron - -vely charged.
* Simple form of atom → H_2
* H_2 → No Neutron.
* Electron Capacity → $2n^2$

K	L	M	N
2	8	18	32

* Valence :- No. of atom present in outermost shell.
* Ionization :- Loose or gain electron.
* Large no. of free ele. → High current capacity.
* Conductor :- 1) Gold, copper, silver (contain free ele.)
  2) Less than 4 ele.
* Insulator :- 1) More than 4 ele.
  2) Do not conduct current.
  3) eg - Glass, ceramic, plastic.
  4) No Free ele.
* Mass of proton is 1.837 times greater the $e^{\ominus}$.
* Proton wt. ≃ 1.845 times as much as $e^{\ominus}$

Atomic No. → No. of protons

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Atomic Mass = Proton + Neutron

* Semiconductor :- 1) Equal to 4 ele.
  2) Si & Germanium (Most used)
* Nucleous → +ve charge.
* Neutron has no ele. charge but will add in weight
* Good insulator → strongly bonded electron.
* Smallest partical than can split and shows the same properties as whole → Atom
* Protons → +ve charge.
* Effect of ele of 1 atom on another → No effect.
* Molecule is smallest partical of → ~~Compound~~ ~~Element~~
* g) A neutron is a partical which → contained within the nucleus of most items
* Loose or gain electron → An ion.
* Deficiency of electron :- ~~High~~ Low Resistance.

2) STATIC ELECTRICITY (1-2)

* Electricity → Static (At Rest electron)
  → Dynamic (At Motion electron)

* Like charges Repel each other
* unlike attract each other.
* Electrons (-ve) & Protons (+ve) Attaract each other.
* Unit of charge → Coulomb.
* one Coulomb → Charged carried by 1 ampere in 1 sec.
* Ampere → Flow of 6.241×10^{18} electrons.
* Electrostatic field :- Field of force exist around a charged body.
* electrostatic field also called as dielectric field.
* Lines are used to represent dir^2 of intensity.
* Intensity of field → No. of lines per unit area.
* Direction → Arrowhead.

* ESD (Electro static discharge) :- Damage component or IC from human body.

(3) ELECTRICAL TERMINOLOGY (2-3)

* Conventional flow :- +ve to -ve.
* Electron flow :- -ve to +ve.
* EMF :- voltage across two points.
* EMF Symbol :- "$\mathcal{E}$" (~~Apsr~~ Epsilon)

Potential diff. (volts) $E = \frac{\mathcal{E} \text{ (In Joules)}}{Q \text{ (charge)}}$

* Current :- Electrons in motion make up ele. current.

Moving charges - copper, silver, al & gold.

$\text{current } (I) = \frac{\text{charge } (Q)}{\text{Time } (t)}$

* Unit of current => Ampere.

$1\ A = \frac{1 \text{ Columb}}{\text{sec}}$.

* When current flow in 1 dir^{n} → DC current.

* Resistance :- Two fundamental properties of current and voltage are related by a third property known as resistance.
  i) Resistance reduce current increase.

(4) GENARATION OF ELECTRICITY (1-2)

* Method of producing electricity :-
  i) Pressure
  ii) chemical
  iii) thermal
  iv) light.

* Pressure source (~~ph~~ Piezo or piez) :- (pressure to ele.)
This form of generation is commonly known as piezoelectric.
* Piezoelectric material → crystalline quartz & Rochelle Salt.
* Piezoelectric material are extensively use in
IMP → transducers for converting mechanical strain to ele. signal. eg- Microphones, phonograph

* Chemical Source :- eg - Battery (chemical to ele.)

* Thermal Source :- (Thermocouples) these are widly used as temp. sensors.
Thermocouples → pair of dissimilar metal.
* voltage bet² two wires that is prop. to temp. at the junⁿ is known as Seebeck effect.

* Light Source :- (light energy to ele. energy)
eg - Solar cell or photovoltaic cell.
* Photons are taken from sunlight
+ve charge creats Holes.

* Friction (Building up static charge)
*when non conducting material rubbed together.

Sub Mod. 5
DC Source of Electricity (2-3)

* Batteries :-
combiⁿ of cells.

Most common pri. cell → Zn - Carbon

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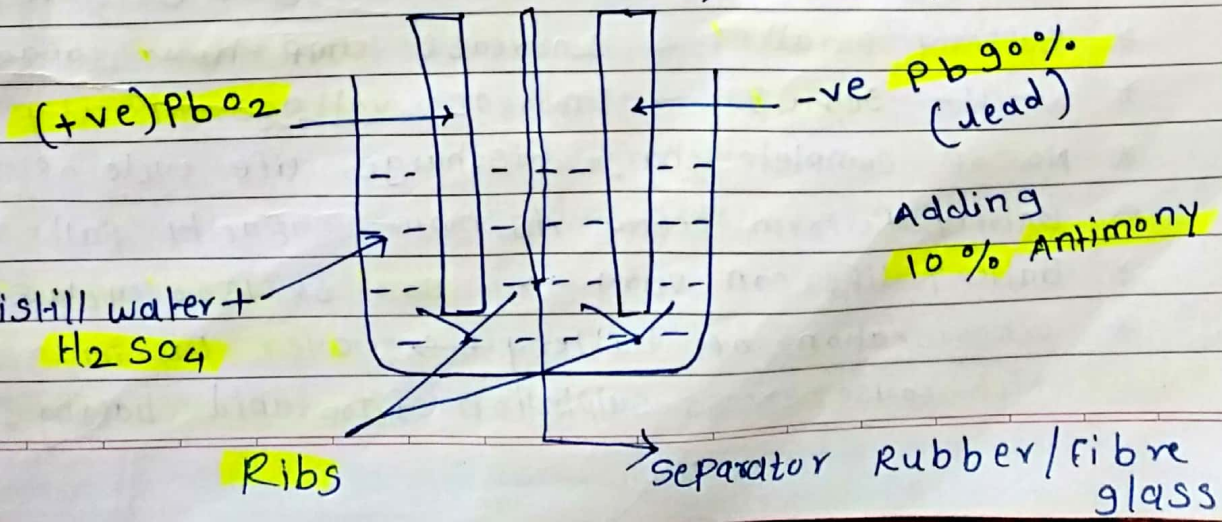
* Primary cell / dry cell → Not rechargible.
  secondary cell → Rechargible.
* Primary cell voltage → 1.5 V

Primary
- voltic cell
- Dry cell

* Dry cell :-
  - +ve is cathode (carbon Rod)
  - Electrolyte - MnO_2
  - -ve anode (zinc)
* In primary cell electrochemical rea^n take place during discharge & result in consumption of metal
* Graphite is mixed with MnO_2 to reduced internal resistance.

* Secondary cell :—
  - *Lead acid battery is sec. cell
  - *electrolyte → sulphuric acid (H_2SO_4) & distill H_2O
* +ve plate is lead peroxide (PbO_2)
* -ve —11— Pure spongy lead (Pb)
* Voltage per cell is 2V & required 12 cell OR 24V
* commonly used secondary cell :— i) Ni-Cd.
  - ii) NiMH (Nickel metal hydride)
  - iii) Li-ion (Lithium ion)
  - iv) Li-ion polymer



During inverted flight cells are coverded by → lead weight

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* **Lead acid batteries :-**

  After some days :→

  +ve colour → Chocklete Brown. PC

  -ve colour → Pearl Gray. NP

* +ve plate always placed bet 2 -ve plates.
* Seprator have vertical ribs on the side facing +ve plate.
* vent → escape to permits gas.
* Cells of batteries are connected in series. by cell straps.
* quick disconnect → removal & installation.
* open cct. vol. 2.1V & close cct. voltage (CCV) is 2.0 v when battery is fully charge.
* each plate consists of material +ve plate consist of 90 % leads & 10 % Antimony. (to Harden lead)
* -ve plate paste is called expender. (To prevent loss)
* +ve plate lead acid → deficiency of ele.
* -ve — 11 — → excess of ele.
* voltage determine by no. of cells connected in series.
* voltage of 1 lead of cell just remove from charge is 2.2V But normally it is 2V
* Battery rating → amp-hours → Battery capacity.
* When cells are connected in parallel vol. remain same & current is adding & vise versa.
* For airplane batteries 5 hrs has been discharge time in rating of battery capacity.
* Battery capacity depends → on total effective plate area.
* Battery parallel → Increase amp-hour capacity (current)
* — 11 — series → Increase voltage capacity
* No. of complete charge discharge life cycle of battery.
* Battery Perform before its normal capacity falls below 80%
* Battery life can vary → 500 to 1300 cycles.
* Deterioration of battery → over Discharging. which cause excess sulphation. & Too rapid charging & Discharging.

Le-acid battery frame made upof → grid

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* Shedding of active material → Due too rapid charging & Discha-
* State of charge of battery indicated by Density Checked by hydrometer (measure gravity).
* S.G of acid greater than H_2O.
* Condition for S.G :- 1.300 to 1.275 → Fully charged.
  1.275 to 1.240 → medium —11—.
  1.240 to 1.200 → Low —11—.
  1.200 to 1.100 → Discharge.
  (EMP)
* Range of Hydrometer :- 1.100 to 1.300.
* No correction necessary when temp. bet 70°F to 90°F
* when temp. greater than 90°F or less than 70°F necessary to apply correction.
* Batteries are charge either by constant vol. or constant current.
* Ribs → Avoid internal shorting.
* Seperator :- Made up of Fibre glass OR Rubber OR Glass wool
* In cold climate state of charge should be max.
* Battery Charging → constant vol. charger of 28v supply
* Charging precau → Removing battery From A/C remove -ve lead 1st & At install connect -ve lead at last
* Terminal coated with grease or jelly.

* **Nickle-cadmium Batteries :-**
* During charge +ve plate is NiooH (Nickle oxyhydride) & -ve cadmium. (EMP)
* During discharge condi +ve plate is NioH (Nickle hydride) & -ve plate is $(Cd(OH)_2)$ cadmium hydroxide.
* In Ni-Cd every cell is of 1.2 v
* Electrolyte :- Distilled Water H_2O → 70 %
  Potassium hydride KOH → 30 %
* H_2 Formed at -ve electrode
* O_2 —11— +ve —11—
* OCV of Ni-Cd battery is about 1.2v to 1.25 v
* A unit in which two disimilar metal create opp. charge is called → Cell.

Discharging cycle is Reversible → secondary.

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(8)

* ** water should be added when battery is fully charged.
* Ni-cd is interchangable with Lead-acid.
IMP { * Ni-cd → Neutralizing agent dilut boric acid sol^{n} &
* Lead acid → — 11 — :- Sodium bicarbonate.
* Morden a/c use Ni-cd battery.
* Internal resistance :- It always becomes greater when battery becomes discharge condi^{n}.
* Battery Internal resi. will not adversly affect a/c ele. system unHil beattery becomes 75 % discharge
* occasion of capacity test :-
  i) on recept new battery.
  ii) every 3 month interval.
  iii) capacity suspected to low.
  iv) IF battery capacity less than 80 % it is unfeet for a/c use.
* Insulator used in seprater → Woven Nylon.
* woven nylon coted by cellphone layer to avoid Flow of O_2 to cd. rod to avoid thermal runway
* Thermal Runway :- Boiling of electrolyte.
* outer covering made up of stailess steel of Ni-cd OR carbon steel cases, fiber glass.
* Stainless steel used plastic liner as internal insulater
* Epoxy → High dielectric property.
* More area of plate more capacity vise versa.
* Internal resi. of Nicd is very low (less than 1 mega Ω/cell)
* Battery insp^{n} → 50 hrs of flight or 1 month.
* Adding dishll water after two yrs
* ** Never add water in discharge condi^{n}.
* Reconditioning of battery :- perform at every 100 Hrs to 300 Hrs of Flight. necessory to prerent cell imbalancing

current (I) = charge x time || V = IR

If more than 2 battery charge in constant voltage method then they should put in Parallel.

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* To prevent cell imbalance battery discharge to zero capacity & again recharge this called as DEEP CYCLE
* leckage more than 50 mAm → excessive leak.
* constant current /voltage will req. charge of 120 to 140 % of 5 hrs rate.
* Constant current :- current constant voltage कम ज्यादा
* —11— voltage :- voltage —11— current कम ज्यादा
* cheaking during charging :-
  I^st Hour → voltage & current
  Last Hour :- Boiling of electrolyte.
* When charging done → electrolite level rise & Boiling.
* Trickle charge :- Ni-cd battery inwhich battery charged at very low current.

IMP
* Battery store in discharge condi^n. & in cold cond^n store in charge cond^n
* +ve & -ve ~~she~~ b should be shorted with clips.
* Battery MFR. Determine that temp. 110 °F to 115 °F (43 °C to 46 °C) cause deterioration.
* Battery load → Load is apply for 15 sec & test it.

IMP
* Primary cells are :- Dry cell, zinc carbon, zinc-chloride, Lithium Air Battery, Mercury battery. solid State battery.

IMP
* Secondary cells are :-
  Li-ion, Silver-cd, Ni-cd, Lead-acid, Al-ion, Potassium-ion, Ni-zn, silver-calcium.

* cells interconnected with → straps.

* Internal Resistance determined by :-

$$IR = \frac{(OCV - CCV)}{i \text{ load}}$$

P.D.

6) DC CIRCUITS (2-3)

E=IR* ohm's Law :- Relation bet^n vol., current & resistance

* Voltage drop calculated by ohm's law.
* Voltage Source in series :- Sum of all voltage connected in series.
* Polarity indicated by plus or minus. (Depend on dir^n)
* Kirchhoff's Voltage law :- Algebric sum of all voltages around a close path or loop is zero. OR sum of all voltage drop is equal to total source voltage.
* Parallel DC cct. :- Voltage across one path is equal to vol. across all of the other path
* Resistor in parallel :- $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_N}$ IMP
* Resistor in series :- $R_T = R_1 + R_2 + R_3 + \dots + R_N$.
* when resistors are in parallel, total resistance decrease.
* Kirchhoff's current Law :- Sum of currents into a junction is equal to sum of the currents flowing out of same junction. $I_T = I_1 + I_2 + I_3$
* Series-parallel DC circuits :- cct. which are combi^n of both, known as ---.
* ~~In pa~~

7) RESISTANCE / RESISTOR (2-3)

* Resistance :- opp. the flow of current.
* Greater the resistance, less the current.
* If voltage across a resistor is double, then current is double
* Conductor → Low Resistance.
* Insulator → High —11—
* Unit of Resistance → ohm Ω
* Factor affecting Resistance :-
  R ∝ Length (R ↑se when L ↑)

* In some conductor double in length the R also **double** then current flow becomes **Half**
* R is inversly prop. to cross section area. i.e IF cross section area **double** resistance becomes **halved**
* 1 columb = 6.28×10^{18} electron.
* Temp. Coe. (α) = $\frac{R_t - R_o}{R_o t}$.
* Temp. ↑se R ↑se. is called +ve temp. coe. & vise versa.
* Resistivity – ohm meters.

Material	Resistivity.
Silver	1.64×10^{-8}
Copper	1.72×10^{-2}
Nickel	7.80×10^{-8}
Iron	12.0×10^{-8}

* Resistance of material determined by :- material, length, area & temp.
* ~~Types of resistor~~.
* Superconductor → zero resistance.
* Conductance (G) is reciprocal of resistance. (℧) siemen
* Types of resistors :-
A) **Fixed resistor** :- i) opposing current. ii) Limiting the amount of current flow.
B) **carbon composition** :- i) Made up of mix. of carbon/graphite
* Types of Fixed resistor :- i) carbon Film ii) Metal oxide iii) Metal film. iv) Metal glaze.
* Resistive material :- Graphite for carbon film, Nichromium for metal film, metal & glass for metal glaze, insulating oxide for metal oxide resistor.
* Temp. ↑se R ↓se is called -ve temp. coe. happens in carbon & Thermistors

* Resistor Rating :-
  Actual resistance can be 20 % higher or lower.
  known as **tolerance.**

* Resistor Colour code :-

	Colour	Number	Tolerance
B	Black	0	–
B	Brown	1	1 %
R	Red	2	2 %
O	orange	3	3 %
Y	Yellow	4	4 %
of	Green	5	5 %
Great	Blue	6	6 %
Britian	Violet	7	7 %
very	Gray	8	8 %
Good	white	9	9 %
wife	Gold	–	5 %
&	Silver	–	10 %
Good	No colour	–	20 %
San			

BB ROY of Great Britian Very Good Wife

* First colour band → First digit.
* Second —11— → Resistance.
* Third —11— → No. of zeros **OR** Multiplier.
* Fourth —11— → Tolerance

eg – Red, Green, Red, Red

$\Rightarrow$ 2 5 10^2 2 %

$25 \times 10^2 \pm 2\%$

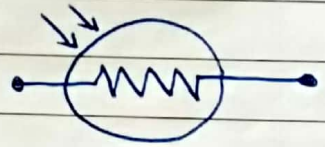
$\therefore 100x = 2500 \times 2$

$\boxed{x = 50}$

$\therefore R_{max} = 2500 + 50 = 2550$

$\therefore R_{min} = 2500 - 50 = 2450$

imp * Wire Wound :- controls large amount of current. constructed by winding a wire around rod.
* Resistor create heat.
* Resistor can block both AC & DC.
* Variable Resistors :- i) Resistive valve can be change easily. (Adjust by Rheostat & 2nd is Potentiometer)
* Rheostat → variable resistor used to vary amount of current flowing in cct. connected in series 2 terminal
* Potentiometer :- Three terminal device. used to vary voltage.
* Thermistors → Temp. sensitive. (Negative temp. Coe.) means Temp ↑ resistance ↓ ses.
* Photoconductive cells :-
  i) similar to thermistor.
  ii) -ve temp. coeficient.
  iii) Resistance controlled by light intensity.
  iv) Found in radio control.



* Wheastone Bridge :- i) constructed of three rsistor & voltmeter. ii) unknown valve is calculated by kirchoff's law.
iii) This used to measure capacitance, inductance & impedance.
iv) Formula → $R_2/R_1 = R_x/R_3$ (R_x → unknown resistance)

* Parallel Resistor :- $\frac{R_1 \times R_2}{R_1 + R_2}$

(8) POWER (2-3)

* Power :- Amount of energy used or converted in a given amount of time.

$$P = \frac{\mathcal{E}}{t}$$

P = Power in watts (W)
$\mathcal{E}$ = Energy in Joules (J)
t = Time in seconds (s)

* Unit of Power is Watt.
* watt, which refers to rate of energy conversion of 1 Joule/sec.

$$P = \frac{\text{energy}}{\text{Time}}$$

eg- energy = 300 J & Time 10 s

$$\therefore P = \frac{30\cancel{0}}{1\cancel{0}}$$

$$P = 30 \text{ watt}$$

$$P = \frac{\text{Work Done}}{\text{Time}}$$

* voltage expressed in terms of energy & charge

(P.D in volt) (voltage) $E = \frac{W}{q}$ (energy in Joules (J)) (charge measure in colombs)

* current = $\frac{\text{charge}}{\text{Time}}$ OR $I = \frac{Q}{t}$ ($\frac{\text{colomb}}{\text{sec.}}$)
* voltage into current = Power

* General Power Formula :-

$$P = I(E)$$

P → Power, I → current, E → volt (v)

eg- IF Cct has voltage of 24 volts & current of 2 amps then power in cct will be ?.

$$\Rightarrow P = I E$$

$$\therefore P = 2\,A \times (24\,v)$$

$$\therefore P = 48\,W$$

$E = V = \text{volt} = P.D$

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* Recall ohm's law. $E = IR$ OR $V = IR$ — (*)

$P = I(E)$ ... General formula.

$P = I(IR)$ ... [From (*)]

* 2nd form of Power. $\boxed{P = I^2R}$

eg- ckt. has current of 2A & a resistance of 100 Ω then power will be ?.

current दिला असल आणी पावर काढणे $P = I^2R$

$\Rightarrow P = I^2R$

$P = (2)^2 (100)$

$\boxed{P = 400\ W}$

* ohms Law $I = E/R$ OR $I = V/R$ — (**)

$P = I(E)$ ... General formula

$P = \frac{E}{R} \times E$ ... [From (*)(*)]

$\boxed{P = \frac{E^2}{R}}$

eg- IF Ckt. voltage 24 V & a resistance 20 Ω then the power will be ?.

voltage दिल असल पावर काढणे $P = E^2/R$.

$\Rightarrow P = \frac{E^2}{R}$

$P = \frac{(24)^2}{20} = \frac{576}{20} = \boxed{28.8\ W}$

* Power in Series And Parallel Circuit.

Total power in both series & parallel is equal to sum of power dissipiated in each resistor.

VIRal ?

$\therefore P_T = P_1 + P_2 + P_3 + \text{-----} + P_N$

Series parallel दोन्ही साठी same.

* ~~Eee~~ Energy → Ability to do work.

Power x Time = Energy.

Joules unit of energy. OR watt second. or KWh Kilowatt hrs.

* Frequency selective network is known as → Filter.

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Date

9) CAPACITANCE / CAPACITOR (2-3)

* Capasitor is represented by capacitor.
* 2 parallel plate's seprated by nonconductor called dielectric.
* In ele. cct capacitor serves as → reservoir, storehouse.
* RC time constant :- Time req. for capacitor to attain full charge is prop. to capacitance & resistance of cct.
* Rate of charging & dis-charging determined by time constant.

Time constant (τ) Tau = RC (Resistance / capacit.)

~~(RC)~~

* Resistance → Ω (ohm) * capacitance → Farad.
* seperating material → Dielectric.
* Current zero when capacitor is fully charged.
* when capacitor is fully charged voltage is equal to appliedvot.
* Time constant → Time to charge constant.

$$\tau = RC$$

* Capasitor :- Ability to store charges
* Capasitor Block → DC & pass pluse heating DC & AC
* 1 Farad → 1 columb of charge is store with 1 volt called one farad.

$$C_{(Farad)} = \frac{q\ (charge)}{e\ (voltage)}$$

1 Columb → 6.24×10^{18} electrons.

* microfarad → 10^{-6} * Picofarad → 10^{-12} farad.
* Voltage rating :- i) capacitor are designed 50% of its rated highest capacity.
  ii) Rating voltage / safe voltage also known as Break down voltage means safe to charge.
  iii) If vot. applied across plate is too grt., dielectric will break down & arcing occurs bet^{n} the plates.
* Capacitance decrease as thickness of dielectric increase.
* High Voltage → Thick dielectric → Large plate area.
* Low —11— → Thin —11— → small —11—

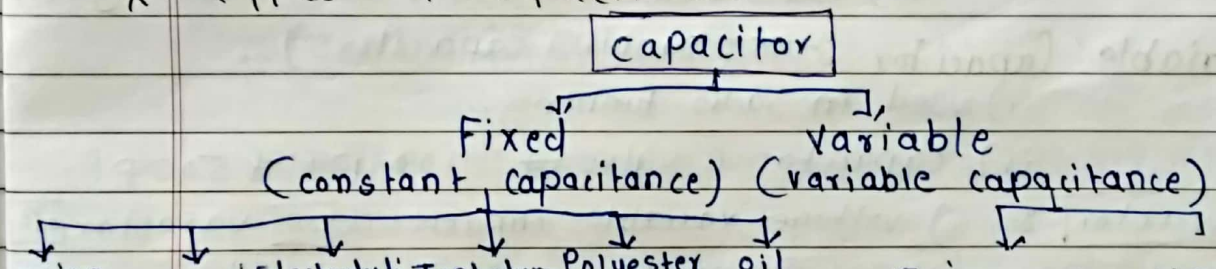
* Factor affecting capacitance :-
  i) capacitance $\propto$ plate area
  ii) capacitance $\propto \frac{1}{\text{spacing}}$ (inversly prop.)
  iii) Dielectric Material. (Air)

* Dielectric constant of vaccum is **1**

* other All material capacitance value compared with vaccum.

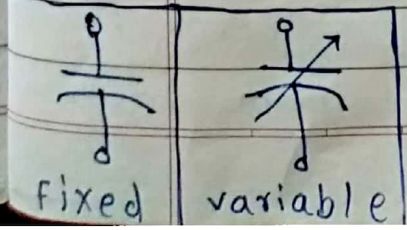
Dielectric	K	
Air	1.0	A
Glass	4.2	G
castor oil	4.7	C
Bakelite	6.0	B
Mica	6.0	M
Fiber	6.5	F

* Types of capacitors :-



* **Mica** :- i) Made up of metal foil.
  ii) Mica is an excellent dielectric & will withstand higher voltage.
  iii) common values of capacitor → 50 μμfarad to 0.02 μf.

* **Ceramic** :- i) Material → Titanium acid barium for dielectric
  ii) High Frequency applications.
  iii) shape like → disk ; small sizes.
  iv) ceramic & electrolytic are most widely available & used capacitor.



* **Electrolytic** :- i) wet electrolytic ii) Dry electrolytic.
iii) Provide large capacitance in small size.
iv) Range - 1 to 1500 μ farads.
v) Dry electrolyte → cylindrical
→ Rectangular

* **Tantalum** :- i) Material → tantalum
ii) Better temp. & freq. characterstics
iii) Cracks in this capacitor used to store charge.

* **Polyster film** :- i) inexpensive, temp stable & widely used.
ii) Tolerance → 5 - 10 %

* **oil capacitors** :- i) Used in Radio & Radar transmiter
ii) More Expensive.
iii) Restricted to radio & radar transmiting equip

* Variable Capacitor :- (Tunning capacitors)
i) Used in radio tunning.
ii) capacitance valve → 100 pf & 500 pf.

* **varactor** :- i) voltage variable capacitor **OR** varactor **OR** vericap. **OR** variable capacitance diode

* capacitors in parallel :-
Total capacitance → Sum of all capacitance.
$\therefore C_T = C_1 + C_2 + C_3 + \dots + C_n$

* capacitor in series :-
Total capacitance is less than that of **smaller capacitor**.

$$\therefore \frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots + \frac{1}{C_n}$$

* Time req. to charge capacitor is up to 63.2 % of its fully charged is called time constant.

* Capacitive Reactance $(X_C) = \frac{1}{2\pi FC}$

F = Freq. in capa.
C = capacity in farad.
$2\pi = 6.28$.

* Pure capacitive capacitance & current lead the voltage by **90°**
* Voltage rating is max. vot. it can gives.
* Removing time of capacitor → must be discharge.
* 1 coulomb is 10^{18} electrons.

10) Magnetism (3-4)

* Magnetism → Property of object to attract metallic subs.
* Non-Ferrous → Ni, Co, Gadolinium.
* Diamagnetic → Repelled by both poles of magnet.
* Natural mag. called as load stone / leading stone.
* Retained magnetism called as **Residual magnetism**
* Mag. store → Keeper bars.
* Mag. field lines are concentrated at end of mag.
* Like Poles → Repel each other.
* unlike poles → Attract each other.
* Mag. field of 2 mag. do not combine.
* Bar mag. cut in two pieces then it form two seprate mag.
* Permiability & Ability of material to get magnetised
  ii) material having high permiability get easily magnetised.
  iii) soft iron & ferrous have high permiability.
  iv) Air = 1 permiability
* Permeability $(\mu) = \frac{B}{H}$ (Flux density / mag. force

* who observed ~~bet~~ abel betele. ϕmag → orested
* More than 1 → High permiability
* Less —11— → Less —11—
* Ferromagnetic material can be magnetised below a certain temp.
* Bismuth → Diamagnetic Imp
* Heating, sudden shock, vibra^{n} can cause strength decrease
* Mag. Store in pair.
* Non-Ferrous metal with **permeability** greater than **one** such as Ni & Co are called **paramagnetic**.
* **Ferromagnetic** → Is applied to iron & its alloys which have **greatest** permiability.
* Substance such as **Bismuth** having permiability **less** than **1** are called **diamagnetic**.
* Reluctance :- The measure opposition to lines of Force.
* Magnetomotive Force measured in → gilberts.
* **Flux density** is denoted by B (vector)

S.I unit → Tesla
C.G.S —11— → Gause

Flux density (B) = $\frac{F}{Il}$ (F - Total Force, I - current, l - length)

* ~~Flux~~ **Mag. Flux** → Denoted by ϕ

S.I unit → weber (volt/sec)
C.G.S unit → Maxwell

* Flux intensity → **vector quantity**.
* Retentivity :- Ability of mag. to hold its magnetism
* **Soft iron** easily magnetised & loose magnetism easily when external force removed.
* Eddy currents induce their own mag. fields.
* The small amount of magnetism remaining called residual magnetism.
* Corrosivity :- reverse field needed to derived magnetism to zero after being saturated

* Unit of Conductance - Simen.
* Reciprocal of reluctance → Permiance
* Types of mag → Ring mag.
→ Gramme mag. {No poles}
* Most mag. don't lose their magnetism until temp. is elevated above 400°C
* Electromagnet →
The dir^{n} of induced voltage depend on dir^{n} of field & by left hand rule
* Polarity of electromagnet determined by left hand rule.
* Strength of ele. mag. increased by increasing flow of current or loops in the wire.
* Doubling current flow doubles the strength.
* The part of relay attracted by an electromagnet to close the contact point is called armature.
* Dimagnetic material :- Bismuth, Glass, Silver, Gold, Marbal, Anthmony, copper, zinc,

IMP * Magnetic Deepeel :- It is 0° at equator & max. at poles
* Mag. inclination least at equator
* —— 11 —— great at Pole
* Ferromagnetic mat. can be mag. → Below a certain temp.
* Mag. strength depend on → current passing, No. of turns.
g) To find ele. magnetic dir^{n} of lines of force
⟹ Right Hand claps rule.
* Earth mag. field greatest at ⟹ Pole
* Soft Iron → High Permiability.
* Force in 2 pole directly prop to field strength.
* Held magnetism → Residual magnetism.
* opp. of mag. lines of force → Relactance.
* Dir^{n} of current obtained by → Flemings Rs hand rule.
* Permanent mag. in Generator → Initial excitation.
* Pair which get easily magnetised → Soft iron - Stainless steel
* Remance & Residual mag. are same.

C-C
I-V

Page No.
Date

11) Inductor / Inductance (2-3)

1) Voltage → voltameter.

2) Faraday's law / Law of electromagnetic induc^{n} :-
The amount of induce vol. is directly prop. to the rate of change of the mag. field with respect to coil.

* Property to oppose any change in current through it is known as inductance.
* Induced vot. is always in opp. dir^{n} of current flow.
* Time Constant :- $\tau = \frac{L\ (\text{inductance})\ \text{Henry}}{R\ (\text{Resistance})\ \Omega}$
* Series RL cct. the current will ↑se to 63 % of its Full value in 1 time constant.

* Factor affecting inductance :- $\Rightarrow I \propto A$ and $I \propto \frac{1}{l}$
  i) No. of turns.
  ii) Cross-section Area (directly)
  iii) Material.
  iv) length of coil.

$L = \frac{N^2 \mu A}{l}$

* Doubling no. of turns in coil produce field **twice** as strong if same current used.

IMP * Doubling length of coil, while keeping same no. of turns **halves** the inductance.

* 1 milihenry is equal to 1000 of Henry
* Self induction is given by Len's Law.
* Self induc^{n} → Generat^{n} of voltage in an electric cct.
* opposition to change in current → inductance.
* Mutual induction :- one cct. produce EMF in other cct.
* Inductor range From → Nano-Henries to tens of Henries.
* No. of winding & core material determine capacity of inductor
* Types of inductor :-
  classified on basis of i) No. of turns
  ii) Core Material

* Core Material :- Air, Solid Ferrite, Powdered Ferrite, steel, toriod & Ferrite toroid.

* Core made up of dielectric material → Ceramic, wood, Paper.
* Unit of inductance → **Henry.**
* 1 Henry → current changes of 1 Ampere per sec induce voltage of 1 volt. into cct.
* milihenry & microhenry → Mostly used.
* Inductor in series :-
  Total inductance → Sum of individual inductor.
  $L_T \rightarrow L_1 + L_2 + L_3 + \dots + L_N$.
* Inductor in parallel :-
  Total inductance is less than smallest inductance
  $L_T = 1/L_1 + 1/L_2 + 1/L_3 + \dots + 1/L_n$.

* Higher stored energy → Ferrite substance.
* Inductive reactance ∝ Inductance. ∝ Applied Frequency.
  Inductive reactance (X_L) = $2\pi F L$ ← inductance
* Current = $\frac{\text{voltage}}{\text{Reactance}}$ or $I = \frac{E}{X_L}$
* The opposition offered by a coil to the flow of AC current is called (inductive reactance.)
* Small store degree → Material made up of ceramic, paper
* Property of coil to induce EMF that tends to oppose any change in cct. **Self inductance**
* Purely inductive → Current Lag 90°
* Circuit in which power is dissipated → Inductive.

(13) AC Theory (2-3)

* AC voltage can be ↑se or ↓se by means of Transformer.
* Galvanometer → Current flow..
* When conductor moved through mag. field an EMF is induced in the conductor.
* The general left hand rule is used to determine dire^{n} of induced EMF.
* Induced EMF depends ~~upon~~ on 3 factor :-
  i) No. of wires moving through mag. field.
  ii) Strength of mag. field.
  iii) Speed of rotation.
* Cycle → A cycle is repetition of pattern.
* Frequency → No. of cycle of alternating current per sec. unit of Freq. is Hertz (Hz)
* Period → Time req. For a sine wave to complte one full cycle.
* Wavelength → Distance that waveform travel during a period.
* Inphase → voltage signal & current signal superimposed on the same time axis.
* out of phase :- voltage & current signal at diff. time.
* values of Alternating current :-
  1) Instantaneous value
  2) Peak value (V_p)
  3) Effective (Root mean square) value. (V_{rms})

1) Instantaneous → Induced vol. or current flowing at any instant during cycle.
2) Peak → Largest instantaneous valve.

Peak value (V_p) = 1.414 × V_{rms} (RMS value)

effective or RMS value = 0.707 × V_p (Peak vale.)

Form Factor = $\frac{RMS}{Average}$

Average = 0.63

* Effective Value / RMS value :-
  RMS value is less than max. value.

$$V_{rms} = 0.707 \times V_p$$

* Triangular square wave → These are created by oscillators.
* A conductor move parallel to lines of force the voltage is zero.

14 Resistive (R), Capacitive (C) & Inductive (L) circuit (2-3)

* The combined effect of R, C, L reactance make total opposition to current flow. The total opposition is called as **impedance** (Z) → unit → Ω
* Value of impedance is same as resistance.
* In AC cct. opposition consist of resistance & reactance either inductive or capacitive or elements of both.
* Resistance & Reactance → Acting right angle to each other.

$$\text{Impidance } (Z) = \sqrt{R^2 + X_L^2}$$

R → Resistance; X_L → inductive Reactance.

In some case capacitive Reactance (X_C) also their ↑

* Resonance :- Both inductive reactance (X_L) & capacitive reactance (X_C) are functions of an alternating current Frequency.
* Resonant Frequency → Reactive effect of capacitor & inductor will be equal. (F_n)

Resonant Frequency

$$F_n = \frac{1}{2\pi\sqrt{LC}}$$

* True power :- The power actually used in the cct.
* Voltameter → effective Voltage
* Ammeter → —11— current

* Product of effective voltage & effective current called apparent power.

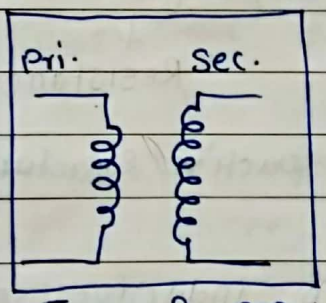
* True power (watt) KW
* Apperent power (volt Ampere) KVA

* Ac cct made up of pure resistance → TP equal to AP

* Power Factor = $\frac{\text{True Power}}{\text{Apperent Power}}$ } %

15) Transformers (3-4)

* Transfor consist of two coils.
* Transformer :- It is electrical device which ↑se or ↓se Voltage in cct.
*



Transformer

* ∴ Transformer consist of 3 basic parts.
  1) Iron core - Provide cct. low reluctance.
  2) Pri. winding - Electrical energy receive.
  3) sec. —11— → receive ele. energy from pri winding

* Working Principle :- Faraday's law of EMI but in Form of mutual induction
  * Pri. winding → i) connected to source /supply.
    ii) Mag. Flux generated

* Sec. winding :- Connected to sec. ckt. / connected to load.
  ii) Generate the power.
* Iron Core :- Winding wound on it.

* Transformer only used in AC
* Voltage Transformer are of 2 type.
  i) step up.
  ii) step down.
  } Depend on the "TURN RATIO."
* step up :- No. of turns in primary are less & secondary are high.
* Step down :- No. of turns in primary are high & secondary are less.
* Transformer is 100 % efficient means → input = output. such transformer are called as ideal transformer.
* Ratio :- IF N_1 is no. turns in primary winding.
  N_2 is — " — secondary winding.
  E_1 is voltage induced in primary winding.
  E_2 — " — " — secondary — " —

$$\therefore \text{Transformer Ratio} = \frac{E_2}{E_1} = \frac{N_2}{N_1}$$

eg- IF pri. has 200 turns & sec. has 1000 turs the voltage available at sec. terminal will be ---- times of primary voltage

→ 5 times.

$$\text{Sec} \rightarrow \frac{1000}{200} = \frac{N_2}{N_1}$$

$$\text{pri} \rightarrow \frac{5}{1} \quad \therefore \boxed{1:5}$$

* Each sec. winding has midpoint conn^{n} called as "center tap".

* one of important feture of a transformer a primary winding can be lef connected to the power supply even when the load is disconnected From the secondary winding.

* When load is disconnected from secondary again primary current is reduce to a small excitation current sufficient only to magnetis the core.

* Types of transformer as per Construction :-
  i) Core type
  ii) Cell type.

* The Voltage & current relation in primary winding the voltage in primary winding is 90° out-off current.

* Because of inductive reactance of primary & sec. coil or winding the induce voltage in secondary winding is nearly 180° out of phase with primary volt.

* In theory sec. emf will be exactly 180° out of phase with emf in primary. since there is no cct. free of resistance, two voltage cannot be out of phase 180° But some what less than 180° depending upon resistance.

IMP * Normal condi^n secondary induced voltage is **nearly 180°** out of phase than pri. voltage.

IMP * In theoriotical if their is no resistance in cct. the sec. winding voltage induce is **exactly 180°** out of phase than primary voltage.

* The emf in sec. coil will depend on the no. of lines cut per second.

* The ratio of no. of turns in pri. to sec. determine the step-up OR step-down transformer.

* Power output of transformer cannot greater than input.

Imp * IF transformer connected in **series** **voltage** are **additive**
IF connected in **parallel** **current** are **additive**

* Transformer are rated VA , KVA.

* Losses in Transformer :-
1) Copper loss :- i) Due to resistance of pri. winding & sec. winding.
ii) some time due to imperfect coupling.
2) Iron loss of two type.
A) Hystrisys loss.
B) Eddy current loss.

* Hystrisys loss two dir^n loss → Minimise by **silicon steel**
* Eddy current loss reduced by core made From laminated coated with **insulation**.

* Hystrisys loss & Eddey current loss are called Iron loss / core loss.

* Smaller transformer used in **radio receiver** & larger transformer used in step down the voltage 110 v to 120 v For the houses.

* Voltage Transformer :- Primary winding connected **Parallel** with cct.

* Current Transformer :- Primary winding Connected **series** with cct.

* More No. of turn in primary → step-~~up~~ Down.
* less No. of turn in primary → step-up.

* Transformer connected always with **Jumper**
* current transformer **inversly prop.** to turn ratio.

* ~~Audio~~ Audio Transformer → operated over range 20 to 20,000 frequency
* RF transformer → i) used in radio equipment.
  ii) symbol like RF chock coil.

* Current transformer is like **ring transformer.**

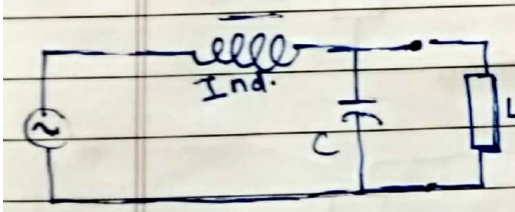
* ~~Ty~~ Diff. Types of transformer :-
  i) power -11-
  ii) Auto -11-
  iii) Audio -11- (20 to 20,000 Freq.)
  iv) RF -11- (Radio equipment)

16 - Filters. (1-3)

* Inductor :- Block high Frequency conduct High low Freq.
  Pass DC Block AC. (Electro static Field)
* capacitor :- Store the charges.
  pass AC Block DC
* Filter :- Combi^{n} of capacitor & inductor.
* Fiter :- Remove unwanted signals.
* Impedance :- oppose to flow of current.
* Filters classified as active & passive filters
* Active filter are more sensitive of temp & environment.
* Req. DC power for active is disadvantage of Active filter.

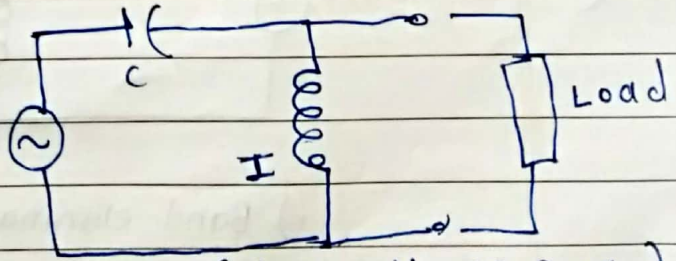
* Commonly Use filters :-
  i) Low - Pass filter
  ii) High - Pass -11-
  iii) Band - Pass -11-
  iv) Band - Stop -11-
  } known as passive ~~Active~~ filters.

* Low - Pass filter :- i) Passes low Frequency attenuates (reduces) High Frequency.



ii) Inductor → series & capacitor → Parallel with load.
iii) Block unwanted signals.

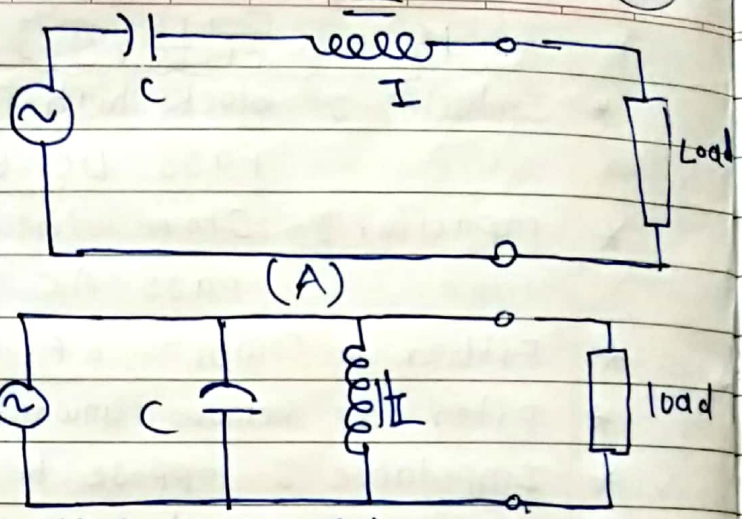
* High Pass filter :-



L H
S P
P S

i) Passes high Frequency. (low cutt off Freq.)
ii) Inductor → Parallel & capacitor → Series with load.

* Band-Pass Filter :-



i) Combination of High-pass & low-pass filter.

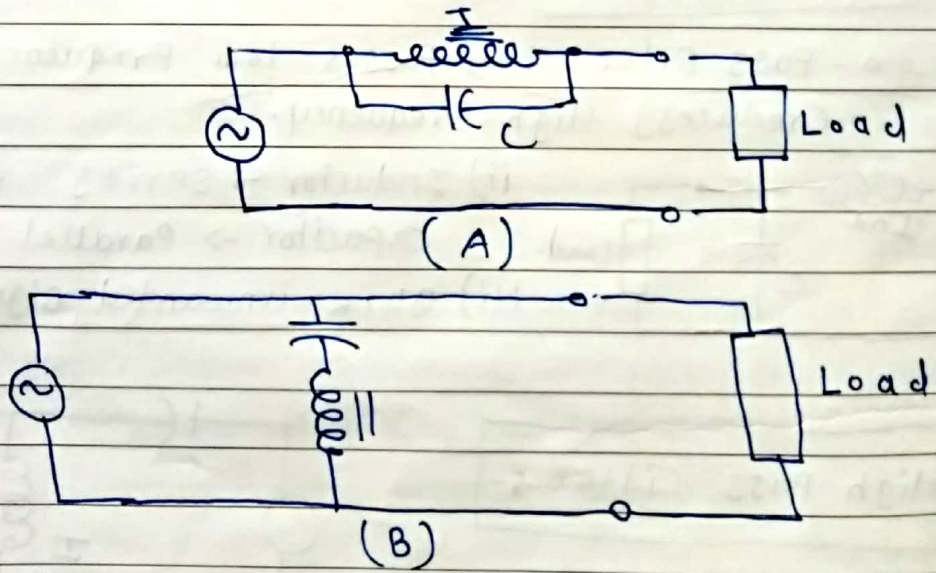
ii) It has two stop bands.

iii) Designed to perform High & low into single filter.

iv) Inductor & capacitor are series & Parallel with load.

v) radio & Tv broad casting used.

* Band-Stop Filter. :-



i) Band-elimination, Band rejection, Band-limit, T-nautch filter.

ii) The characteristics is exactly opp. to band-pass filter.

iii) It is used in live sound production & instrument amplifire.

iv) Use in PA system (Public Address)

v) Inductor & capacitor are parallel & then series with load.

* Active Filter :- Amplifire, Diode, Transistor, Rectifire. (Depend on external source / Power)

* Passive Filter :- capacitor, Resistor, inductor. (Not depend on external source / Power)

* Cutt-off Frequency - Signal block & directly passes.

* Rectifire → convert AC into DC.

* Impedance :- (oppose flow of current).

Rc cct :- $Z = \sqrt{R^2 + X_C^2}$ (X_C: capacitive reactance)

RL cct. :- $Z = \sqrt{R^2 + X_L^2}$ (X_L: Inductive reactance)

RLC cct. :- $Z = \sqrt{R^2 + (X_L - X_C)^2}$ (R: Resistance.)

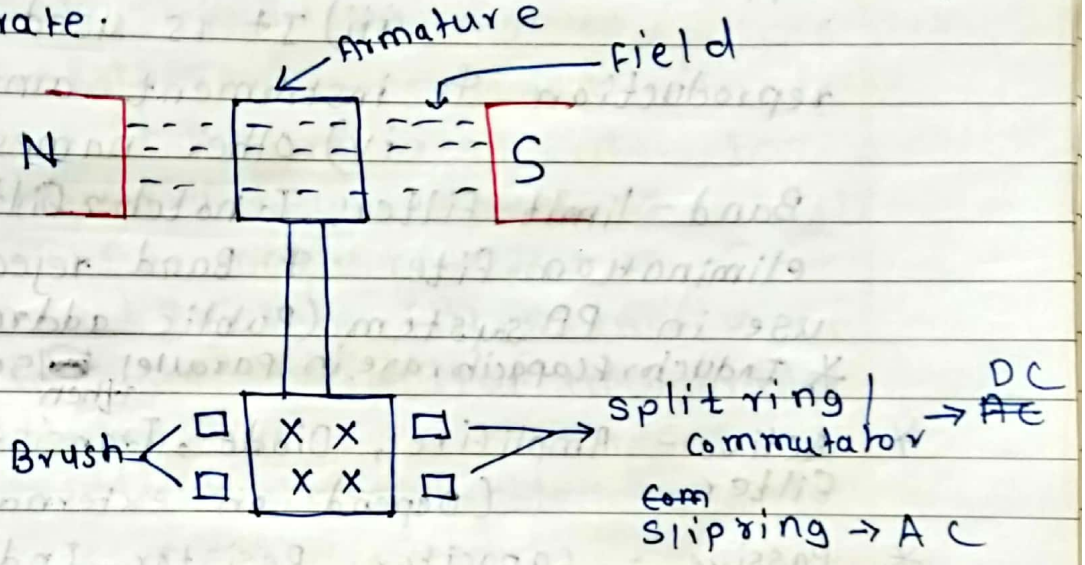
DC GENERATOR (5-6)

Page No. | Date | (34)

* Generator :- Mechanical energy convert into ele. energy. Electricity in generator produce by ele. mag. indu^{n}.

* when lines of mag. force cuts the vol' is induced.

* In generator when mag. are more then electricity is generate.



* Left Hand rule :- Thumb - Motion of conductor
Fore finger - Mag. field
Middle -11- - Induced current.

Commutator :- AC convert into DC

Slip ring :- AC to AC current.

* Value of induced EMF depend on :- output depend on :-
1) No. of wire moving through mag. field.
2) strength of mag. field. (Practical strength)
3) speed of rotation.
4) No. of winding in armature.

* Commutation Sometime called as rectification.

* For DC — Generator is measure in KW / KV

* For AC — — 11 — 11 — — KVA

Poles are laminated → to reduced Eddy Current loss

Winding type → Wave
Winding type → Lap.

* System of changing Ac to DC is called Commutation.
* Brush are made up of Carbon / Graphite.
  EMF = Current + voltage.
* Mag. Poles in field are in even no. (2, 4, 6 ---)
* change in dir^{n} of mag. line called distortion.
* Parts of DC Generator :-
  1) Yoke / Frame (outer covering)
  2) Mag. field.
  3) Conductor (Armature)
  4) Brush
  5) Slip ring / commutator.
  6) Bearing & shaft.

* Yoke :- i) Mechanical Support.
  Poles are usually to reduce eddy current losses.

* DC generator used electromagnet instead of permanent.
* When pole pices are made up to project they are called salient pole.
* Core of armature acts as iron conductor in mag. field.

Armature → Drum type (Mostly used)
Armature → Gramme-Ring (use to give less Vol. because Full winding Not in work)

* Drum type :- Mag. Flux & Vol. induce is greater.
  Drum type have lap & wave winding Method.

EMF - Force
MMF - Work done

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* Drum type have Lap & Wave winding.

Lap winding :- i) use for generate high current. (Additive)
ii) connected in parallel & req. several brushes. (as per pole)

VIMP

Wave winding :- i) Use for generate high voltage (Additive)
ii) connected in series & Always 2 brushes.
iii) Dummy coil are used.

* Energy conversation take place in Armature.

* Simplex Winding :- No. of parallel path is similar to no. of pole winding.

* Duplex Winding :- No. of parallel path be⁻ pole is twice the no. of pole.
ii) use in heavy current Appli⁻.

Brushes Placed here.

* Neutral plane :- zero EMF is induce is Neutral plane
* Sparking is indi⁻ of improper brush placement. which is main cause of Commutation.
* In neutral plane armature winding moving parallel to mag. flux. (zero EMF)

* GNA - Geometric Nutral axis (cuts in 2 equal part)
* MNA - Magnetic — 11 — (⊥ar to mag. lines of force).
* MNA is shift in dir⁻ of rotation.

9) The commutator segments one insulated From each other with Mica

DGCA

* Brush Shape → Rectangular.
* Arm. Rea⁻ :- MMF to opposing direction/Rota⁻

* Practical Method of constant output → Field Strength

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Date

* Equilizer ring present in Lap winding.
* Cross magnetisation :- Distort the generator field & shift the neutral plane.

* Brushes of generator set in neutral plane.

* Compensating winding or interpoles may be used to counteract some effect of field distortion.

* Compensating winding is in series with interpole.

* Winding of interpole are series with load.
* Sparkless commutation is obtained by work of interpole & compensating winding.

* Due to Armature :- (sparking)
  i) Fault in Armature Winding.
  ii) Short Ckt. in Armature coil.

* Due to Commutator :- (sparking)
  i) Weak mica bet^n segment of commutator.
  ii) oil & dirt on commutator.

* DC ripple cause HUM (Disturbance) in radio opera.

To reduce ripple :- (It is reduce by ripple filter)
connect :-
capacitor :- Parallel
chock Coil / Inductance :- Series.

* Generator fails to give output due to.
→ Residual mag. & it is corrected by Flashing the field.

* Arm. Rea cause :-
i) Pitting
ii) output reduce.
iii) Life reduce

* Types of DC Generator :- They are depend on armature winding & field.

① Series Wound DC Generator.
② Shunt / Parallel wond — " —
③ Compound — " —

* Series wound :- i) Field winding is connected in series with load or external ckt.
ii) Field coils composed of Few turns of thick wire
iii) Poor voltage regulation.
iv) These generator are not suitable for a/c use.
Output Voltage is control by RHEOSTAT. connected in parallel with field winding.

* shunt / Parallel Wound :- i) Field winding is connected parallel with load or external ckt.
ii) Field coil composed of MANY TURNS OFF THIN WIRE, v) It will start OFF load.
iii) RHEOSTAT connected in series with field winding.
iv) Normally use in A/C

* Compound Wound DC Generators :-

i) combi^{n} of series & shunt winding.
ii) Field coil connected in series with armature ckt.
iii) Terminal voltage of generator ↑se or ↓se ~~by~~ with load

* Flat Compound generator :- In which No load & Full load voltage have same value.
* opp. Polarity is induced by Lenz Law.
* EMF induced by → i) Moving coil across mag. field

* When Coil is parallel → No cutting of line → 0 EMF (39)
* Under Compound generator :- Full load voltage less than no. load ~~voltage~~ Voltage
* over compound generator :- Full load voltage higher than no load value.
* Compound generator are used where voltage regulation is important.
* long shunt :- shunt field is connected across Both armature & series field.
* short shunt :- shunt field is connected across the armature alone.
* Pigtail :- It will never permit to alter or restric Free motion of brush.
  ii) Also eliminate to sparking.
  iii) Conduct current.

IMP

* Fild Strength double Speed double then output quadraple.
* Speed half & Field strength double then output No change (Same).
* A/C Generator cooled by Ram Air
* No. of line per unit area → field strength
* Current Direction :-
  Dirn of mag. Flux
  Dir in which conductor move.
* Growler tester - Determine shorted armature.
* Doubing the running time double the jouls.
* Ripple Fielter →

AC
~~DC~~ MOTOR

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Date

* Ac motor are less expensive than DC motor.
* In Ac motor do not use brush & commutators so Sparking at brushes is avoided.
* Suitable For constant speed. & variable speed.
* Speed of AC motor depends upon no. of poles & Frequency of elc. source of power. IMP.

$$rpm = \frac{120 \times \text{Frequency}}{\text{No. of poles}}$$

* AC electrical system operates at → 400-cycle
* It operate at 7 time the speed of cycle commercial motor with the same no. of poles.
* 400 cycle induction type motor operates at speed rating From 6,000 rpm to 24,000 rpm.
* Ac motors rated in :- i) HP output ii) operating Vot. iii) Full load current iv) Speed. v) No. of phase vi) Frequency.
* Types of AC motors :-

Induction — synchronous

↓

* Three phase induction motor :-
  i) It is also called as squirrel cage motor.
  ii) Both single & 3 phase motors operate on principle of rotating magnetic field.
* The operating principle depend on :- - revolving or - rotating, - Mag. field to produce torque.
* End Frame :- It does not req. special starting device or excitation from a auxilary source.
  2) It can handle wide range of load.

* Advantage of AC :-
1) Several Rating.
2) constant output.

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* Rotating Mag. field :-
i) A single revolution → one cycle.
ii) e if exciting voltage have a Frequency of cps, the mag. field makes 60 rotations per second, or 3,600 rpm. This speed is known as synchronous speed of rotating field.

* Construction of Induction motor :-
stationary portion → Stator
Rotating —11— → Rotor.

Non synchronous → speed slightly less than synchronous speed.

No. of pole → $P = \frac{120 \times F}{N}$ ← Frequency
N ← speed in rpm.

eg- A 60 cycle three phase motor with a rated speed of 1750 rpm.

→ $P = \frac{120 \times 60}{1750} = \frac{7,200}{1750} = \boxed{4.1}$ pole.

IMP

* Rotor of induc^n motor consist of iron core - in which heavy copper or alumi. bar are present

* Induction Motor Slip :-
* Voltage induce :- when rotor of indu^n motor is revolving field produce by Stator winding.
* Induce voltage cause to current flowing through the bars.
* If rotor were to turn same speed as rotating field :- i) rotor conductor not cut by mag. line of force
ii) No emf should induce.
iii) No current could flow.
iv) No torque.
v) Rotor will slow down.

* For this, there must always be a diff. in speed betⁿ rotor & rotating field this diff. speed called as slip & expressed as % of synchronous speed.

* Single Phase induction motor :—
i) only one stator winding.
ii) When rotor is stationary → expanding & collapsing stator field induces current in rotor.
iii) These current generate a rotor field opposite in polarity to that of the stator.
iv) single phase induⁿ motor are use 2 HP or less

* Split Phase Motor :-
i) Also known as self-starting motor.
ii) Such motor have starting winding displaced 90° From main winding.
MP iii) A Centrifugal switch disconnect the starting winding automatically, after rotar has attained appro. 25% of rated speed.
iv) Stator winding → High Resistance.

* Capacitor Start Motor :—
i) This emplies a capacitor For stator or continious operation are caused capacitor motor.
ii) It offen use to provide starting torque.
MP → iii) Capacitor connected in Series with starting winding.
iv) High capacity electrolytic capacitor are used such motor are used when initial load is high.
v) A Centrifugal switch is req. For disconnecting the starting winding when rotor speed appro. 25 % rated speed.

* Direⁿ of Rotation of induction motors :-

VIMP
i) In single phase indⁿ motor dirⁿ can be changed by reversing connection to starting winding.
ii) In two phase motor by reversing connecting to one phase.
iii) In three phase motor dirⁿ change by simply reversing two of the lead to motor.
iv) After starting one connⁿ of 3 phase motor broken the motor will continue to run but will deliver only one-third rated power.
IMP & Two phase motor will rune at one-half its rated power
v) Neither motor will start under these abnormal condiⁿ

* Synchronous Motor :-

i) It is one of the type of AC motor.
ii) It makes use of rotating mag. field.
iii) The torque developed does not depend on induⁿ of current in rotor.
iv) It is similar to induⁿ motor.
v) Stator winding → Produce mag. field.
vi) Rotor may be permanent mag.
vii) It has a little starting torque to bring up it to Synchronous speed.
viii) The mag. field of rotor → locks the mag. field of stator → & then motor operates at Synchronous speed.
ix) It is not a self-starting motor.
x) It having same kind of starting device which bring the rotor up to approx. 90% of its synchronous speed.
1) Simple starter
2) AC or DC.

* AC Series Motor :-
1) Single phase motor.
2) it is not Sindu^n motor or synchronous.
3) It operat on either AC or DC cct.
4)

* To design series motor satisfactory operaⁿ :-
i) Eddy current loss → reduce by laminating Field pole.
ii) Hysteresis losses → Minimized by high permeability, Si-steel laminations.
iii) Reactance kept low.
iv) Reactance of armature reduced by → using compensating winding.
v) Sparking at commutator is reduced by → Preventive leads.

* Universal Motor :- It can be use on AC also DC also.
These are not used in A/C because this will have high power loss at high frequency

Dire → By Right hand Rule

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AC GENERATOR. (4-5)

* AC Generator :- Slip Ring
* DC -11- :- Commutator
* Alternator works on electromag. induction principle.
* Integrated brushless type → Excitation cct. complete through Silicon rectifire & rather than commutator.
* In a/c 3 phase alternator is most common.
* single phase :- Same type of winding used on an alternator as on DC generator.
* Two phase :- Two or more single phase winding around the stator.

  AC voltage induced in one winding is 90° out of phase with voltage induce in other.
* Three phase Alternator :- (Polyphase)
  i) Mostly used in a/c
  ii) It has three single phase winding.
  iii) voltage induced in each winding is 120° o/t of phase with other two winding.

* Wye Connection (Three phase) :- (Star connection)
  i) 1 end of each winding is connected to common pt. called neutral lead.
  ii) While opp. end of each winding is connected to saperete line.
  iii) The voltage bet netural line & other end of any of wire is phase voltage. (EPH)
  iv) The vot. bet^n two wire → line voltage.

Increase (voltage)

$$\text{Line } v = \sqrt{3} \times EPH$$

If Phase vol. = 120°

$$\therefore R = 1.732 \times 120$$

$$= 208 \text{ V}$$

v) line current & phase current are equal in this.
vi) For balance condition line voltage is equal to 1.732 times phase voltage.

IMP

* voltage & current in phase → Resistive load.
* change dir^n & continious change in magnitude → AC

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AC GENERATOR

(46)

* Delta connection (Three phase) :- (Incr. current)
1) winding are connected in Δ Form to form a close & end to end connection.
IMP → 2) line vot. always equal to phase vot.
3) Many turns of copper wire wound on soft iron.
4) line current is equal to vector sum of phase current.
IMP → 5) Line current is equal to $\frac{1.732}{\sqrt{3}}$ times — 11 —

* All generator produce AC only.
Input supply to Commutator is AC always.

* No. of lines force per unit area is called Field strength / flux.

IMP * Phase angle 0 → Resistive load.

IMP * AC Generator output → KVA (Power Factor) (No. of phases)

* Power Factor → $\frac{\text{True Power (KW)}}{\text{Apperent -11- (KVA)}}$

* The max^m current that can be supply by an alternate is depends on max heat loss I^2R power loss in armature & field winding.

IMP * Peak value = 1.414 × RMS value OR
— 11 — = $\sqrt{2}$ RMS.

* In AC generator vot. & curr. are out of phase by 90° called as quadrature. ple

IMP * Period of sin wave is inversly prop to frequency

* value of induced EMF :-
  i) speed of rotation
  ii) strength
* Value of AC current & vot → Sin wave

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* Alternator Frequency :-
  Depends on
  i) speed of rotation of rotor.
  ii) No. of poles.

* AC generator are cooled by → RAM Air.

IMP * Power Factor → Cosine of phase angle.

* Resultant valve → RMS value.

IMP * In AC generator voltage & current in phase power Factor will be UNITY 100 %.

* Frequency calculate :-

$$F = \frac{P \times N}{120} \quad \boxed{OR} \quad P = \frac{120\,F}{N}$$

eg. A 6 Pole generator operating at 8000 rpm the freq. will be ---

→ 400 Hz

$$F = \frac{6 \times 8000}{120} = 400$$

$$\boxed{F = 400}$$

* Wave length → Lamda & λ
* Phase angle → Theeta. θ

IMP * Most Voltameter display RMS value.

* RMS value is equal for AC & DC

* Diff bet^{n} in degree of Rot^{n} of current & voltage → Phase angle / Lag.

* DC MOTOR * (5-6)

* It convert ele. energy into mech. energy.
* Dirⁿ of Field depends on dirⁿ of current.
* The tendency of a force to produce a rotation is called torque.
* Dirⁿ of torque armature can be determined by Right / Left hand rule.

* Armature :- - Made up of laminⁿ of soft iron
  - end of winding connected to commutator.
  - Commutator segment are insulated from each other with MICA

* Field coil are wound on laminated soft steel pole pieces.

* End frame → opp. to commutator.

* Counter emf / Back emf :- oppose the current which cause armature to rotate.

IMP

* Current Flowing in armature ↑es counter emf ↑ses.

MP →

* Net emf :- It is diff. bet. applied emf & counter emf.

* Counter EMF may be only a few volt less than the input voltage.

* Reversing dirⁿ Method DC motor :-
  By reversing the dirⁿ of current flow in either the armature or the field windings the dirⁿ of rotation may be reversed.

IMP

IMP

Back emf in DC motor is less than applied emf.

* DC Motor interpole part of → Stator / Field

* Types of Motor :—
  1) DC shunt Motor
  2) DC Series —11—
  3) DC Compound —11—

1) DC shunt Motor :- Field winding is connected in parallel with armature winding.
   - Resis. of shunt field winding is always higher that armature winding.
   - It is known as **constant speed motor.** IMP

2) DC Series Motor :- - Field winding is connected in series with armature.
   - Current passing through series & armature winding is same.
   - Therefore series field winding has **Few turns of thick wire.** IMP
   - Starting torque will be **high** (Engine Stator)

many turns thin wire

3) DC Compound Motor

- Long shunt Compound Motor
  - Cumulative Comp. Motor
  - Differential Comp. motor.
- short shunt compound motor

* DC shunt more are use where load is small at starting & ↑se as speed ↑se.

* Compound ~~wound~~ wound :- - when load is applied speed will decrease.
  ii) use for hydrolic pump & operate from no load condi^n to full load condi^n

* Stator Motor are → series.
* Current desided by → i) Applied vot. EMF

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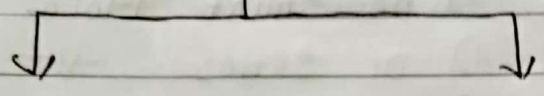
* Energy losses in DC Motor



Mechanical energy Loss

Electrical energy Loss

* Mech. energy loss :- due to Friction when operating.

* Electrical energy loss :-
  1) Copper losses
  2) Iron losses.

* Iron losses are of 2 types
  1) Hysteresis loss
  2) Eddy current loss.

* Copper loss :- - This are proportional to the square of current & are called I^2R losses.
- These are due to power dissipated in the Form of heat.

1) Hysteresis loss :- - Armature becomes magnetised 1st in one dirⁿ then in other dirⁿ.
- The residual mag. of iron or steel cause losses.

2) Eddy current loss :- - Laminated Core is used to reduce eddy current losses.

* DC motor speed control :-
- It can be ctrl. by field winding.
- When speed is controlled in motor is known as variable speed motor.

* The Armature reaction causes neutral plane to shift. direction opp. to dir^{n} of rotation In Motor & In generator same to dir^{n} of rotation.

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- In shunt motor rheostat is connected in series with field winding

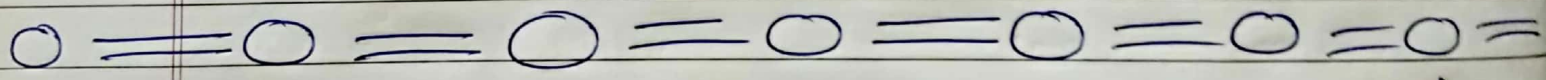
- In series motor rheostat is connected either in series or ||^{el} with field winding.

* Protective Devices :-

1) Limit Switch :- (Use in split field motor (AC), DC)
when mechanism has reached to limit of travel limit switch will be activated by Camor or lever & cutt of Power
ii) used in reversible motor.

Engine Starter Motor :- use reversible motor. (Both direction)

2)* overload relese clutch :- disconnect motor From driven machanism.



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