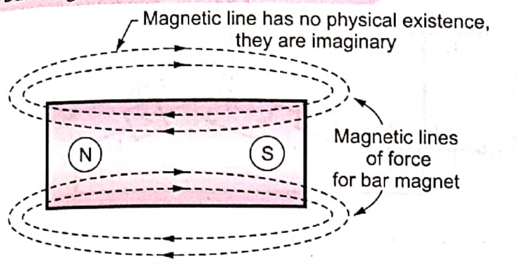
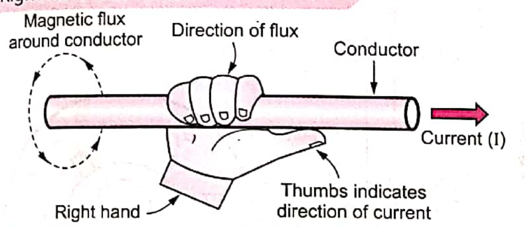
Exam Preparation Chart

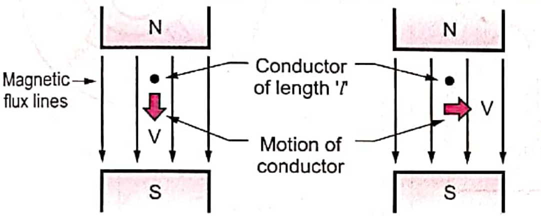
Chapter 1 (Unit I) Electromagnetism

Bar magnet - Magnetic lines of force



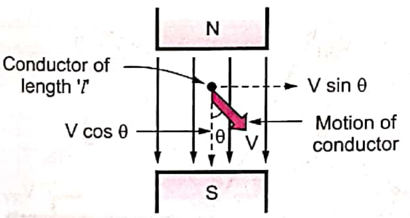
Right hand thumb rule





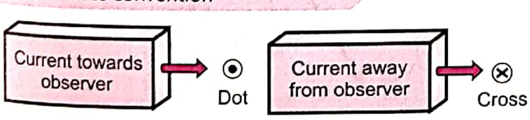
(a) Conductor moving in magnetic field

(b) Perpendicular motion of conductor

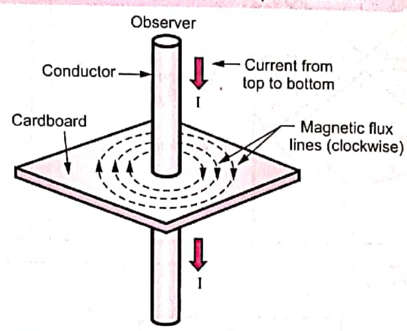


(c) Conductor making an angle

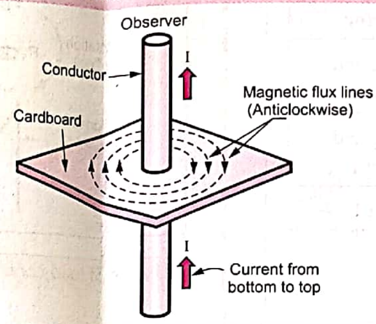
Dot and cross convention



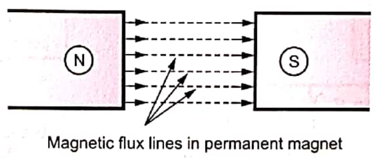
Conductor carries current from top to bottom



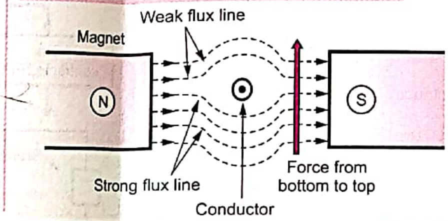
Conductor carries current from bottom to top



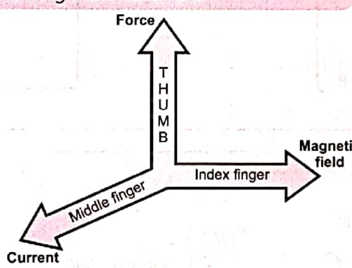
Permanent magnet



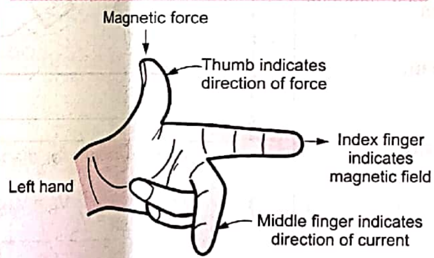
Force on current carrying conductor



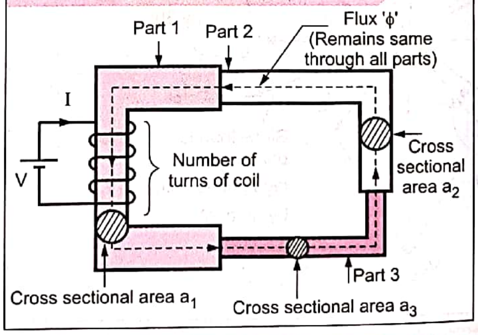
Fleming's left hand rule



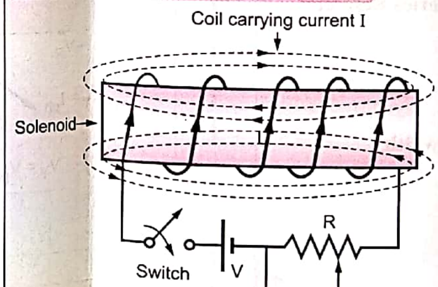
Fleming's left hand rule



Series magnetic circuit



Energy stored in magnetic field



Important Formulae

1. **Absolute Permeability (μ)** $\mu = \frac{B}{H}$

Where, B = magnetic flux density

H = magnetic field strength

2. **Permeability of Vacuum or Free Space (μ_0)**

$\mu_0 = \frac{B}{H}$ in vacuum or free space $= 4\pi \times 10^{-7}$ H/m

Where, B = magnetic flux density,

H = magnetic field strength

3. **Magnetic Permeability**

$\therefore \mu = \mu_0 \mu_r$

Magnetic permeability — Permeability of free space — Relative permeability

4. **Magnetomotive Force (MMF)**

$\therefore$ mmf $= N \times I$

Number of turns of coil — Current through the coil

5. **Reluctance** $s = \frac{l}{\mu a}$

Here, l = Length of magnetic circuit in meter

a = Cross-sectional area in (meter)^2

and, μ = Permeability $\therefore s = \frac{\text{mmf}}{\phi}$

The magneto motive force is given by, mmf = NI

$\therefore s = \frac{NI}{\phi}$ AT / Wb

Number of turns of coil — Current through coil — Magnetic flux

6. **Equation of reluctance**

$s = \frac{l}{\mu a}$

mean length — Permeability — Cross sectional area

7. Total reluctance of series magnetic circuit with air-gap. $s_T = \frac{l_i}{\mu_0 \mu_r a} + \frac{l_g}{\mu_0 a}$

8. The magnitude of force exerted on current carrying conductor, placed in magnetic field, is given by

$F = BIl$

Mechanical force — Magnetic flux density — Current through conductor — Active length of conductor

9. If a conductor is inclined and it makes an angle 'θ' with respect to axis of magnetic field then force is given by,

$F = BI\, l \sin\theta$

10. **Faraday's Second Law**

$\therefore e = N\frac{d\phi}{dt}$

Number of turns of coil — Rate of change of flux

11. **Lenz's Law**

$\therefore e = -N\frac{d\phi}{dt}$

Induced emf — Number of turns of coil — Change in flux — Negative sign indicates opposition to cause producing current

12. **Mathematical Eqn. of Dynamically Induced emf**

$\therefore e = BlV$

Induced emf — Flux density — Length of conductor — Velocity of conductor

13. **Dynamically induced emf** $e = Bl\underbrace{V\sin\theta}_{\text{Perpendicular component of V}}$

14. **Equation of self inductance** $e = -L\frac{dI}{dt}$ Volts

15. **Another Equation of Self Inductance**

$\therefore L = \frac{N^2 \mu_0 \mu_r a}{l}$ Henry

16. **Equation of mutually induced emf in terms of mutual inductance**

$e_2 = -M\frac{dI_1}{dt}$ Volts

17. **Coefficient of Coupling (k)** $M = k\sqrt{L_1 L_2}$

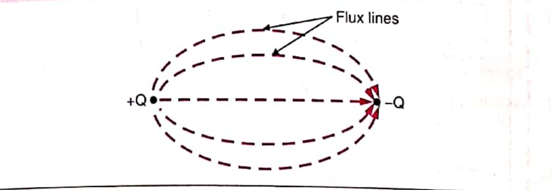
18. **Energy Stored in Magnetic Field** $\therefore E = \frac{LI^2}{2}$

19. **Equation of energy stored per unit volume**

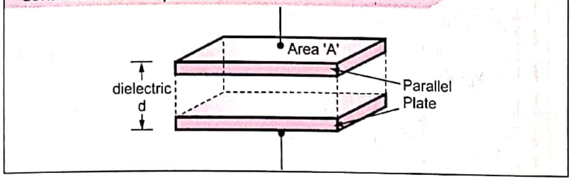
$\therefore E = \frac{1}{2}\mu_0 \mu_r H^2 = \frac{1}{2}\mu H^2$

Chapter 2 (Unit II) Electrostatics

Flux lines from + Q to - Q



Construction of Capacitor



Important Formulae

Electric flux density $= \dfrac{\text{Electric flux}}{\text{Surface area}}$

Relationship between 'D' and 'E'

$D = \epsilon E$, But $\epsilon = \epsilon_0 \epsilon_r$,

$\therefore D = \epsilon_0 \epsilon_r E$

Coulomb's Law

$$F = K \cdot \frac{Q_1 Q_2}{R^2}$$

Here, F = Force in Newton

Q_1 and Q_2 = Point charges in Coulomb's

K = Constant of proportionality

R = Distance between Q_1 and Q_2 in meters

Capacitance

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

Capacitance — C; Charge — Q (coulumbs); Voltage — V (volts)

Capacitance of Parallel Plate Capacitor

$$C = \epsilon_r \epsilon_0 \frac{A}{d} \text{ Farad}$$

Capacitor in Series

The equivalent capacitance C_S of n capacitors connected in series is given as,

$$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \cdots \frac{1}{C_n}$$

Capacitors in Parallel

The equivalent capacitance C_p of n capacitors connected in parallel is gives as,

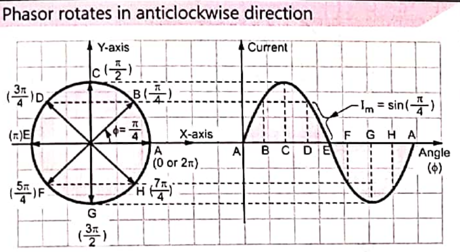
$$C_p = C_1 + C_2 + C_3 + \ldots + C_n$$

Energy Stored by a Capacitor

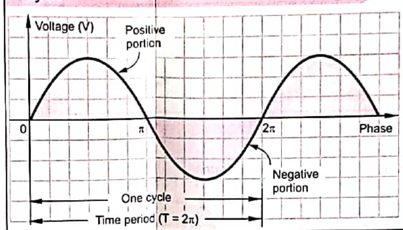
$$E = \frac{1}{2} QV = \frac{1}{2} CV^2 \text{ (Joules)}$$

Chapter 3 (Unit II) AC Fundamentals

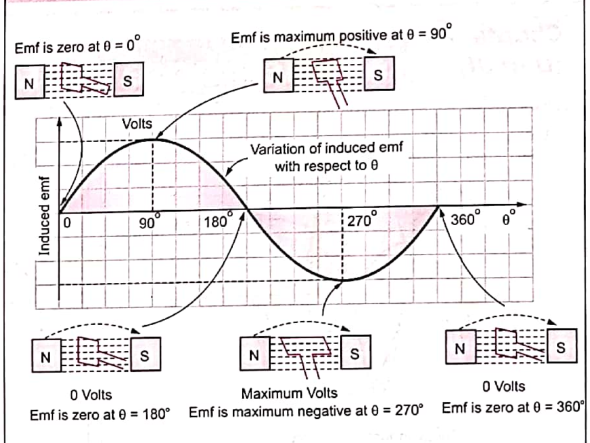
Phasor rotates in anticlockwise direction



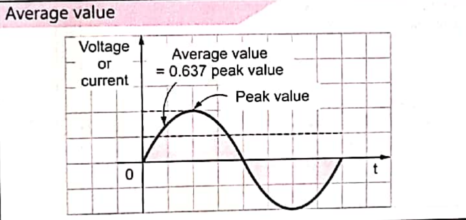
Cycle



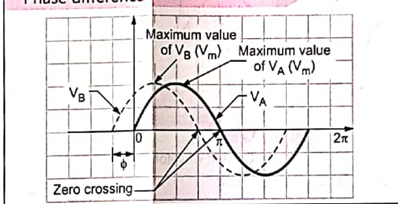
Generation of alternating voltage



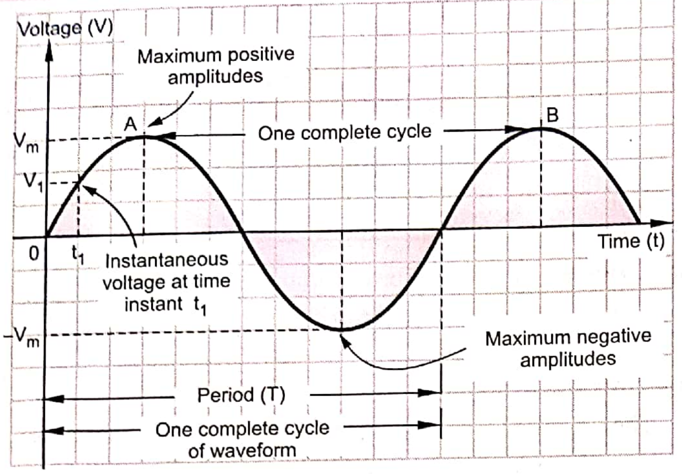
Average value



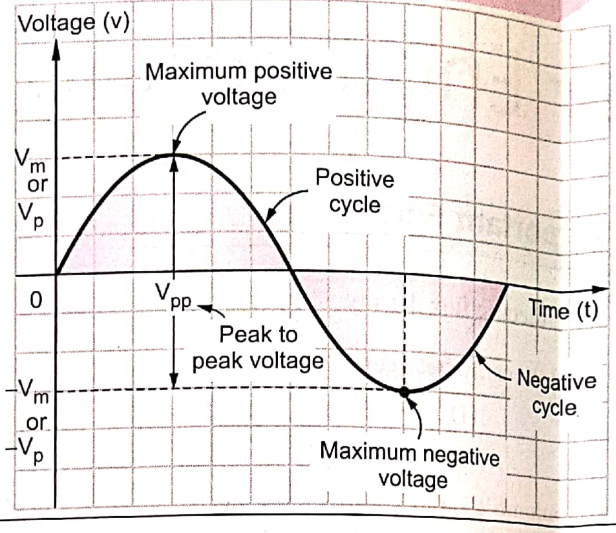
Phase difference



Voltage waveform (amplitude verses time)



Voltage waveform



Important Formulae

Summary of some important terms related to alternating quantity.

Sr. No.	Quantity	Notation	Formula	Unit
1.	Period	T	$T = \frac{1}{f}$	Sec
2.	Amplitude	V_m or I_m	V_m or I_m = Peak value	Voltage or ampere
3.	Frequency	f	$f = \frac{1}{T}$	Cycles/sec or Hz
4.	Electric angle	θ	θ = 360° or 2π radian for one complete revolution.	degree or radian
5.	Angular velocity	ω	ω = 2πf	rad/sec

The following table shows different forms of equations of voltage and current

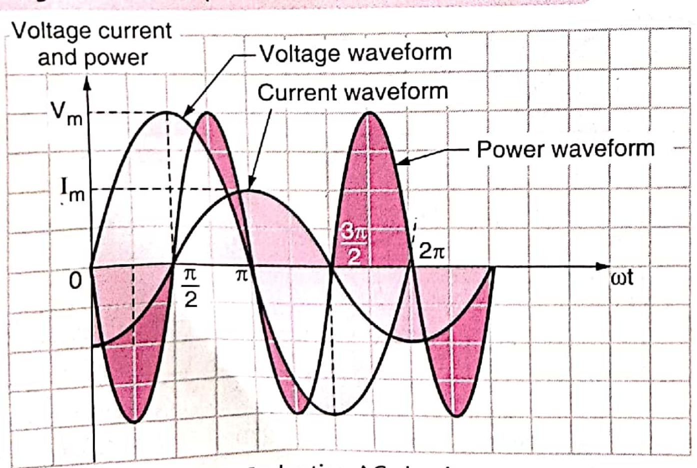
Equations of voltage	Equations of current
(i) $e = E_m \sin(\omega t)$ or $V = V_m \sin(\omega t)$	(i) $i = I_m \sin(\omega t)$
(ii) $e = E_m \sin(2\pi ft)$ or $V = V_m \sin(2\pi ft)$	(ii) $i = I_m \sin(2\pi ft)$
(iii) $e = E_m \sin\left(\frac{2\pi t}{T}\right)$ or $V = V_m \sin\left(\frac{2\pi t}{T}\right)$	(iii) $i = I_m \sin\left(\frac{2\pi t}{T}\right)$

Summary of Important Parameters

Sr. No.	Quantity	Notation	Basic equation	Unit
1.	Peak to peak value	V_{P-P}	$V_{P-P} = 2 \times$ Maximum value	Volts
2.	rms value	V_{rms} or I_{rms}	0.707 × Maximum value	Volts or ampere
3.	Average value	V_{av} or I_{av}	0.637 × Maximum value	Volts or ampere
4.	Form factor	K_F	$K_F = \frac{\text{rms value}}{\text{average value}}$	Unitless
5.	Crest factor	K_P	$K_F = \frac{\text{Peak value}}{\text{rms value}}$	Unitless

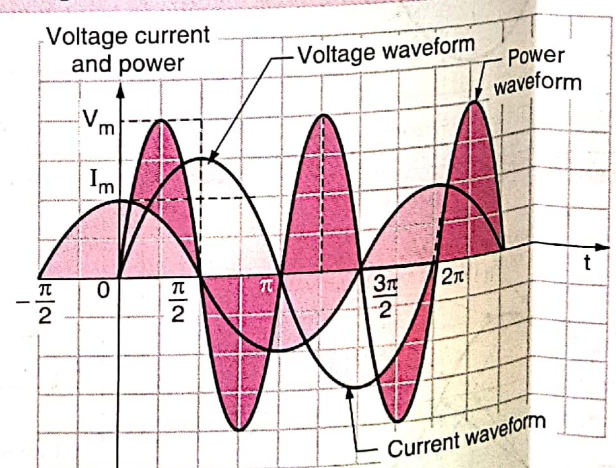
Chapter 4 (Unit III) Single Phase AC Circuits

Voltage current and power waveform



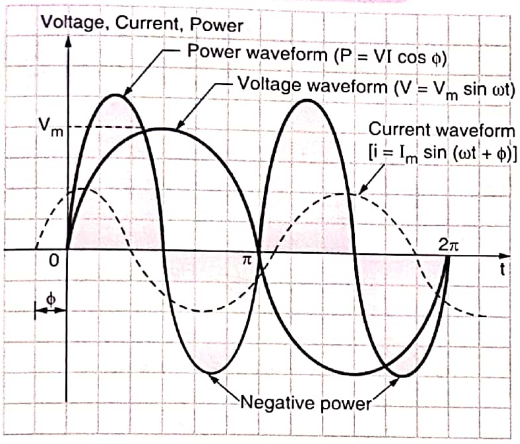
Purely Inductive AC circuit

Voltage current and power waveforms



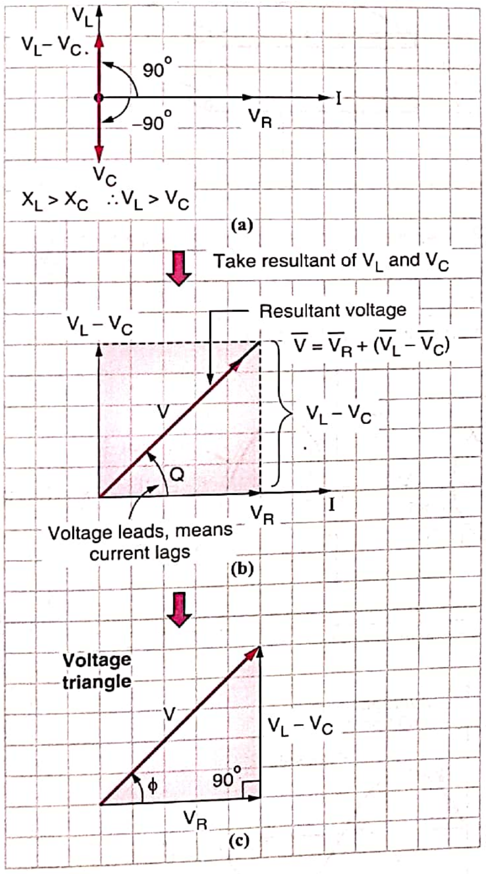
Purely Capacitive AC circuit

Voltage, current and power waveforms



Series RL circuit

Phasor diagram for RLC circuit



Important Formulae

Expression for Purely Resistive AC Circuit

1. **Average power (P_{av})**

$$\therefore P_{av} = V_{RMS} I_{RMS} \text{ watts}$$

Expression for Purely Inductive AC Circuit

2. **Voltage applied to purely inductive circuit**

$$V = V_m \sin \omega t$$

3. **Equation of current**

$$i = \underbrace{I_m}_{\text{Peak value}} \sin (\omega t - \underbrace{\tfrac{\pi}{2}}_{\text{Phase shift; Lagging phase}})$$

Here, $I_m = \dfrac{V_m}{X_L}$;

Where X_L = Reactance of inductor $= \omega L = 2\pi f L$

4. **Instantaneous power (P)**

$$\therefore P = \underbrace{v}_{\text{Instantaneous voltage}} \times \underbrace{i}_{\text{Instantaneous current}}$$

5. **Average Power (P_{av})** $\therefore$ $P_{av} = 0$

Expression for Purely Capacitive AC Circuit

1. **Equation of current**

$$i = I_m \sin (\omega t - \underbrace{\tfrac{\pi}{2}}_{\text{Phase shift}})$$

Lagging phase

2. **Voltage applied to purely capacitive circuit**

$$V = V_m \sin \omega t$$

3. **Basic equation of X_C**

$$\therefore X_C = \frac{1}{\underbrace{2\pi}_{\text{Constant}}\underbrace{f}_{\text{Frequency (variable)}}\underbrace{C}_{\text{Value of capacitance (constant)}}}$$

4. **Instantaneous power**

$$\therefore P = \underbrace{v}_{\text{Instantaneous voltage}} \times \underbrace{i}_{\text{Instantaneous current}}$$

5. **Average power (P_{av})**

$$\therefore P_{av} = 0$$

Types of power in AC circuits

1. **Apparent power (S)**

$$S = V_{RMS} \times I_{RMS}$$

2. **Real or True or Active power (P)**

$$\underbrace{P}_{\text{Real power}} = \underbrace{V}_{\text{rms voltage}}\ \underbrace{I}_{\text{rms current}} \cos \underbrace{\phi}_{\text{phase between voltage and current}}$$

3. **Imaginary or Reactive Power (Q)**

$$\underbrace{Q}_{\text{Reactive power}} = \underbrace{V}_{\text{rms voltage}}\ \underbrace{I}_{\text{rms current}} \sin \underbrace{\phi}_{\text{phase between voltage and current}}$$

4. **Range of Power Factor**

$$\text{P.F.} = \cos \phi$$

Expressions for RL circuits

1. **Equation of supply voltage**

$$V = V_m \sin \omega t$$

2. **Instantaneous current**

$$\underbrace{i}_{\text{Instantaneous current}} = \underbrace{I_m}_{\text{Peak amplitude}} \sin (\omega t - \underbrace{\phi}_{\text{Phase shift; Lagging}})$$

3. **Instantaneous power**

$$\therefore P = \underbrace{\frac{V_m I_m \cos \phi}{2}}_{\text{Constant term as } \phi \text{ is constant}} - \frac{V_m I_m}{2} \cos (\underbrace{2\omega t}_{\text{Double frequency}} - \underbrace{\phi}_{\text{Phase shift; Lagging}})$$

4. **Average power**

$$\therefore P_{av} = VI \cos \phi$$

Expressions for RC circuits

1. **Equation of supply voltage**

$$V = V_m \sin \omega t$$

2. **Instantaneous current**

$$\underbrace{i}_{\text{Instantaneous current}} = \underbrace{I_m}_{\text{Peak amplitude}} \sin (\omega t + \underbrace{\phi}_{\text{Phase shift; Leading}})$$

3. **Instantaneous power**

$$\therefore P = V_m \sin (\omega t) \cdot I_m \sin (\omega t + \phi)$$

4. **Average power**

$$\therefore P_{av} = VI \cos \phi$$

Types of power in AC circuits

1. Apparent power (S)

$$S = V_{RMS} \times I_{RMS}$$

2. Real or True or Active power (P)

$$P = V\,I \cos\phi$$

Real power

rms voltage

rms current

phase between voltage and current

3. Imaginary or Reactive Power (Q)

$$Q = V\,I \sin\phi$$

Reactive power

rms voltage

rms current

phase between voltage and current

4. Range of Power Factor

$$P.F. = \cos\phi$$

Expressions for RL circuits

1. Equation of supply voltage

$$V = V_m \sin\omega t$$

2. Instantaneous current

$$i = I_m \sin(\omega t - \phi)$$

Instantaneous current

Peak amplitude

Phase shift

Lagging

3. Instantaneous power

$$\therefore P = \underbrace{\frac{V_m I_m \cos\phi}{2}}_{\text{Constant term as } \phi \text{ is constant}} - \frac{V_m I_m}{2}\cos(\underbrace{2\omega t}_{\text{Double frequency}} - \phi)$$

Phase shift

Lagging

4. Average power

$$\therefore P_{av} = VI\cos\phi$$

Expressions for RC circuits

1. Equation of supply voltage

$$V = V_m \sin\omega t$$

2. Instantaneous current

$$i = I_m \sin(\omega t + \phi)$$

Instantaneous current

Peak amplitude

Phase shift

Leading

3. Instantaneous power

$$\therefore P = V_m \sin(\omega t) \cdot I_m \sin(\omega t + \phi)$$

4. Average power

$$\therefore P_{av} = VI\cos\phi$$

Expressions for RLC circuits

1. Nature of Power Factor

Following table shows the nature of power factor.

Serial No.	Condition	Type of RLC circuit	Nature of power factor
1.	$X_L > X_C$	Inductive	Leading and less than 1
2.	$X_L < X_C$	Capacitive	Leading and less than 1
3.	$X_L = X_C$	Resistive	Equal to 1

2. Q factor in RLC series circuit

$$Q = \frac{X}{R}$$

Rectance

Resistance

Here $X = X_L - X_C$

Capacitive reactance

Inductive reactance

Expressions on series resonance

1. Resonant Frequency

$$\therefore f_r = \frac{1}{2\pi\sqrt{LC}} \text{ (Hz) Unit}$$

2. Impedance of Series Resonant Circuit

$$\therefore Z = R + j(X_L - X_C)$$

3. Bandwidth (B.W.) of Series Resonance

$$\therefore B.W. = f_2 - f_1$$

4. Selectivity

$$\therefore S = \frac{f_r}{B.W.}$$

5. Quality Factor (Q-factor) of Series Resonant Circuit

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$$

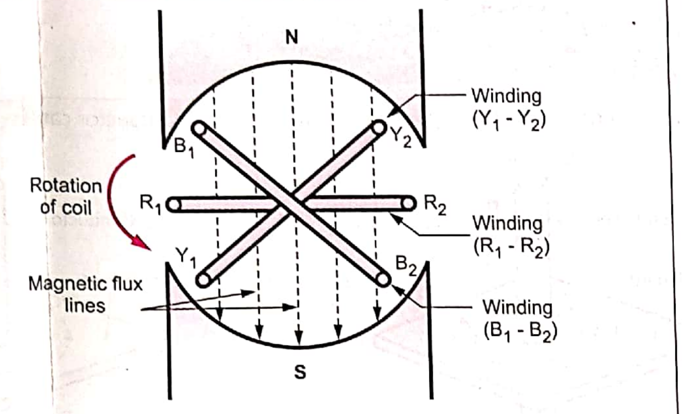
6. Relation between Q and bandwidth

$$\therefore Q = \frac{f_r}{B.W.}$$

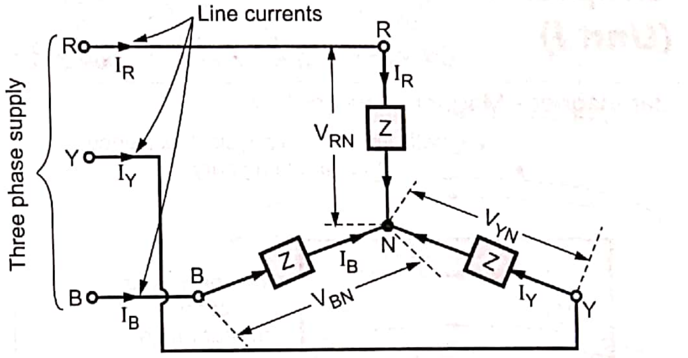
Chapter 5 (Unit IV)

Polyphase A.C. Circuits

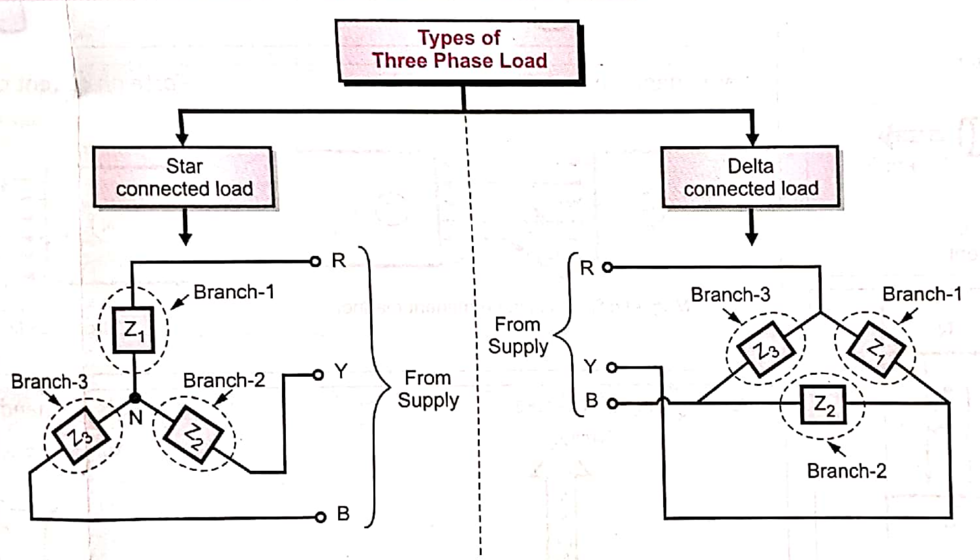
Winding is rotating



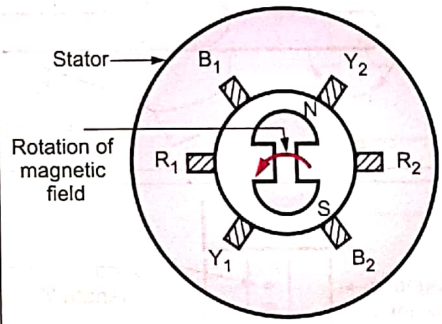
Balances star connected load



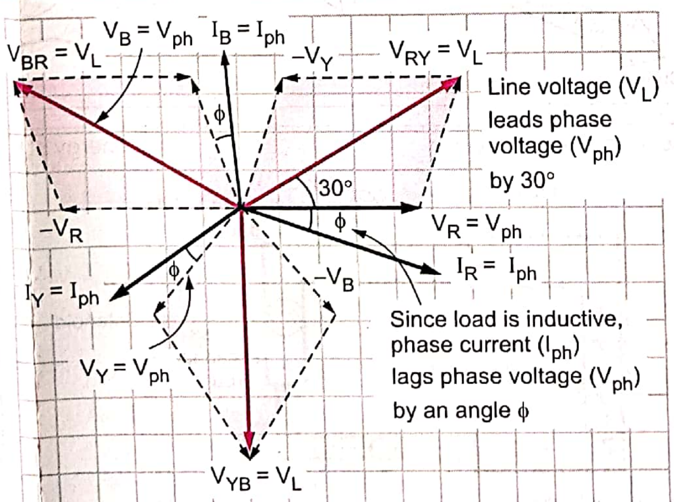
Types of load connections



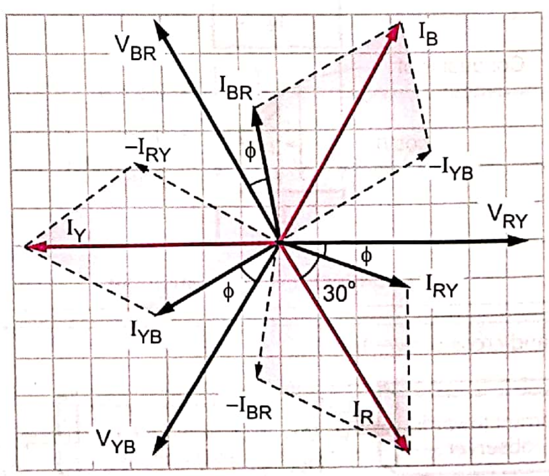
Field is rotating



Complete phasor diagram per star connection



Complete Phasor Diagram for delta connection



Important Formulae

Relationship for balanced star connected load

1. The line current is same as phase current. That means,

$$I_L = I_{ph}$$

2. The line voltage is $\sqrt{3}$ times the phase voltage. That means,

$$V_L = \sqrt{3}\, V_{ph}$$

3. The line voltage leads the phase voltage by 30°.

Summary of equations of power

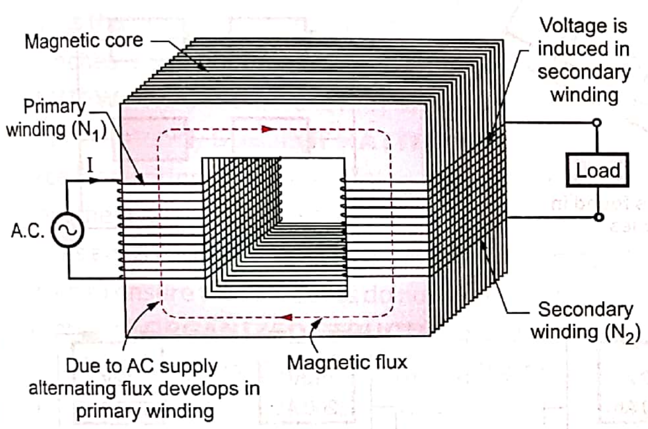
The following table shows summary of mathematical equations of different powers.

Sr. No.	Type of power	Unit	Equation in terms of phase voltage and current	Equation in terms of line voltage and current
1.	Apparent power (s)	VA	$s = 3\, V_{ph} \cdot I_{ph}$	$s = \sqrt{3}\, V_L \cdot I_L$
2.	Active power (P)	W	$P = 3\, V_{ph} \cdot I_{ph} \cos\phi$	$P = \sqrt{3}\, V_L \cdot I_L \cos\phi$
3.	Reactive power (Q)	VAR	$Q = 3\, V_{ph} \cdot I_{ph} \sin\phi$	$Q = \sqrt{3}\, V_L I_L \sin\phi$

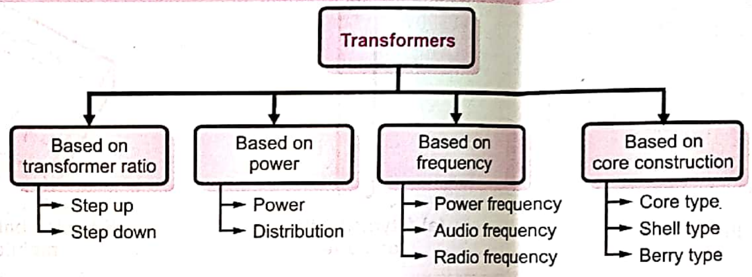
Power Factor (P.F.) $\therefore$ **P.F. = $\cos\phi$**

Chapter 6 (Unit IV) Single Phase Transformer

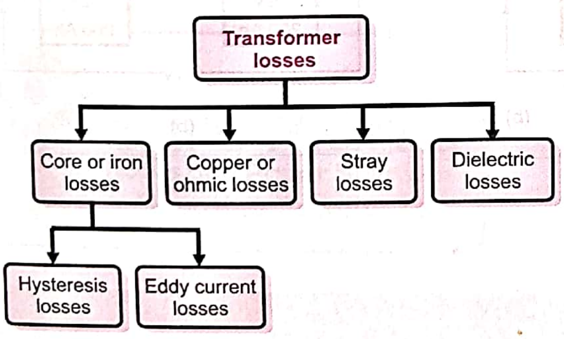
Basic transformer



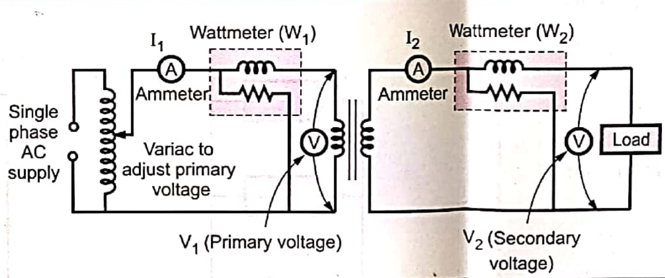
Types of transformer



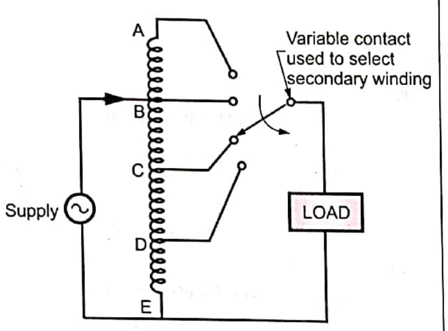
Transformer losses



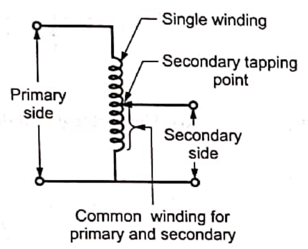
Experimental setup for direct loading method



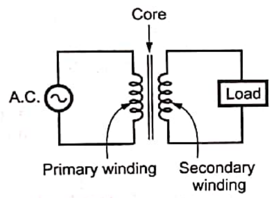
Basic auto transformer



Symbol



Symbol of transformer



Important Formulae

EMF and Transformer Ratios

1. Induced emf (e) is given by,

$$e = -\underbrace{N}_{\text{Number of turns of coil}} \underbrace{\frac{d\phi}{dt}}_{\text{Rate of change of flux}}$$

2. Maximum value of e

$$\therefore e_{max} = N \phi_m 2\pi f \text{ volt}$$

$$\therefore e_{max} = \phi_m 2\pi f \text{ volts}$$

Above equation gives maximum value of induced emf per turn.

$$\therefore e_{rms} = 4.44 \phi_m \cdot f$$

3. Above equation gives rms value of induced emf per turn.

$$\therefore \mathbf{E_1 = 4.44 \phi_m \cdot f N_1}$$

and $\mathbf{E_2 = 4.44 \phi_m f N_2}$

Above equations gives the value of statically induced emf in primary and secondary windings respectively.

4. $\therefore$ e.m.f. / turn for primary $= \frac{E_1}{N_1} = 4.44 f\Phi_m$

and e.m.f. / turn for secondary $= \frac{E_2}{N_2} = 4.44 f\Phi_m$

$$\therefore \text{emf ratio} = \frac{E_1}{E_2} = \frac{N_1}{N_2}$$

5. **Voltage ratio without load**

$$\therefore \underbrace{V_2}_{\text{Load voltage (secondary terminal voltage)}} = \underbrace{E_2}_{\text{Secondary induced voltage}}$$

6. **Primary terminal voltage**

$$\therefore \underbrace{V_1}_{\text{Primary terminal voltage}} \approx \underbrace{E_1}_{\text{Primary induced voltage}}$$

1. **Calculation of efficiency (η)**

$$\eta = \frac{\text{Output power } (W_2)}{\text{Input power } (W_1)} \times 100\ \%$$

8. **Voltage Ratio :** $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

9. **Transformation ratio :** $K = \frac{V_2}{V_1} = \frac{N_2}{N_1}$

10. **Current ratio :** $\frac{I_1}{I_2} = \frac{V_2}{V_1} = \frac{N_2}{N_1} = K$

11. **Equations of full load currents**

$$I_1 \text{ (full load)} = \frac{\text{kVA rating} \times 1000}{V_1}$$

and $I_2 \text{ (full load)} = \frac{\text{kVA rating} \times 1000}{V_2}$

12. The transformer ratings are specified in the following format.

Primary voltage/secondary voltage, kVA rating, supply frequency.

Efficiency

1. Power loss in primary winding $= I_1^2 R_1$

and power loss in secondary winding $= I_2^2 R_2$

Copper loss $\therefore P_{cu} = I_1^2 R_1 + I_2^2 R_2$

Thus total losses = Iron loss (P_i) + Copper loss (P_{cu})

2. The generalized equation of efficiency is,

$$\eta = \frac{n \text{ (VA)} \cos\phi}{n \text{ (VA)} \cos\phi + P_i + n^2 P_{cu}} \times 100\ \%$$

3. The condition for maximum efficiency is,

$$P_i = P_{cu}$$

4. Mathematically, voltage regulation is expressed as,

$$\%\ \text{Voltage regulation} = \frac{\underbrace{E_2}_{\text{Secondary terminal voltage at no load}} - \underbrace{V_2}_{\text{Secondary terminal voltage at given load}}}{E_2} \times 100$$

Direct loading method

1. **Calculation of efficiency (η)**

$$\eta = \frac{\text{Output power } (W_2)}{\text{Input power } (W_1)} \times 100\ \%$$

Here $\underbrace{W_1}_{\text{Input power}} = \underbrace{V_1}_{\text{Input voltage}} \underbrace{I_1}_{\text{Input current}} \underbrace{\cos\phi_1}_{\text{P.F.}}$, $\underbrace{W_2}_{\text{Output power}} = \underbrace{V_2}_{\text{Output voltage}} \underbrace{I_2}_{\text{Output current}} \underbrace{\cos\phi_2}_{\text{P.F.}}$

2. **Calculation of regulation (R)**

Percentage regulation =

$$\frac{\text{No load output voltage } (V_{2NL}) - \text{Full load output voltage } (V_{2FL})}{\text{No load outptu voltage } (V_{2NL})} \times 100\ \%$$

$$\therefore \%\ R = \frac{V_{2NL} - V_{2FL}}{V_{2NL}} \times 100\ \%$$

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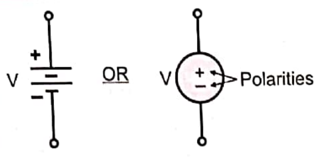
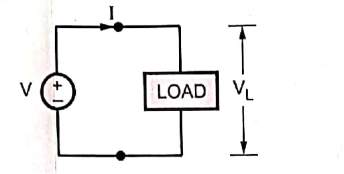
Chapter 7 (Unit V)

DC Circuits

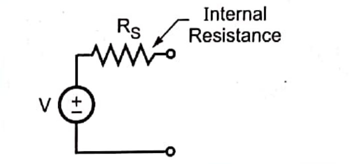
Ideal voltage



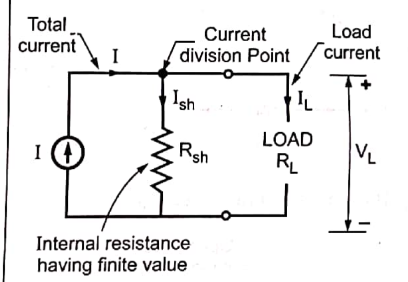
Load is connected to Ideal voltage



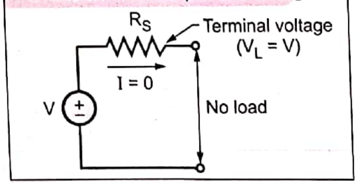
Practical voltage



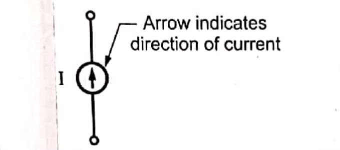
Current through R_{sh} and load RL



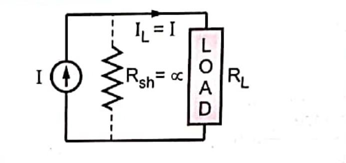
No load condition of practical voltage



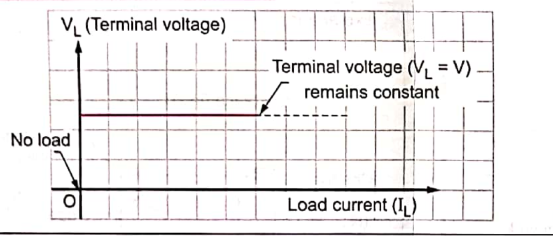
Ideal current source



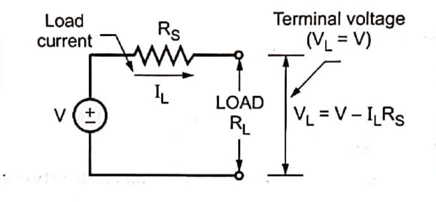
Ideal current source with load



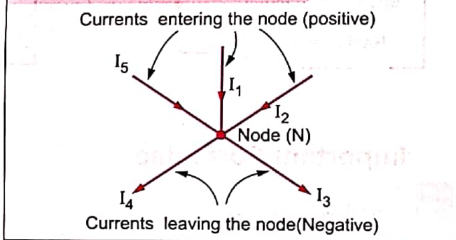
Voltage vs Current



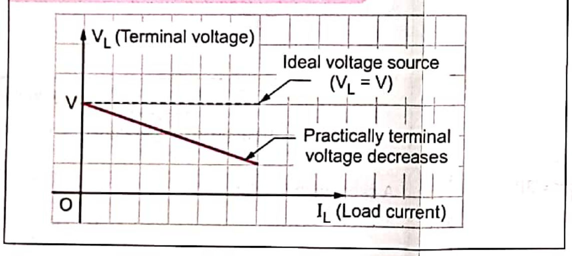
Terminal voltage with load



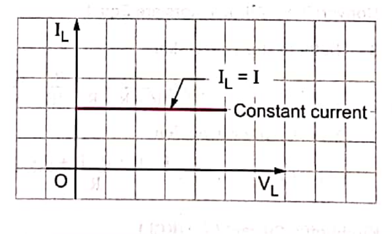
Five branches connected



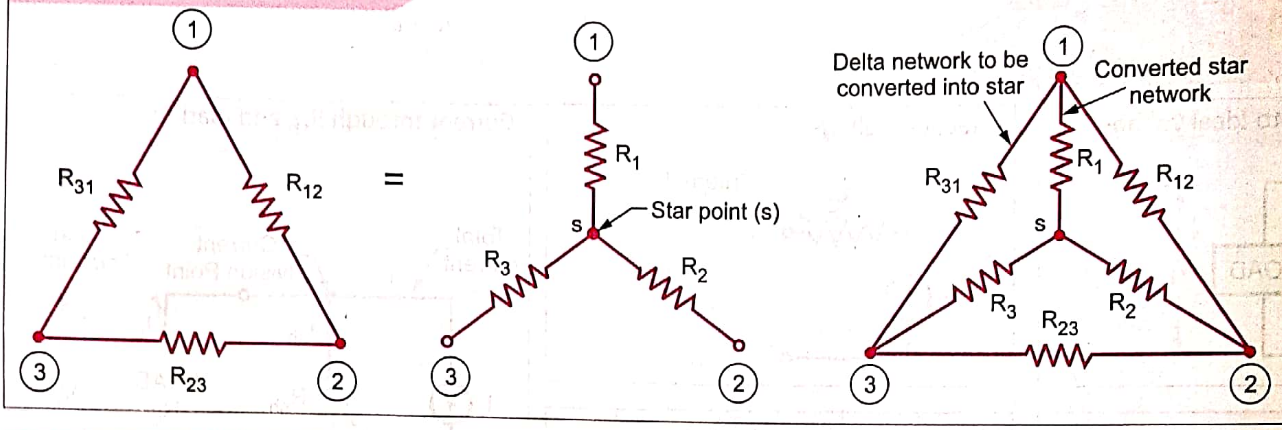
Variation of terminal voltage (V_L) with I_L



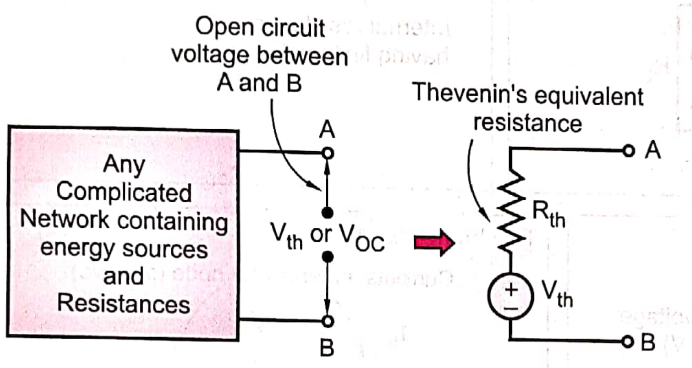
Variation of load current (I_L) with V_L



Delta to star conversion



Thevenin's equivalent resistance



Important Formulae

1. Resistors in Series

If 'n' resistors are connected in series then equivalent resistance is,

$$R_T = R_1 + R_2 + ... + R_n$$

2. Voltage Division formula

$$\text{Voltage across any resistance} = \frac{\text{Supply voltage} \times \text{that resistance}}{\text{Addition of all resistances}}$$

3. Resistors in Parallel

In general, if 'n' resistors are connected in parallel then total resistance is,

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ... + \frac{1}{R_n}$$

4. Case of Two Resistances in Parallel

$$\text{Equivalent resistance } (R_T) = \frac{\text{Multiplication of resistances}}{\text{Addtion of two resistances}}$$

5. Current Division in Parallel Circuit

$$\text{Current in any branch} = \frac{\text{Total current x Opposite branch resistance}}{\text{Addition of resistances}}$$

1. To convert delta network into star network

$$\text{Any resistance in star network} = \frac{\text{Product of adjacent resistors in delta network}}{\text{Addition of all resistors in delta network}}$$

2. To convert star network into delta network

$$\text{Any resistance in delta network} = \frac{\text{Total resistance } (R_T) \text{ of star network}}{\text{Opposite resistance of star network}}$$

Conversion if All Resistors are Equal

3. Delta to star conversion

$$\text{Any resistance in star} = \frac{R \cdot R}{R + R + R} = \frac{R^2}{3R} = \frac{R}{3}$$

4. Star to delta conversion

$$\text{Any resistance in delta} = \frac{R \cdot R + R \cdot R + R \cdot R}{R} = \frac{3R^2}{R} = 3R$$

Kirchhoff's Current Law (KCL)

Summation of incoming currents = Summation outgoing currents

$$\underbrace{I_1 + I_2 + I_3}_{\text{Current entering the node}} = \underbrace{I_3 + I_4}_{\text{Current leaving the node}}$$

Kirchhoff's Voltage Law (KVL)

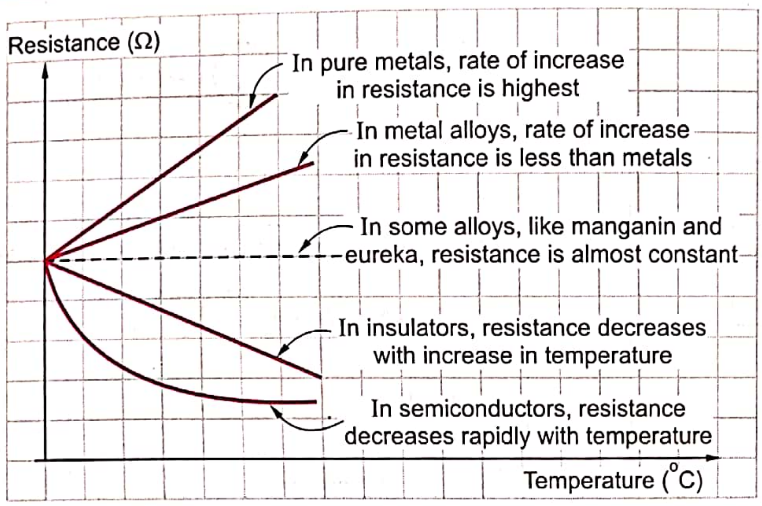
Around a closed path Σ voltage across all elements = 0

$$\text{Current in any branch} = \frac{\text{Supply current x Opposite branch resistance}}{\text{Addition of resistances}}$$

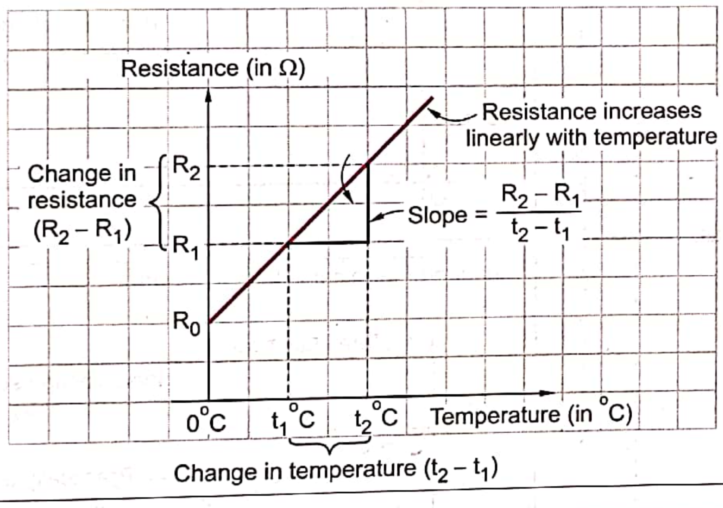
$$\text{Voltage across any resistor} = \frac{\text{Supply voltage} \times \text{that resistor}}{\text{Addition of resistors}}$$

Chapter 8 (Unit VI) Work Power Energy

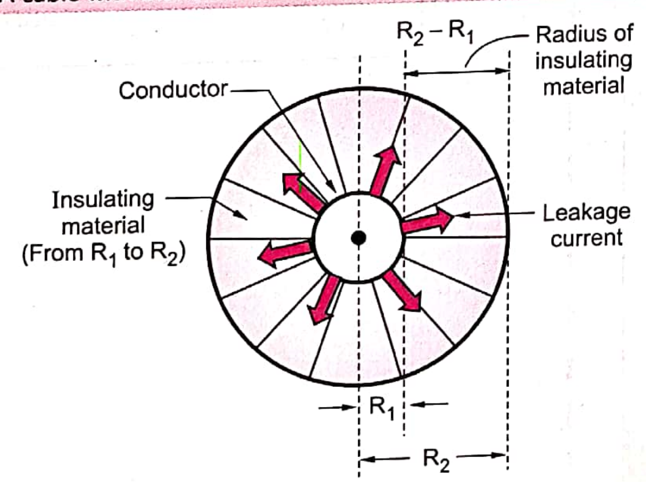
Concept of decrease in resistance in semiconductor



Explanation of RTC



A cable with insulator



Important Formulae

(i) Equation of resistance temperature coefficient at t_1° C (α_1)

$$\alpha_1 = \frac{(R_2 - R_1)/(t_2 - t_1)}{R_1}$$

Where, R_1 = Resistance at t_1° C, R_2 = Resistance at t_2° C

α_1 = RTC at t_1° C

(ii) Equation of RTC at 0°C (α_0)

$$\alpha_0 = \frac{(R_1 - R_0)/(t_1 - 0)}{R_0}$$

Where, R_1 = Resistance at t_1° C, R_0 = Resistance at t_0°C

α_0 = RTC at t_0° C

(iv) Equation of Resistance in Terms of RTC

Resistance at t_1°C — RTC at t_1°C

$$\therefore\ R_2 = R_1\,[1 + \alpha_1 \underbrace{(t_2 - t_1)}_{\text{Temperature difference}}]$$

Resistance at t_2°C

(v) Effect of Temperature on RTC (α_t)

$$\therefore\ \alpha_t = \frac{\alpha_0}{1 + \alpha_0 t}$$

Where, α_t = RTC at t°C, α_0 = RTC at 0°C

(vi) Temperature Coefficient of Resistivity

Resistivity at t_1°C — Resistivity at t_0°C

$$\alpha_0 = \frac{(\rho_1 - \rho_0)/\underbrace{(t_1 - 0)}_{\text{Change in temperature}}}{\rho_0}$$

(vii) Composite temperature coefficient (α)

$$\therefore\ \alpha = \frac{R_1\alpha_1 + R_2\alpha_2}{R_1 + R_2}$$

Where, R_1 = Resistance of material 1

R_2 = Resistance of material 2

α_1 = Temperature coefficient material 1

α_2 = Temperature coefficient material 2

(i) Relation between resistance (R) and resistivity (ρ) is,

Resistivity — Length

$$R = \frac{\rho\, l}{a}$$

Resistance — Cross sectional area

C

(ii) Resistivity

Resistivity

Radius (Conductor + insulator)

$$\therefore R_i = \frac{\rho}{2\pi l} \log_e \frac{(R_2)}{(R_1)}$$

Length

Radius of conductor

(i) Force

Mass

$$F = m \times a$$

Force

Acceleration

(ii) Weight

Mass

$$W = m \times g$$

Weight

Gravitational acceleration = 9.81 m/s^2

(iii) Torque

Force

$$T = F \times r$$

Torque

Radial distance

(iv) Work

Force

$$W = F \times d$$

Workdone

Displacement

(v) Kinetic energy

Mass

$$K.E. = \frac{1}{2} mV^2 \text{ J}$$

Velocity

(vi) Potential energy

Mass

Height

$$P.E. = m\,g\,h$$

Gravitational force

(vii) Power

Power

Angular velocity

$$\therefore P = \omega T$$

Torque

ρ) is,

(viii) Electrical work

Electric work

Charge

$$W = V \cdot Q \text{ J}$$

Potential difference

Unit of work done (Joules)

(ix) Electric power

Electric power

Voltage

$$\therefore P = V I \text{ Watts}$$

Current

(x) Electric energy

Energy

Power

$$\therefore E = P \times t$$

Time

(xi) Heat energy (Joule's law)

Current

$$\text{Heat energy (H)} = V I t$$

Voltage

Time

(xii) Specific heat

Heat supplied

$$C = \frac{Q}{m\underbrace{(t_2 - t_1)}_{\text{Change in temperature}}}$$

Mass of body

(xiii) Sensible heat

Mass

Specific heat

$$\text{Sensible heat} = mC \underbrace{(t_2 - t_1)}_{\text{Change in temperature}}$$

(xiv) Latent heat

$$\text{Latent heat} = m \,.\, L$$

Mass of substance

Specific latent heat or enthalpy

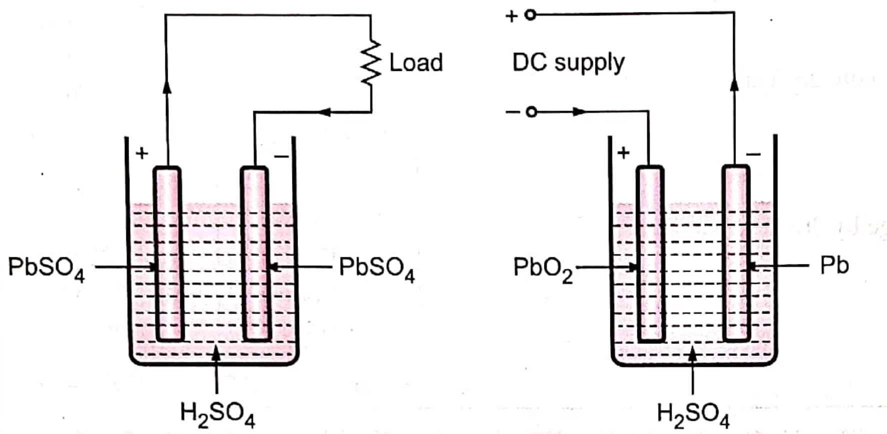
(xv) Efficiency of System

$$\eta = \frac{\text{Energy Output}}{\text{Energy Input}} \times 100\%$$

$$\text{OR} \quad \eta = \frac{\text{Power Output}}{\text{Power Input}} \times 100\%$$

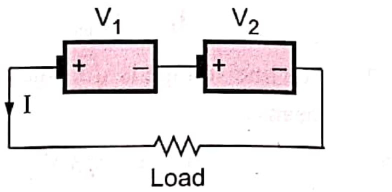
Chapter 9 (Unit VI) Batteries

lead Acid Battery

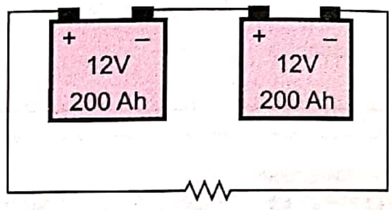


(a) Discharging (b) Charging

Parallel connection of batteries



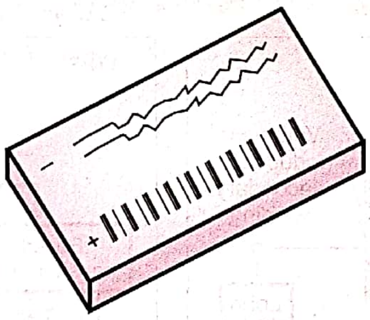
(a)



(b)

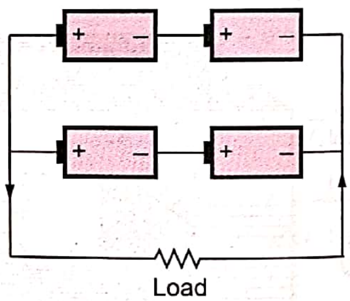
Types of lithium ion batteries

(a) A typical lithium ion battery

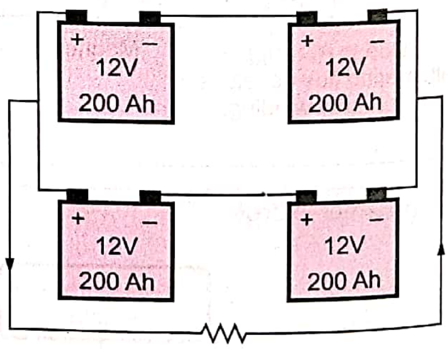


(b) Li ion batteries found in mobile phones

Series parallel connection of batteries

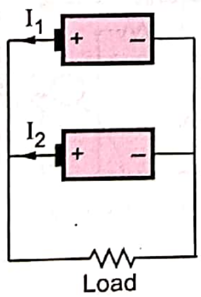


(a)

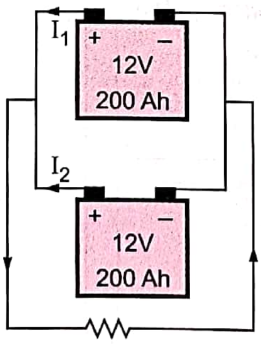


(b)

Series connection of batteries



(a)



(b)