CLASS NOTES OF "BASIC ELECTRICAL ENGG."

Technical Classes

✅ Technical Classes के Course में उपलब्ध फीचर्स

1. सभी कक्षाएं स्मार्ट बोर्ड पर Live
2. विशेषज्ञ शिक्षको द्वारा पठन पाठन
3. Lecture के दौरान डाउट सॉल्विंग
4. Recorded Lecture (VOD)
5. प्रत्येक क्लास का PDF नोट्स
6. SBTE Exam की तैयारी के लिए ब्रह्मास्त्र क्लास
7. Laptop में क्लास देखने की सुविधा

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नोट :-

1. सभी ऑफलाइन कक्षाएं Technical Classes के कैंपस तथा सभी ऑनलाइन कक्षाएं Technical Classes के एप्लीकेशन पर चलेगी।

2. यह नोट्स टेक्निकल क्लासेस के स्टूडेंट्स के लिए है, तथा क्लास करने के बाद अधिक प्रभावी होगा।

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2420104

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Explain the concept of AC and DC currents. TSO 1b. Identify practical and Ideal current sources. TSO 1c. Explain the concept of DC and AC Voltage. TSO 1d. Distinguish practical and Ideal voltage sources. TSO 1e. Calculate equivalent resistance of the given electric circuit. TSO 1f. Explain the given effect of the electric current with a relevant application. TSO 1g. Calculate work, power, and energy for the given circuit.	**Unit-1.0 Basic Concepts of Electrical Engineering** 1.1 Electrical Charge and flow of Charges 1.2 Current (D.C/A.C): Concept of Ideal & Practical current sources 1.3 Voltage (D.C /A.C): • Concept of E.M.F. • Potential difference • Terminal voltage. • Concept of Ideal & Practical voltage sources 1.4 Resistor. • Properties. • Classification of resistors • Practical application of resistors. • Commonly used resistance material. • Effect of temperature on resistance. • Series and parallel combination of resistances 1.5 Heating Effect, Magnetic effect, Chemical effect of electric current. 1.6 Electrical work, power and Energy	**CO1**
TSO 2a. Explain the concept of Capacitance. TSO 2b. Calculate energy stored in the given capacitor. TSO 2c. Deduce Voltage and Current equation of a Capacitor. TSO 2d. Calculate equivalent capacitance in the given series and parallel capacitive circuit. TSO 2e. Explain effect of the given dielectric media on capacitance. TSO 2f. Describe the process of charging and discharging of capacitor. TSO 2g. Explain the behavior of a Capacitor in the given circuit. TSO 2h. State the criteria for the Selection of type of the capacitors for the given applications. **Inductors**	**Unit-2.0 Energy Storing Elements** **Capacitors** 2.1 Capacitance formation, Expression for capacitance 2.2 Capacitive reactance. 2.3 Energy stored in a Capacitor. 2.4 Voltage and Current equation for capacitor. 2.5 Series & Parallel combination of capacitors. 2.6 Effect of dielectric media on capacitance. • Electric field strength • Electric flux density. • Permittivity. 2.7 Charging and discharging of capacitors.	**CO1, CO2**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 2i. Explain Self & mutual Inductance and Inductive reactance. TSO 2j. Explain the behavior of inductor to AC and DC sources. TSO 2k. Calculate energy stored in the given inductor. TSO 2l. Deduce voltage and current equation of an Inductor. TSO 2m. Explain the behavior of current and voltage in an inductor. TSO 2n. Describe the process for Selection of the Inductors for the given applications.	2.8 Initial and Final Conditions in a capacitor- rise of current and voltage (No derivation, numerical only) 2.9 Leading power factor behavior of a capacitor 2.10 A.C./D.C. capacitors and Applications. **Inductors** 2.11 Self and mutual inductance, Inductive Reactance 2.12 Behavior of inductor to AC and DC sources 2.13 Energy stored in an inductor. 2.14 Voltage and current equations of inductor. 2.15 Initial and final conditions in an Inductor - rise of current and voltage (No derivation, numerical only). 2.16 Inductor types and their applications.	
TSO 3a. Apply Ohm's law to calculate internal resistance of the given circuit. TSO 3b. Identify the given circuit elements. TSO 3c. Apply concept of node, branch, loop, mesh in the given circuit. TSO 3d. Apply Kirchhoff's laws to determine current and voltage in the given circuit. TSO 3e. Explain various quantities related to A.C. TSO 3f. Calculate RMS and Average value of the given waveform. TSO 3g. Represent given A.C quantities in rectangular and polar form. TSO 3h. Draw phasor diagram for series R-L and R-C circuit. TSO 3i. Determine Voltage and Current in a simple series R-L and R-C circuit.	**Unit-3.0 Basics of D.C & A.C Circuits** **D.C Circuits;** 3.1 Ohm's Law 3.2 Internal resistance of source 3.3 Internal voltage drops, Terminal voltage. 3.4 Active & Passive elements. 3.5 Linear & Non-linear circuit. 3.6 Unilateral and Bilateral circuit element. 3.7 Node, Branch, Loop, Mesh 3.8 Kirchhoff's Current Law (KCL). 3.9 Kirchhoff's Voltage law (KVL). **A.C Circuits** 3.10 Frequency, Time period, Amplitude, Angular Velocity, RMS Value, Average Value, Form factor, Peak factor, power factor. 3.11 Representation of AC quantities in rectangular and polar form and conversion. 3.12 Phasor representation of alternating quantities. 3.13 Phasor representation of sinusoidal quantities. 3.14 Voltage and current response in R-L and R-C circuit.	**CO2, CO3**
TSO 4a. Define the given terms related to a magnetic circuit. TSO 4b. Calculate various parameters of the given magnetic circuit. TSO 4c. Interpret B-H curve and Hysteresis loop of the given magnetic material. TSO 4d. Compare the characteristics of the given electric and magnetic circuit.	**Unit-4.0 Magnetic Circuits** 4.1 Terms related to magnetic circuit; • Magnetic flux • Magnetomotive force • Magnetic field strength • Permeability • Reluctance. • Magnetic leakage, leakage coefficient	**CO3, CO 4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
	(Simple numerical on above) 4.2 Magnetic circuits; ● Uniform magnetic circuits. ● Series & parallel circuits 4.3 Magnetic Hysteresis, Hysteresis loop. 4.4 Magnetization (B-H) Curve and its Applications. 4.5 Comparison of Electric and Magnetic circuits	
TSO 5a. Explain the phenomenon of production of induced e.m.f and current in the given equipment. TSO 5b. Differentiate between statically and dynamically induced emf. TSO 5c. Apply principles of Faraday's law to calculate induced e.m.f in the given circuit. TSO 5d. Apply principles of the given Laws and rules in the given magnetic circuit. TSO 5e. Calculate self-inductance and mutual inductance in the given magnetic circuit. TSO 5f. Identify the given types of coupling.	**Unit-5.0 Electromagnetism** 5.1 Electromagnetic induction, Induced e.m.f and current. 5.2 Statically and dynamically induced emf. 5.3 Farady's Laws of Electromagnetic Induction. 5.4 Lenz's Law, Fleming's R.H. rule; direction of induced E.M.F, Fleming's L.H. rule, Ampere's Law. 5.5 Self and mutual inductances. 5.6 Co-efficient of mutual inductance (M), Co-efficient of coupling. 5.7 Interaction between two or more magnetic field.	**CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2420104

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Identify the Resistor Component available in the Laboratory.	1.	Identification of Resistor	CO1
LSO 1.2. Plot the terminal voltage of a source starting from no load to different load (Current) conditions.	2.	Effect of different load conditions on terminal voltage of a source	CO1
LSO 1.3. Measure current and voltage in a branch of the given electric circuit	3.	Measurement of current and voltage in a branch of the given electric circuit	CO1
LSO 1.4 Connect resistors in series and parallel combination on bread board and measure resistance using digital multimeter.	4.	Measurement of resistances in series and combination in an electric circuit	CO1
LSO 1.5 Calculate the value of color-coded resistor and verify it by measuring the value of resistor using digital multimeter	5.	Value of color-coded resistor	CO1
LSO 2.1 Calculate the value of equivalent Inductance in series and parallel combination and verify by measuring the value of capacitance using suitable meter (Digital Multimeter/LCR Meter).	6.	Measurement of the value of Inductor in series and parallel combination in a circuit	CO1, CO2

Welcome
to
Technical Classes

BASIC ELECTRICAL ENGINEERING

Imp.

Sem-1st

Electrical Engineering

Er. Vijay Pandit

UNIT - 1

Basic Concepts of Electrical Engineering

1.1 Electrical Charge and flow of Charges
1.2 Current (D.C/A.C): Concept of Ideal & Practical current sources
1.3 Voltage (D.C /A.C):
- Concept of E.M.F.
- Potential difference
- Terminal voltage.
- Concept of Ideal & Practical voltage sources

1.4 Resistor.
- Properties.
- Classification of resistors
- Practical application of resistors.
- Commonly used resistance material.
- Effect of temperature on resistance.
- Series and parallel combination of resistances

1.5 Heating Effect, Magnetic effect, Chemical effect of electric current.
1.6 Electrical work, power and Energy

UNIT- 2

Energy Storing Elements

- Capacitors

2.1 Capacitance formation, Expression for capacitance
2.2 Capacitive reactance.
2.3 Energy stored in a Capacitor.
2.4 Voltage and Current equation for capacitor.
2.5 Series & Parallel combination of capacitors.
2.6 Effect of dielectric media on capacitance.
- Electric field strength
- Electric flux density.
- Permittivity.

2.7 Charging and discharging of capacitors.
2.8 Initial and Final Conditions in a capacitor- rise of current and voltage (No derivation, numerical only)
2.9 Leading power factor behavior of a capacitor
2.10 A.C./D.C. capacitors and Applications.

Inductors

2.11 Self and mutual inductance, Inductive Reactance
2.12 Behavior of inductor to AC and DC sources
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2.16 Inductor types and their applications

UNIT- 3

Basics of D.C & A.C Circuits

- D.C Circuits;

3.1 Ohm's Law
3.2 Internal resistance of source
3.3 Internal voltage drops, Terminal voltage.
3.4 Active & Passive elements.
3.5 Linear & Non-linear circuit.
3.6 Unilateral and Bilateral circuit element.
3.7 Node, Branch, Loop, Mesh
3.8 Kirchhoff's Current Law (KCL).
3.9 Kirchhoff's Voltage law (KVL).

A.C Circuits

3.10 Frequency, Time period, Amplitude, Angular Velocity, RMS Value, Average Value, Form factor, Peak factor, power factor.
3.11 Representation of AC quantities in rectangular and polar form and conversion.
3.12 Phasor representation of alternating quantities.
3.13 Phasor representation of sinusoidal quantities.
3.14 Voltage and current response in R-L and R-C circuit.

UNIT-4

Magnetic Circuits

4.1 Terms related to magnetic circuit;

- Magnetic flux
- Magnetomotive force
- Magnetic field strength
- Permeability
- Reluctance.
- Magnetic leakage, leakage coefficient (Simple numerical on above)

4.2 Magnetic circuits;

- Uniform magnetic circuits.
- Series & parallel circuits

4.3 Magnetic Hysteresis, Hysteresis loop.

4.4 Magnetization (B-H) Curve and its Applications.

4.5 Comparison of Electric and Magnetic circuits

UNIT-5

Electromagnetism

5.1 Electromagnetic induction, Induced e.m.f and current.

5.2 Statically and dynamically induced emf.

5.3 Faraday's Laws of Electromagnetic Induction.

5.4 Lenz's Law, Fleming's R.H. rule; direction of induced E.M.F, Fleming's L.H. rule, Ampere's Law.

5.5 Self and mutual inductances.

5.6 Co-efficient of mutual inductance (M), Coefficient of coupling.

5.7 Interaction between two or more magnetic field.

BEE

Course → Bilingual (Hindi + English)

Requirement –

1. Note Copy = 300 Pages
2. Calculator
3. Book :– Basic Electrical Engg By V.K Mehta

Charge (आवेश)

Matter: Property

↑

Molecules

↑

Atom

→ Atomic structure

Copper

Thank

You

Welcome
to
Technical Classes

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-02

Electrical Engineering

Er. Vijay Pandit

UNIT - 1

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UNIT- 2

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UNIT- 3

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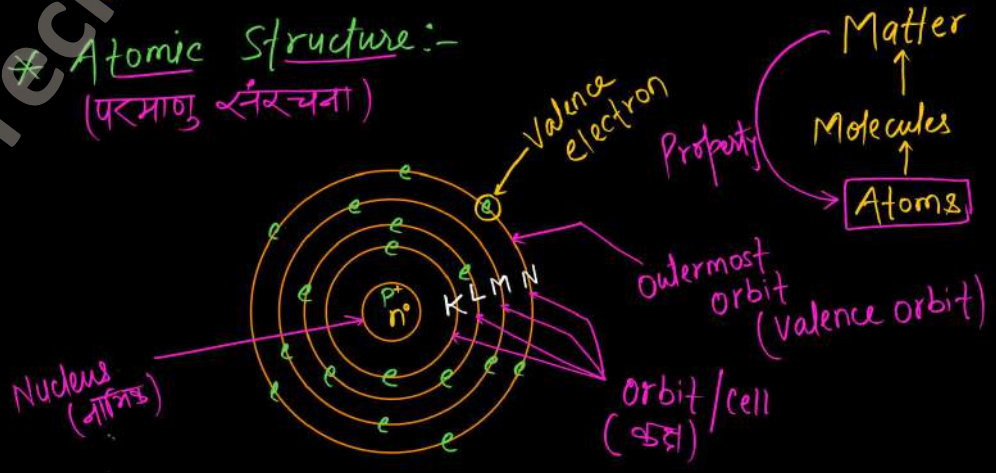
UNIT-01: Basic Concepts of Electrical Engg

* Atomic Structure :-
(परमाणु संरचना)



→ To know the property of any matter we have to study Atomic structure of Atoms of that matter.

→ Central part of atom is called Nucleus.

→ Proton and Neutron are present in Nucleus.

→ Circular path is available around the Nucleus is called orbit or cell.

→ electrons are presents in orbit or cell.

→ Nucleus of atom is positively charged because Proton has positive charge. ($+1.602 \times 10^{-19} C$)

→ Every electron present in orbit are bounded by Nucleus Forces of Attraction.

→ Nucleus Forces decreases as electrons moves from Nucleus to outer orbit.

→ Energy level of electrons Increases as its distances increases from Nucleus.

i.e $E_K < E_L < E_M < E_N$

→ Orbit or Cell is denoted by K, L, M, N and so on in order.

→ Every orbit has Fixed Max^m No. of electrons, which is given by Formula of $\boxed{2n^2}$; Here, n = No. of orbit

For 'K' Cell : $n = 1 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(1)^2 = 2$

For 'L' Cell : $n = 2 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(2)^2 = 8$

For 'M' Cell : $n = 3 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(3)^2 = 18$

For 'N' Cell : $n = 4 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(4)^2 = 32$

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-03

Electrical Engineering

Er. Vijay Pandit

UNIT - 1

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Lec-03 UNIT-01: Basic Concepts of Electrical Engg

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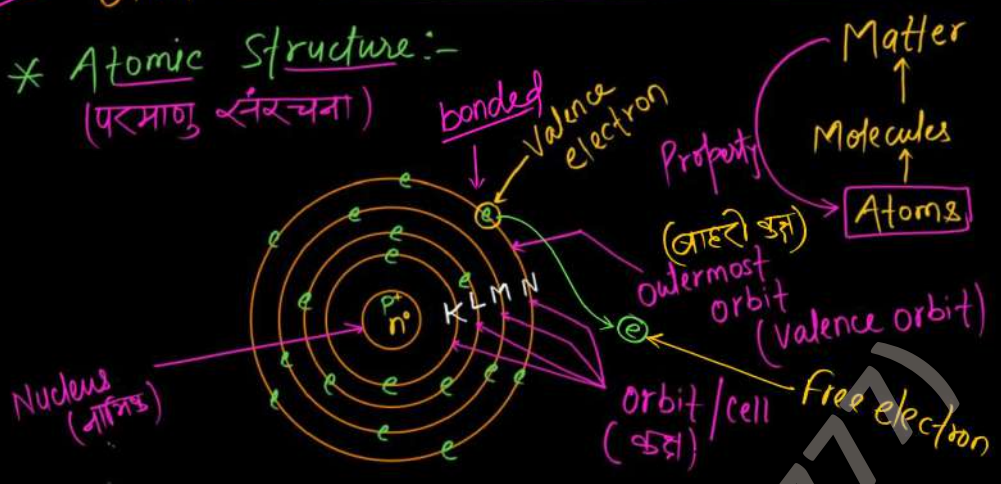

→ Outermost orbit of atom is called valence orbit
परमाणु के बाहरी कक्ष को valence कक्ष कहते हैं।

→ Electrons present in valence orbit is called valence electron.
Valence कक्ष में मौजूद इलेक्ट्रॉन को Valence इलेक्ट्रॉन कहते हैं।

→ Valence electron does not takes part in current conduction.
Valence इलेक्ट्रॉन धारा प्रवाह करने में सक्षम नहीं होता है।

→ If External Energy is supplied to valence electron then valence electron leaves the valence orbit and becomes free in crystal as free electron.
यदि Valence इलेक्ट्रॉन को बाहरी ऊर्जा प्रदान किया जाए तो Valence इलेक्ट्रॉन, Valence कक्ष को छोड़कर बाहर निकल जाता है और आजाद (स्वतंत्र) इलेक्ट्रॉन बन जाता है।

→ Electric current flows due to flow of free electron.
विद्युत धारा का प्रवाह स्वतंत्र इलेक्ट्रॉन के द्वारा होता है।

Q. Why an atom is Electrically Neutral?
एक परमाणु विद्युत: उदासीन होता है, क्यों?

Home work

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-04

Electrical Engineering

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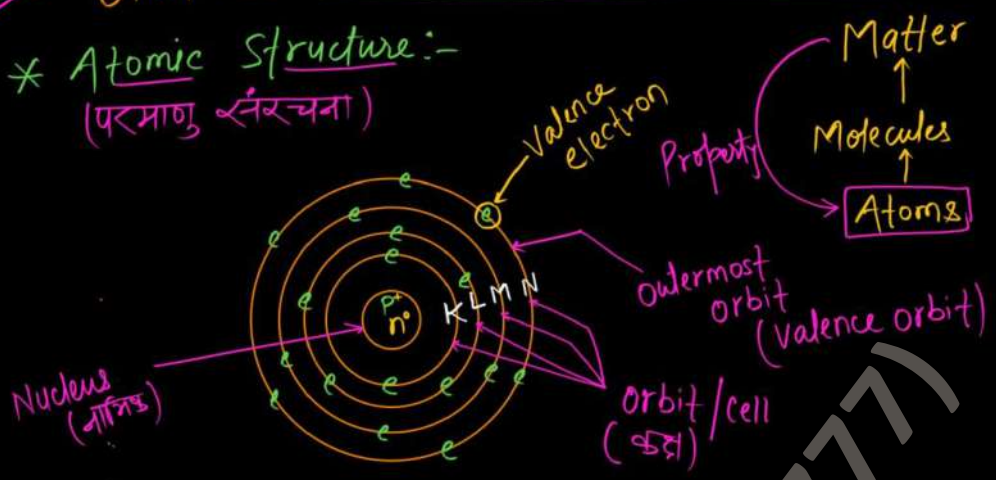
Lec-02 UNIT-01: Basic Concepts of Electrical Engg

* Atomic Structure :-
(परमाणु संरचना)



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Lec-03 UNIT-01 : Basic Concepts of Electrical Engg

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(परमाणु संरचना)

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परमाणु के बाहरी कक्ष को valence कक्ष कहते हैं।

→ Electrons present in valence orbit is called Valence electron.
Valence कक्ष में मौजूद इलेक्ट्रॉन को Valence इलेक्ट्रॉन कहते हैं।

→ Valence electron does not takes part in current Conduction.
Valence इलेक्ट्रॉन धारा प्रवाह करने में सहायक नहीं होता है।

→ If External Energy is Supplied to valence electron then valence electron leaves the valence orbit and becomes free in crystal as free electron.

यदि Valence इलेक्ट्रॉन को बाहरी ऊर्जा प्रदान किया जाए तो Valence इलेक्ट्रॉन, Valence कक्ष को छोड़कर बाहर निकल जाता है और आजाद (स्वतंत्र) इलेक्ट्रॉन बन जाता है।

→ Electric current flows due to flow of free electron.

विद्युत धारा का प्रवाह स्वतंत्र इलेक्ट्रॉन के कारण होता है।

V.V.I

Q. Why an atom is Electrically Neutral?

एक परमाणु विद्युत: उदासीन होता है, क्यों?

Ans:- In an atom,

No. of electrons = No. of Protons

charge on 1 electrons = -1.602×10^{-19} C

Charge on 1 Proton = $+1.602 \times 10^{-19}$ C

Total charge on atom = Total -ve charge on electrons + Total +ve charge on Proton

Total charge on atom = 0

thus An atom is electrically Neutral because net charge on atom is zero.

Thank
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BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-05

Electrical Engineering

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Charge on $1e = -1.602 \times 10^{-19} C$
Charge on $1P = +1.602 \times 10^{-19} C$

* charge :-

$\boxed{Q = ne}$

$\boxed{Q = 1e^-}$

Positive charged Atom

Negative charge Atom

$1e^-$ Remove or Loss (कमी)

A

$P = 10$
$e = 10$ } Neutral (उदासीन)

$P = 10$
$e = 10 - 1 = 9$

Resultant charge = charge on 1 Proton

B

$1e^-$ Gain or Excess (वृद्धि)

$P = 10$
$e = 10$

$P = 10$
$e = 10 + 1 = 11$

Resultant charge = charge on 1 electron

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$$10P = 10 \times 1.602 \times 10^{-19} = (9+1) \times 1.602 \times 10^{-19}$$
$$9e = 9 \times -1.602 \times 10^{-19}$$

$$10P = \cancel{9 \times 1.602 \times 10^{-19} C} + \boxed{1 \times 1.602 \times 10^{-19}}$$
$$9e = \cancel{-9 \times 1.602 \times 10^{-19} C}$$

1P ⊕

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* Charge :-

→ Loss of electron or gain of electron is called Charge.

→ The phenomenon by which any substance Experience a Force of attraction or Repulsion, is called charge.

→ It is denoted by 'Q' and its unit is Coulomb.

→ Magnitude of charge is given by $\boxed{Q = ne}$

n = No. of electrons

e = charge on $1e^-$
$= 1.602 \times 10^{-19} C$

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Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-06

Electrical Engineering

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Charge on $1e = -1.602\times10^{-19}c$

Charge on $1P = +1.602\times10^{-19}c$

* charge :-

$Q = ne$ ← $Q = 1e^-$

Positive charged Atom

Negative charge Atom

$1e^- = -1.602\times10^{-19}c$

$1e^-$ Gain or Excess (वृद्धि)

$1e^-$ Remove or Loss (कमी)

$Q = ne$

A

$1P = +1.602\times10^{-19}c$

(उदासीन)

$P = 10$, $e = 10$ } Neutral

$Q = ne$

$P = 10$

$e = 10 - 1 = 9$

Resultant charge = charge on 1 Proton

B

$Q = ne$

$P = 10$, $e = 10$ } Neutral (उदासीन)

$P = 10$

$e = 10 + 1 = 11$

Resultant charge = charge on 1 electron

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$10P = 10 \times 1.602\times10^{-19} = (9+1)\times1.602\times10^{-19}$

$9e = 9\times -1.602\times10^{-19}$

$10P = \cancel{9\times1.602\times10^{-19}c} + \boxed{1\times1.602\times10^{-19}}$

$9e = \cancel{-9\times1.602\times10^{-19}c}$

1P ⊕

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* Charge :-

→ Loss of electron or gain of electron is called Charge.

The phenomenon (घटना) by which any Substance (वस्तु) Experience (अनुभव) a Force of attraction (आकर्षण) or Repulsion (विकर्षण), is called charge.

→ It is denoted by 'Q' and its unit is Coulomb

→ Magnitude of charge is given by $\boxed{Q = ne}$

n = No. of electrons

e = charge on $1e^-$

$= 1.602 \times 10^{-19} C$

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	Electron	Proton	Neutron
Notation	e	p	n
charge	$-1.602 \times 10^{-19} C$	$+1.602 \times 10^{-19} C$	Zero or Nil
Mass	$9.11 \times 10^{-31} kg$	$1.67 \times 10^{-27} kg$	$1.67 \times 10^{-27} kg$
Discoverer	J.J Thomson	Rutherford	James Chadwick

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Mass of electrons, $M_e = \frac{1}{1837} \times$ Mass of Proton

$M_p = 1837 \times M_e$

$\boxed{M_p \simeq 1840\, M_e}$

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Thank
You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-7

Electrical Engineering

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	Electron	Proton	Neutron
Notation	e	p	n
Charge	-1.602×10^{-19}c	$+1.602\times10^{-19}$c	Zero or Nil
Mass	9.11×10^{-31}kg	1.67×10^{-27}kg	1.67×10^{-27}kg
Discoverer	J.J Thomson	Rutherford	James Chadwick

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Mass of electrons, $M_e = \frac{1}{1837} \times$ Mass of Proton

$M_p = 1837 \times M_e$

$M_p \simeq 1840\, M_e$

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Charge on $1e^- = 1.602 \times 10^{-19} C$

$$\frac{1e}{1.602 \times 10^{-19}} = 1C$$

$\Rightarrow 6.25 \times 10^{18}$ electrons $= 1C$

$\Rightarrow 625 \times 10^{16}$ electrons $= 1C$

No. of electrons in 1 Coulomb of charge

$1C = 6.25 \times 10^{18}$ electrons

$= 625 \times 10^{16}$ electrons.

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* Types of charges :-

① Positive charge → Loss of electrons
इलेक्ट्रॉन की कमी

② Negative charge → gain or Excess of electrons
इलेक्ट्रॉन की वृद्धि

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① Positive charge – When Loss of electrons from atom occurs is called Positive charge.

② Negative charge :- When gain or Excess of electrons from atom is called Negative charge

Magnitude of charge, Q = No. of electrons × charge on $1e^-$

$$Q = ne$$

n = No. of electrons

e = charge on $1e^-$

$= 1.602 \times 10^{-19} C$

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* Classification of material A/c to Valence electrons

Conductor चालक	Semiconductor अर्धचालक	Insulator / Bad Conductor कुचालक
A	B	C
V.e = 3	V.e = 4	V.e = 5
$5e^-$ Flow	$4e^-$ Flow	$3e^-$ Flow
अष्टक के लिए 8 − 3 = 5e	4e	3e

- V.e < 4 ⇒ Conductor (चालक)
- V.e = 4 ⇒ Semiconductor (अर्धचालक)
- V.e > 4 ⇒ Bad conductor / Insulator (कुचालक)

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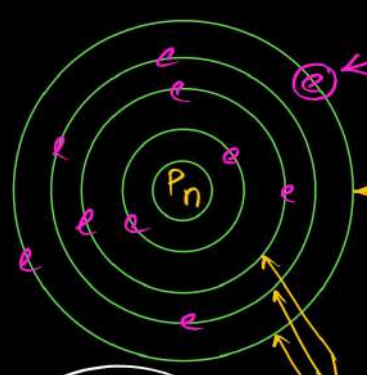

Valence electrons

बाहरी कक्षा
outer orbit
(Valence orbit)

V.e = 5

orbit (cell) कक्षा

octate अष्टक → Valence orbit में select

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Thank You

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Sem-1st

Lec-8

Electrical Engineering

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* Electric current (विद्युत धारा) :-

- The flow of free electrons in a definite direction, is called Electric current.
- Current is denoted by 'I'.
- In a ckt, current measurement is given by 'Flow of charge per unit second'.

Current, $I = \frac{Q}{t}$ → Q: Coulomb, t: Second

→ Unit = Coulomb / Second or Ampere

10 sec → 100 C

$I = \frac{100}{10} = 10 C/s$

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

Q = Total charge

t = time in second

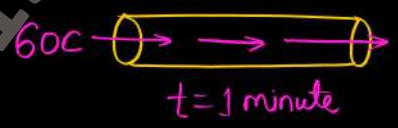
n = No. of Conductor

e = charge on $1e^-$

$= 1.602 \times 10^{-19} C$

Q. Find the current in a conductor when 60C charge is flowing in 1 minute through the conductor.

Sol^n Charge, $Q = 60C$



time, $t = 1$ minute

$t = 1 \times 60 = 60$ sec

Current, $I = \frac{Q}{t} = \frac{60}{60} = 1$ Coulomb/sec or 1 Amp.

$Q = 60C$

$Q = ne$

$n = \frac{Q}{e} = \frac{60}{1.602 \times 10^{-19}} = \frac{60}{1.602} \times 10^{19} = 37.45 \times 10^{19}$

$= 3.745 \times 10^{18} e$

Q. Find the no. of electrons flowing through conductor per second when 1A current is flowing.

Sol^n $I = 1A$, $t = 1$ sec

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

$Q = I \times t$

$= 1 \times 1$

$Q = 1C$

$Q = ne$

no. of electrons

$n = \frac{Q}{e} = \frac{1}{1.602 \times 10^{-19}}$

$= 6.25 \times 10^{18}$

$= 625 \times 10^{16}$ electrons

Thank You

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Sem-1st

Lec-9

Electrical Engineering

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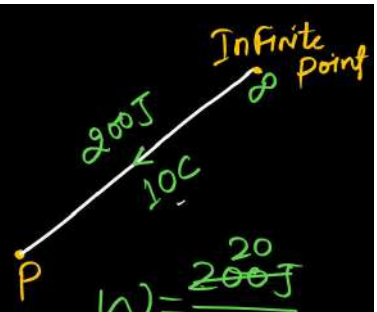
* Electric Potential (विद्युत विभव):-

Electric potential at a point is defined as the workdone which has to be done to bring the unit +ve charge from infinite point to that point.

$$\boxed{\text{Electric potential} = \frac{\text{Workdone}}{\text{Charge}}}$$



$$W = \frac{\cancel{200}^{20}\,J}{\cancel{10}\,C}$$

$$= 20\,J/C$$

$V = \frac{W}{Q}$ → Joule, → Coulomb

→ Unit: $\frac{\text{Joule}}{\text{Coulomb}}$ or Joule/Coulomb (J/C) or Volt

$1\ \text{Volt} = 1\ J/C$

$V_A = 1V$, ∞, 1C, 1Joule, A

* Potential difference (विभवांतर) :-

$V_A > V_B$

V_A, A → Higher Potential (HP)

V_B, B → Lower Potential (LP)

The difference of Electric potential between two point, is called Potential difference.

$$V_{AB} = V_A - V_B$$

HP LP HP LP

$V_{AB} = V_A - V_B$

$= -(V_B - V_A)$

$V_{AB} = -V_{BA}$

$V_{BA} = -V_{AB}$

C, D

$V_{CD} = 12V$

$V_{DC} = -V_{CD}$

$= -12V$

P, Q

$V_P = 5V$, $V_Q = 8V$

$P.D = V_{QP} = V_Q - V_P$

$= 8 - 5 = 3\ \text{Volt}$

$V_{PQ} = V_P - V_Q$

$= 5 - 8 = -3V$

$V_A > V_B$

HP, LP

V_A, A, charge, V_B, B, 100J, 5C

$P.D = \frac{100J}{5C} = 20J/C = 20\ \text{Volt}$

↳ P.D b/w two point is defined as workdone which has to be done to bring the unit +ve charge from one point to another.

$$P.D = \frac{\text{Workdone}}{\text{Charge}}$$

$$P.D = \frac{W}{Q}$$

Unit: Joules/Coulomb or Volt.

Thank You

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Sem-1st

Lec-10

Electrical Engineering

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EMF (Electromotive Force) :-

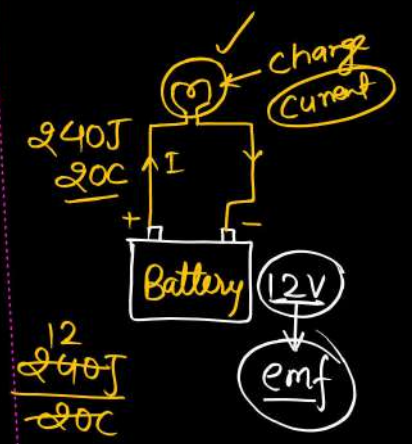
(विद्युत वाहक बल)

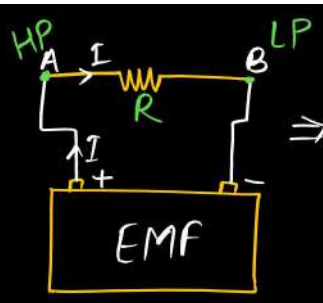
The energy released by Battery to transfer unit Coulomb of charge is called EMF.

$$EMF = \frac{Energy}{Charge} = \frac{Workdone}{Charge}$$

Energy → Joule; Charge → Coulomb

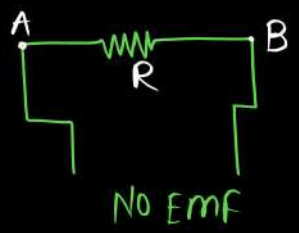
Unit: Joule/Coulomb or Volt





$\Rightarrow V_{AB} = V_A - V_B$

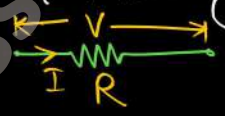
$\rightarrow$ EMF maintain P.D in ckt



$\Rightarrow V_{AB} = V_A - V_B = 0$

Ohm's law (ओम का नियम):-

It states that "at Constant physical Condition (temperature and Pressure), the developed Potential difference b/w ends of a Conductor is directly Proportional to current Flowing through it".



i.e $\boxed{V \propto I}$

$V \propto I$

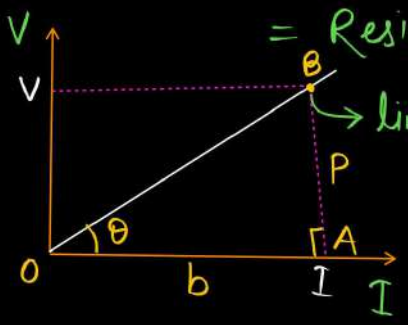
$V = RI$

$\boxed{V = IR}$

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

where, R = proportional Constant

= Resistance of Conductor

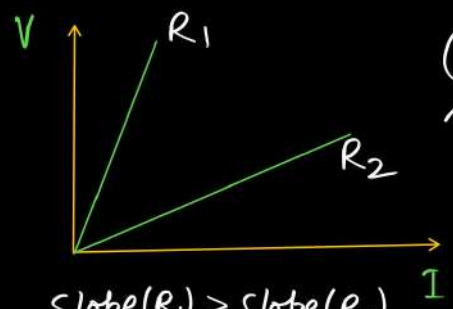


$\rightarrow$ linear

In ΔOAB

$\tan\theta = \frac{P}{b} = \frac{AB}{OA} = \frac{V}{I} = R$

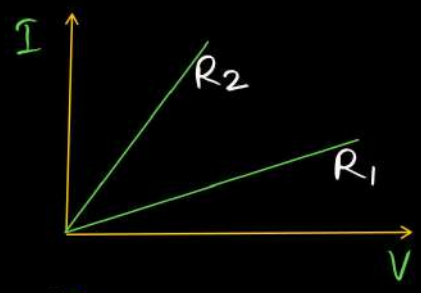
$\boxed{\text{Slope} = \tan\theta = \frac{V}{I} = R}$



Slope(R_1) > Slope(R_2)

$R_1 > R_2$

Q.



(a) $R_1 > R_2$

(b) $R_1 < R_2$

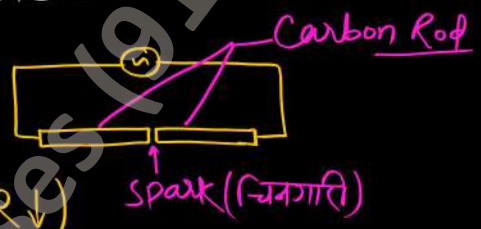
(3) $R_1 = R_2$

(4) None of Above

* Limitations of ohm's law.

(1) Metal which gets heated due to the flow of Electric current.

(2) Arc lamp



(3) Semiconductor (T↑, R↓)

(4) Electrolytes.

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Revision

Electrical Engineering

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UNIT - 1

Basic Concepts of Electrical Engineering

1.1 Electrical Charge and flow of Charges

1.2 Current (D.C/A.C): Concept of Ideal & Practical current sources

1.3 Voltage (D.C /A.C):

- Concept of E.M.F.
- Potential difference
- Terminal voltage.
- Concept of Ideal & Practical voltage sources

1.4 Resistor.

- Properties.
- Classification of resistors
- Practical application of resistors.
- Commonly used resistance material.
- Effect of temperature on resistance.
- Series and parallel combination of resistances

1.5 Heating Effect, Magnetic effect, Chemical effect of electric current.

1.6 Electrical work, power and Energy

UNIT- 2

Energy Storing Elements

- Capacitors

2.1 Capacitance formation, Expression for capacitance

2.2 Capacitive reactance.

2.3 Energy stored in a Capacitor.

2.4 Voltage and Current equation for capacitor.

2.5 Series & Parallel combination of capacitors.

2.6 Effect of dielectric media on capacitance.

- Electric field strength
- Electric flux density.
- Permittivity.

2.7 Charging and discharging of capacitors.

2.8 Initial and Final Conditions in a capacitor- rise of current and voltage (No derivation, numerical only)

2.9 Leading power factor behavior of a capacitor

2.10 A.C./D.C. capacitors and Applications.

Inductors

2.11 Self and mutual inductance, Inductive Reactance

2.12 Behavior of inductor to AC and DC sources

2.13 Energy stored in an inductor.

2.14 Voltage and current equations of inductor.

2.15 Initial and final conditions in an Inductor - rise of current and voltage (No derivation, numerical only).

2.16 Inductor types and their applications

UNIT- 3

Basics of D.C & A.C Circuits

- D.C Circuits;

3.1 Ohm's Law

3.2 Internal resistance of source

3.3 Internal voltage drops, Terminal voltage.

3.4 Active & Passive elements.

3.5 Linear & Non-linear circuit.

3.6 Unilateral and Bilateral circuit element.

3.7 Node, Branch, Loop, Mesh

3.8 Kirchhoff's Current Law (KCL).

3.9 Kirchhoff's Voltage law (KVL).

A.C Circuits

3.10 Frequency, Time period, Amplitude, Angular Velocity, RMS Value, Average Value, Form factor, Peak factor, power factor.

3.11 Representation of AC quantities in rectangular and polar form and conversion.

3.12 Phasor representation of alternating quantities.

3.13 Phasor representation of sinusoidal quantities.

3.14 Voltage and current response in R-L and R-C circuit.

UNIT-4

Magnetic Circuits

4.1 Terms related to magnetic circuit;

- Magnetic flux
- Magnetomotive force
- Magnetic field strength
- Permeability
- Reluctance.
- Magnetic leakage, leakage coefficient (Simple numerical on above)

4.2 Magnetic circuits;

- Uniform magnetic circuits.
- Series & parallel circuits

4.3 Magnetic Hysteresis, Hysteresis loop.

4.4 Magnetization (B-H) Curve and its Applications.

4.5 Comparison of Electric and Magnetic circuits

UNIT-5

Electromagnetism

5.1 Electromagnetic induction, Induced e.m.f and current.

5.2 Statically and dynamically induced emf.

5.3 Faraday's Laws of Electromagnetic Induction.

5.4 Lenz's Law, Fleming's R.H. rule; direction of induced E.M.F, Fleming's L.H. rule, Ampere's Law.

5.5 Self and mutual inductances.

5.6 Co-efficient of mutual inductance (M), Coefficient of coupling.

5.7 Interaction between two or more magnetic field.

Charge (आवेश)

Copper

Matter: Property

↑

Molecules

↑

Atom → Atomic structure

UNIT-01: Basic Concepts of Electrical Engg

* Atomic Structure :-
(परमाणु संरचना)

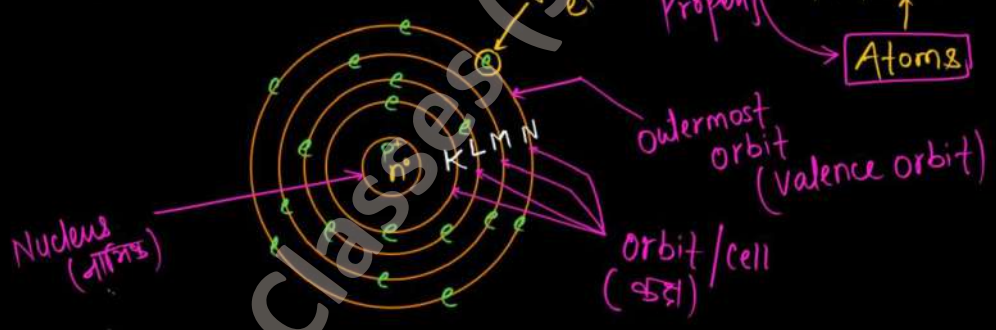
Free electron

Matter

Property

Molecules

Atoms



→ To know the property of any matter we have to study Atomic structure of Atoms of that matter.
→ Central part of atom is called Nucleus.
→ Proton and Neutron are present in Nucleus.
→ Circular path is available around the Nucleus is called orbit or cell.
→ electrons are presents in orbit or cell.
→ Nucleus of atom is positively charged because Proton has positive charge. ($+1.602 \times 10^{-19} C$)

→ Every electron present in orbit are bounded by Nucleus Forces of Attraction.

→ Nucleus Forces decreases as electrons moves From Nucleus to outer orbit.

→ Energy level of electrons Increases as its distances increases From Nucleus.

i.e $E_K < E_L < E_M < E_N$

→ Orbit or Cell is denoted by K, L, M, N and so on in order.

→ Every orbit has Fixed Max^m No. of electrons, which is given by Formula of $\boxed{2n^2}$; Here, n = No. of Orbit

For 'K' Cell : $n = 1 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(1)^2 = 2$

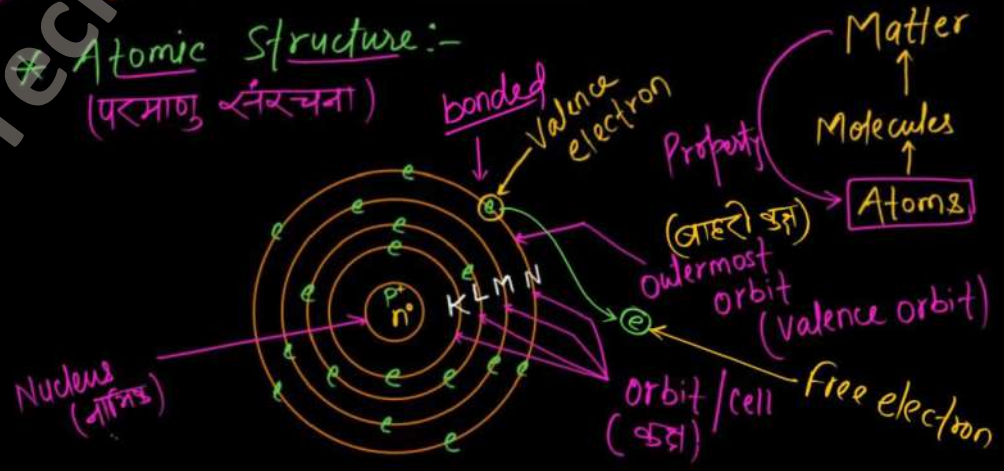
For 'L' Cell : $n = 2 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(2)^2 = 8$

For 'M' Cell : $n = 3 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(3)^2 = 18$

For 'N' Cell : $n = 4 \Rightarrow$ Max^m No. of electrons $= 2n^2 = 2(4)^2 = 32$

Lec-03 UNIT-01 : Basic Concepts of Electrical Engg

* Atomic Structure :-
(परमाणु संरचना)



→ Outermost orbit of atom is called valence orbit
परमाणु के बाहरी कक्ष को valence कक्ष कहते हैं।

→ Electrons present in valence orbit is called valence electron.
Valence कक्ष मे मौजूद इलेक्ट्रॉन को valence इलेक्ट्रॉन कहते हैं।

→ Valence electron does not takes part in current conduction.
Valence इलेक्ट्रॉन धारा प्रवाह करने में सहायक नहीं होता है।

→ IF External Energy is supplied to valence electron then valence electron leaves the valence orbit and becomes free in crystal as free electron.
यदि valence इलेक्ट्रॉन को बाहरी ऊर्जा प्रदान किया जाए तो valence इलेक्ट्रॉन, valence कक्ष को छोड़कर बाहर निकल जाता है और आजाद (स्वतंत्र) इलेक्ट्रॉन बन जाता है।

→ Electric current flows due to flow of free electron.
विद्युत धारा का प्रवाह स्वतंत्र इलेक्ट्रॉन के कारण होता है।

Q. Why an atom is Electrically Neutral?
एक परमाणु विद्युत: उदासीन होता है, क्यों?

Home work

V.V.I

Q. Why an atom is Electrically Neutral?
एक परमाणु विद्युत: उदासीन होता है, क्यों?

Ans:- In an atom,

No. of electrons = No. of Protons

charge on 1 electrons = $-1.602 \times 10^{-19} C$

Charge on 1 Proton = $+1.602 \times 10^{-19} C$

Total charge on atom = Total -ve charge on electrons + Total +ve charge on Proton

Total charge on atom = 0

thus An atom is electrically Neutral because net charge on atom is zero.

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$10P = 10 \times 1.602 \times 10^{-19} = (9+1) \times 1.602 \times 10^{-19}$

$9e = 9 \times -1.602 \times 10^{-19}$

$10P = \cancel{9 \times 1.602 \times 10^{-19} C} + \boxed{1 \times 1.602 \times 10^{-19}}$

$9e = \cancel{-9 \times 1.602 \times 10^{-19} C}$ 1P +

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Charge on $1e = -1.602 \times 10^{-19} C$
Charge on $1P = +1.602 \times 10^{-19} C$

* Charge :-

$\boxed{Q = ne}$ ← $\boxed{Q = 1e^-}$

Positive charged Atom

$1e^-$ Remove or Loss (कमी)

A

$P = 10$
$e = 10$ } Neutral (उदासीन)

$P = 10$
$e = 10 - 1 = 9$

$\boxed{Q = ne}$

Resultant charge = charge on 1 Proton

Negative charge Atom

$1e^-$ Gain (वृद्धि) or Excess

B

$P = 10$
$e = 10$ } Neutral (उदासीन)

$P = 10$
$e = 10 + 1 = 11$

Resultant charge = charge on 1 electron

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* Charge :-

→ Loss of electron or gain of electron is called Charge.

The phenomenon (घटना) by which any Substance (वस्तु) Experience (अनुभव) a Force of attraction (आकर्षण) or Repulsion (विकर्षण), is called charge.

→ It is denoted by Q and its unit is Coulomb

→ Magnitude of charge is given by $\boxed{Q = ne}$

n = No. of electrons
e = charge on $1e^-$
$= 1.602 \times 10^{-19} C$

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	Electron	Proton	Neutron
Notation	e	P	n
Charge	$-1.602 \times 10^{-19} C$	$+1.602 \times 10^{-19} C$	Zero or Nil
Mass	$9.11 \times 10^{-31} kg$	$1.67 \times 10^{-27} kg$	$1.67 \times 10^{-27} kg$
Discoverer	J.J Thomson	Rutherford	James Chadwick

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Mass of electrons, $M_e = \frac{1}{1837} \times$ Mass of Proton

$M_p = 1837 \times M_e$

$M_p \simeq 1840\, M_e$

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Charge on $1e^- = 1.602 \times 10^{-19} C$

$$\frac{1e}{1.602 \times 10^{-19}} = 1C$$

$\Rightarrow 6.25 \times 10^{18}$ electrons $= 1C$

$\Rightarrow 625 \times 10^{16}$ electrons $= 1C$

No. of electrons in 1 Coulomb of charge

$1C = 6.25 \times 10^{18}$ electrons

$= 625 \times 10^{16}$ electrons.

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* Types of charges :-

① Positive charge → Loss of electrons
इलेक्ट्रॉन की कमी

② Negative charge → gain or Excess of electrons
इलेक्ट्रॉन की वृद्धि

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① Positive charge – When Loss of electrons from atom occurs is called Positive charge.

② Negative charge :- When gain or Excess of electrons from atom is called Negative charge

Magnitude of charge, Q = No. of electrons × charge on $1e^-$

$$Q = ne$$

n = No. of electrons

e = charge on $1e^-$

$= 1.602 \times 10^{-19} C$

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* Classification of material A/c to Valence electrons

Conductor चालक	Semiconductor अर्धचालक	Insulator / Bad Conductor कुचालक
A	B	C
V.e = 3	V.e = 4	V.e = 5
$5e^-$ Flow	$4e^-$ Flow	$3e^-$ Flow
अष्टक के लिए 8 − 3 = 5e	4e	3e

- V.e < 4 ⇒ Conductor (चालक)
- V.e = 4 ⇒ Semiconductor (अर्धचालक)
- V.e > 4 ⇒ Bad conductor / Insulator (कुचालक)

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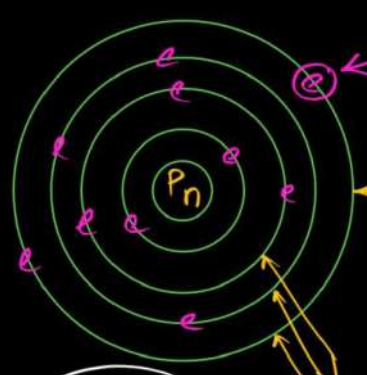

Valence electrons

बाहरी कक्षा
outer orbit
(Valence orbit)

V.e = 5

orbit (cell) कक्षा

octate अष्टक → Valence orbit में select

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* Electric current (विद्युत धारा) :-

↳ The flow of free electrons in a definite direction, is called Electric current.

↳ Current is denoted by 'I'.

↳ In a ckt, current measurement is given by 'Flow of charge per unit second'.

Current, $\boxed{I = \frac{Q}{t}}$ → Coulomb, → Second

↳ Unit = Coulomb | Second or Ampere

10 sec
100 C

$I = \frac{100}{10} = 10 C/s$

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

Q = Total charge

t = time in second

n = No. of electrons

e = charge on 1 e^-

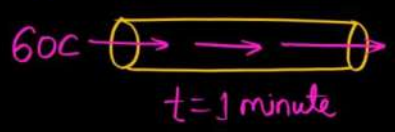
$= 1.602 \times 10^{-19} C$

Q. Find the current in a conductor when 60C charge is flowing in 1 minute through the conductor.

Sol^n Charge, Q = 60C

time, t = 1 minute

$t = 1 \times 60 = 60 sec$



Current, $I = \frac{Q}{t} = \frac{60}{60} = 1$ Coulomb | sec or 1 Amp.

Q = 60C

Q = ne

$n = \frac{Q}{e} = \frac{60}{1.602 \times 10^{-19}} = \frac{60}{1.602} \times 10^{19} = 37.45 \times 10^{19}$

$= 3.745 \times 10^{18} e$

Q. Find the no. of electrons flowing through conductor per second when 1A current is flowing.

Sol^n $I = 1A$, $t = 1 sec$

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

$Q = I \times t$

$= 1 \times 1$

$Q = 1C$

$Q = ne$

no. of electrons

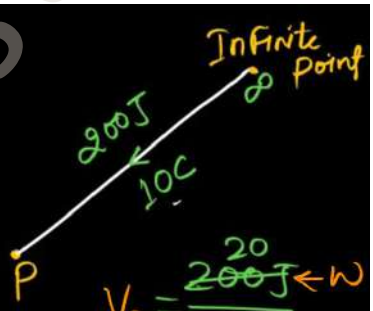
$n = \frac{Q}{e} = \frac{1}{1.602 \times 10^{-19}}$

$= 6.25 \times 10^{18}$

$= 625 \times 10^{16}$ electrons

* Electric Potential (विद्युत विभव):-

Electric potential at a point is defined as the workdone which has to be done to bring the unit +ve charge from infinite point to that point.



$V_P = \frac{\cancel{200J}\ 20 \leftarrow W}{\cancel{10C} \leftarrow Q}$

$= 20 J/C$

$$\boxed{\text{Electric potential} = \frac{\text{Workdone}}{\text{Charge}}}$$

$V = \frac{W}{Q}$ $W \rightarrow$ Joule, $Q \rightarrow$ Coulomb

$\rightarrow$ Unit: $\frac{\text{Joule}}{\text{Coulomb}}$ or Joule/Coulomb (J/C) or Volt

$$\boxed{1 \text{ Volt} = 1 J/C}$$

* Potential difference (विभवांतर):-

$V_A > V_B$

V_A A — Higher Potential (HP)

V_B B — Lower Potential (LP)

The difference of Electric potential between two point, is called Potential difference.

$$V_{AB} = V_A - V_B$$

HP LP HP LP

$V_{AB} = V_A - V_B$

$= -(V_B - V_A)$

$$V_{AB} = -V_{BA}$$

$$V_{BA} = -V_{AB}$$

P Q

$V_P = 5V$ $V_Q = 8V$

$P.D = V_{QP} = V_Q - V_P$

$= 8 - 5 = 3$ Volt

$V_{PQ} = V_P - V_Q$

$= 5 - 8 = -3V$

C D

$V_{CD} = 12V$

$V_{DC} = -V_{CD}$

$= -12V$

$V_A > V_B$

HP LP

V_A Charge V_B

A 100J, 5C B

Charge flows from Lower Potential to Higher potential

$V_{AB} = P.D = \frac{100J}{5C} = 20 J/C = 20$ Volt

↳ P.D b/w two point is defined as workdone which has to be done to bring the unit +ve charge from one point to another.

$$P.D = \frac{\text{Workdone}}{\text{Charge}}$$

$$P.D = \frac{W}{Q}$$

Unit: Joules/Coulomb or Volt.

EMF (Electromotive Force) :—

(विद्युत वाहक बल)

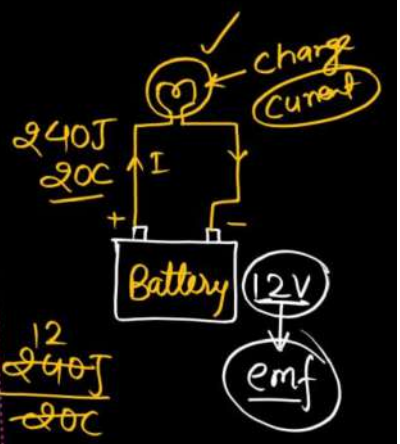
The energy released by Battery to transfer unit Coulomb of charge is called EMF.

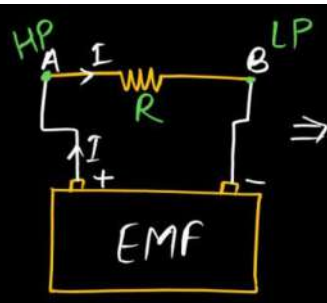
$$EMF = \frac{\text{Energy}}{\text{Charge}} = \frac{\text{Workdone}}{\text{Charge}}$$

Workdone → Joule

Charge → Coulomb

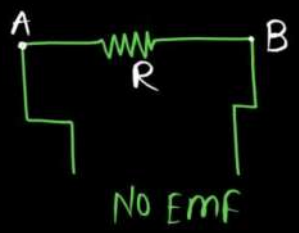
↳ Unit: Joule/Coulomb or Volt





$\Rightarrow V_{AB} = V_A - V_B$

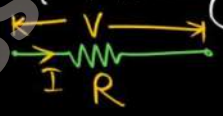
$\rightarrow$ EMF maintain P.D in ckt



$\Rightarrow V_{AB} = V_A - V_B = 0$

Ohm's law (ओम का नियम):-

It states that "at Constant physical Condition (temperature and Pressure), the developed Potential difference b/w ends of a Conductor is directly Proportional to current Flowing through it".



i.e $\boxed{V \propto I}$

$V \propto I$

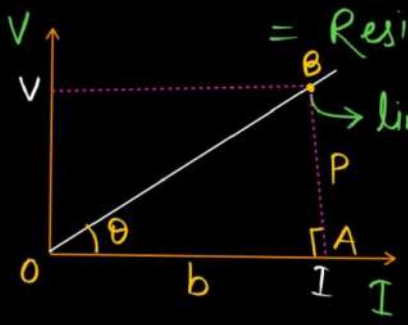
$V = RI$

$\boxed{V = IR}$

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

where, R = proportional Constant

= Resistance of Conductor

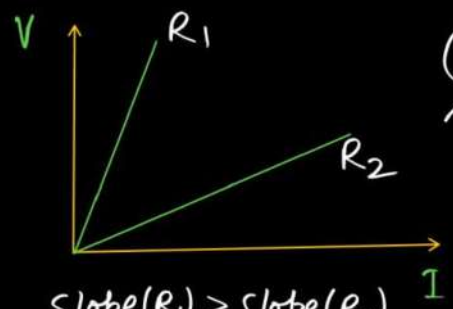


$\rightarrow$ linear

In ΔOAB

$\tan\theta = \frac{P}{b} = \frac{AB}{OA} = \frac{V}{I} = R$

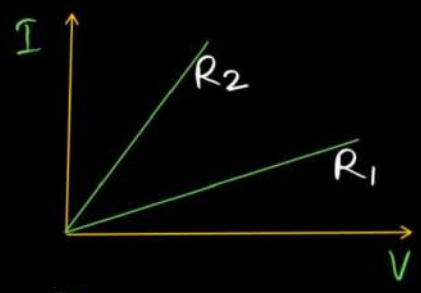
$\boxed{\text{Slope} = \tan\theta = \frac{V}{I} = R}$



Slope(R_1) > Slope(R_2)

$R_1 > R_2$

Q.



(a) $R_1 > R_2$

(b) $R_1 < R_2$

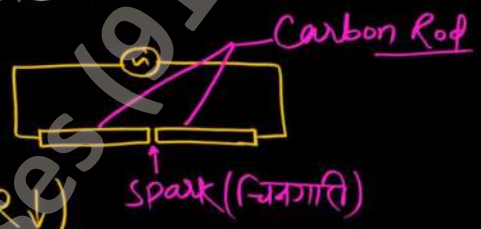
(3) $R_1 = R_2$

(4) None of Above

* Limitations of ohm's law

(1) Metal which gets heated due to the flow of Electric current.

(2) Arc lamp



(3) Semiconductor (T↑, R↓)

(4) Electrolytes

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-12

Electrical Engineering

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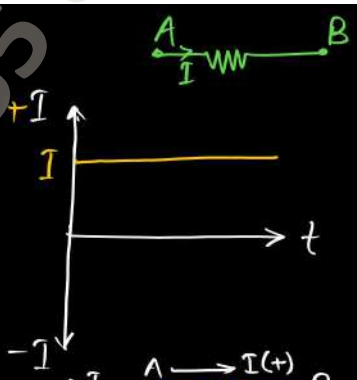
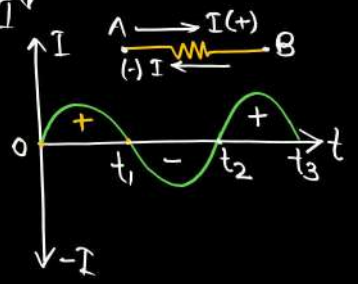
* Types of Current and Voltage.

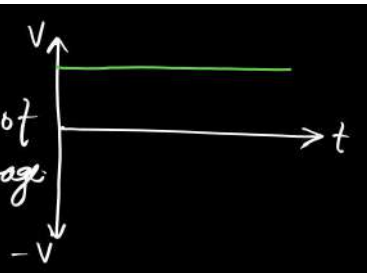
* DC Current (दिष्ट धारा):-
The current whose direction does not change with time is called DC current



* AC Current (Alternating Current):-
The current whose direction changed with time is called AC current.

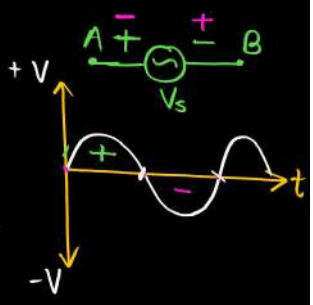


* DC Voltage:- (दिष्ट वोल्टेज)
The voltage whose polarity does not change with time is called DC Voltage



12V
(dc Voltage)

* AC Voltage:-
The voltage whose polarity changed with time is called AC Voltage.



Source (स्रोत)

- Independent Source
  - Voltage Source
    - Ideal V.S
    - Practical V.S
  - Current Source
    - Ideal C.S
    - Practical C.S
- Dependent Source
  - → VCVS (Voltage Controlled Voltage Source)
  - → VCCS (Voltage Controlled Current Source
  - → CCVS (Current Controlled Voltage Source)
  - → CCCS (Current Controlled Current Source.)

* Independent Source :-

The electrical source whose magnitude does not depends on other parameter of the ckt, is called Independent Source.

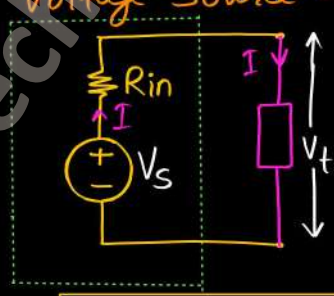
Ex- Voltage source and current source.

↳ Independent Source is represented by a circle shape.

* Voltage Source :-

The Independent Source in which Voltage magnitude is used to supply the energy is called Voltage Source

* Ideal Voltage Source :-



V.drop = IR

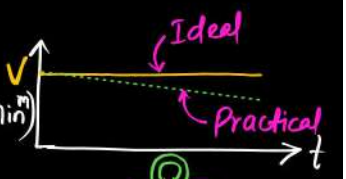
$$V_s - I R_{in} = V_t$$

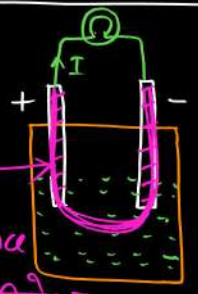
R_{in} → depends on load

R_{in} → should be lowest as possible

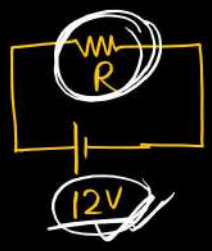
R_{in} → Ideal ($R_{in} = 0$)

R_{in} → Practical ($R_{in} = min^m$)





Internal Resistance आंतरिक प्रतिरोध



Thank
You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-13

Electrical Engineering

Er. Vijay Pandit

Source (स्रोत)

- Independent Source
  - Voltage Source
    - Ideal V.S
    - Practical V.S
  - Current Source
    - Ideal C.S
    - Practical C.S
- Dependent Source
  - → VCVS (Voltage Controlled Voltage Source)
  - → VCCS (Voltage Controlled Current Source
  - → CCVS (Current Controlled Voltage Source)
  - → CCCS (Current Controlled Current Source.)

* Independent Source :-

The electrical source whose magnitude does not depends on other parameter of the ckt, is called Independent source.

Ex- Voltage source and current source.

↳ Independent source is represented by a circle shape.

* Voltage Source :-

The Independent source in which Voltage magnitude is used to supply the energy is called Voltage source

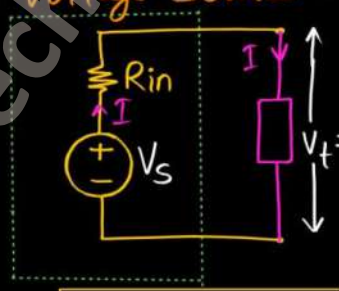
eg- Battery, generator

* Ideal Voltage Source :-

V=IR

I R

V.drop = IR



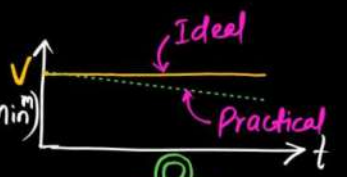
$IR_{in} \to 0$

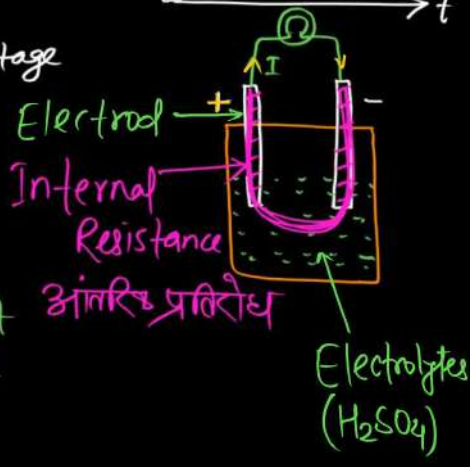
$$V_s - I R_{in} = V_t$$

V_t → depends on load

R_{in} → should be lowest as possible

R_{in} → Ideal ($R_{in}=0$), Practical ($R_{in}=min^m$)

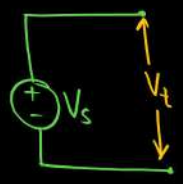




The Voltage Source in which terminal Voltage remains Constant or Fixed with respect to time, is called Ideal Voltage source.

↳ Internal Resistance (R_{in}) is Connected in series with voltage.

↳ In Case of Ideal Voltage Source, Internal Resistance should be zero. ($R_{in} = 0$)



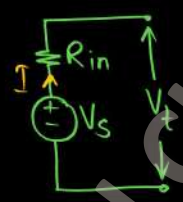
$V_t = V_s$ → Ideal Cond^n

☆ Practical Voltage Source –

The Voltage Source in which terminal voltage decreases with time, is called Practical Voltage Source.

↳ In Practical Voltage Source, Internal Resistance should be minimum as possible.

i.e. R_{in} = min^m Possible Value

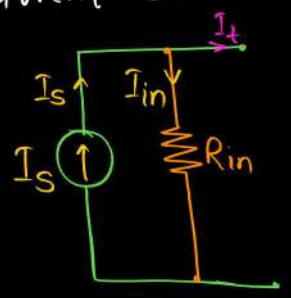


$V_t = V_s - I R_{in}$ → Practical Voltage Source.

$V_t < V_s$

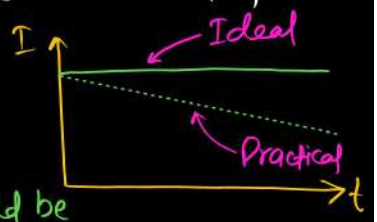
☆ Current Source :–

The Independent Source in which current magnitude is used to supply electrical energy, is called Current Source.



$I_{in} = \frac{V}{R_{in}}$

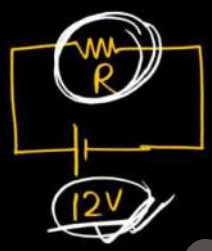
↳ should be highest as possible



↳ Internal Resistance (R_{in}) is always Connected in Parallel with current source.

↳ For Ideal Current Source, $R_{in} = \infty$ (Infinite)

↳ For Practical Current Source, R_{in} = Max^m value as possible.



Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-14

Electrical Engineering

Er. Vijay Pandit

* Dependent Source :-

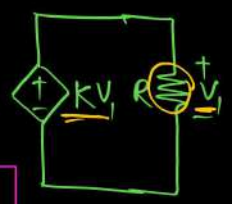
The electrical source whose voltage or current magnitude depends on other parameter of circuit, is called Dependent Source.

↳ Dependent Source is represented in diamond shape.

(i) Voltage Controlled Voltage Source (VCVS) :-

$V_s = KV_1$ ⇒ $K = \frac{V_s}{V_1}$ → Volt, → Volt

↳ Unit less

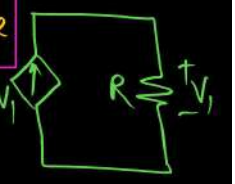


(ii) Voltage Controlled Current Source (VCCS)

$\frac{I}{V} = G$ = Conductance → mho / Siemen

$I_s = KV_1$ ⇒ $K = \frac{I_s}{V_1}$ = Conductance

↳ Unit : mho or Siemen



(iii) Current Controlled Voltage Source (CCVS)

$V_S = KI \Rightarrow \boxed{K = \frac{V_S}{I} = \text{Resistance}}$

→ Unit : ohm (Ω).

(iv) Current Controlled Current Source (CCCS)

$I_S = KI_1$ $\boxed{K = \frac{I_S}{I_1}}$ → Ampere, → Ampere

→ Unitless

* Resistance & Resistor :-

Resistor → Property → opposes the Flow of Current

Resistance → Property

(प्रतिरोध)

* Resistance :- The property of material due to which it opposes the Flow of Current through it, is called Resistance.

↳ The material or Component which has Resistance property, is called Resistor.

* Law of Resistance :-

Resistance of a Resistor depends on Following Factor.

(i) Resistance is directly proportional to length of Conductor i.e $\boxed{R \propto l}$ —(i)

(ii) Resistance is Inversally proportional to Cross-section (X-section) Area of Conductor.

i.e $\boxed{R \propto \frac{1}{A}}$ —(ii)

(iii) Resistance also depends on Nature of materials i.e Resistivity of Conductor material.

(iv) Resistance also depends on temperature.

By Combining above both relation,

$R \propto l$ — (i)

$R \propto \frac{1}{A}$ — (ii)

$R \propto \frac{l}{A}$

$\boxed{R = \rho \frac{l}{A}}$

Unit: ohm (Ω)

ρ (rho) = Proportional Constant
= Resistivity or specific Resistance
= Depends on Nature of material

$\boxed{R = \rho \frac{l}{A}}$

ρ = Resistivity
l = length of Conductor
A = X-Section Area of Conductor

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-15

Electrical Engineering

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* Resistance & Resistor :-

Resistor → Resistance → Property → opposes the Flow of Current

(प्रतिरोध) पदार्थ का ऐसा गुण

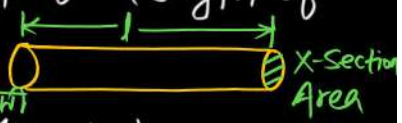
* **Resistance :-** The property of material due to which (जिसके कारण) it opposes the Flow of Current through it, is called Resistance.

↳ The material or Component which has Resistance property, is called Resistor.

* Law of Resistance :-

Resistance of a Resistor depends on Following Factor (कारक).

(i) Resistance is directly proportional (समानुपाती) to length of Conductor i.e $\boxed{R \propto l}$ —(i)



(ii) Resistance is Inversally proportional (व्युत्क्रमानुपाती) to Cross-section (X-section) Area of Conductor. (अनुप्रस्थ काट का क्षेत्रफल)

i.e $\boxed{R \propto \frac{1}{A}}$ —(ii)

(iii) Resistance also depends on Nature of materials i.e Resistivity of Conductor material.

(iv) Resistance also depends on temperature.

By Combining above both relation,

$R \propto l$ —(i)

$R \propto \frac{1}{A}$ —(ii)

$R \propto \frac{l}{A}$

$\boxed{R = \rho \frac{l}{A}}$

Unit: ohm (Ω)

ρ (rho) = Proportional Constant (प्रतिरोधकता) (विशिष्ट प्रतिरोध)
= Resistivity or specific Resistance
= Depends on Nature of material

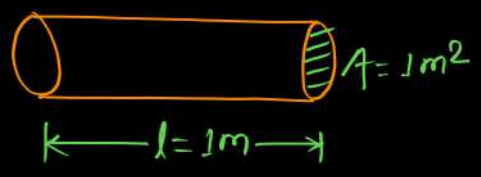
$\boxed{R = \rho \frac{l}{A}}$

ρ = Resistivity
l = length of Conductor
A = X-Section Area of Conductor

Resistance, $R = \rho \frac{l}{A}$

$R = \rho \frac{1}{1}$

$\boxed{R = \rho}$



Resistivity or specific Resistance of a material is defined as Resistance when length and X-section area of Conductor is taken 1m & 1m² respectively.

$R = \rho \frac{l}{A}$

$\boxed{\rho = \frac{R \cdot A}{l}}$

$\rho = \frac{R \cdot A}{l} = \frac{\Omega \cdot m^2}{m} = \Omega\text{-}m$

Ω ℧
↓
ohm mho

* Unit of Resistivity or specific Resistance is ohm-meter (Ω-m).

* Conductance :— The Reciprocal of Resistance is called Conductance

↳ Conductance is denoted by G.

i.e $\boxed{G = \frac{1}{R}}$ Unit $= \frac{1}{\Omega}$ or Ω^{-1} or mho (℧) or Siemen(s)

$G = \frac{1}{R}$

$= \frac{1}{\rho \frac{l}{A}} = \frac{A}{\rho l}$

$\boxed{G = \frac{A}{\rho \cdot l}}$

Conductance :—

The property of Conductor which supports the flow of current through it, is called Conductance.

* Conductivity or specific Conductance :—

The Reciprocal of Resistivity, is called Conductivity.

↳ It is denoted by σ (Sigma).

i.e $\boxed{\sigma = \frac{1}{\rho}}$

$$G = \frac{A}{\rho \cdot l}$$

$$G = \frac{1}{\rho} \times \frac{A}{l}$$

$$G = \sigma \times \frac{A}{l}$$

$$\boxed{G = \sigma \frac{A}{l}}$$

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-16

Electrical Engineering

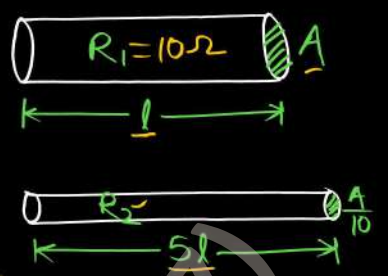
Er. Vijay Pandit

1Q. A wire of Resistance 10Ω, its length increases (बढ़ता) 5 times and Cross-section Area decreases 10 times then Calculate new value of Resistance of wire.

Solⁿ:— $R_1 = 10\Omega$, $l_1 = 1m$, $A_1 = Am^2$

$l_2 = 5l_1 = 5lm$ $\quad \rho_1 = \rho_2 = \rho$

$A_2 = \frac{A_1}{10} = \frac{A}{10} m^2$



$$\frac{R_1}{R_2} = \frac{\rho_1 \frac{l_1}{A_1}}{\rho_2 \frac{l_2}{A_2}} = \frac{\cancel{\rho}\frac{l}{A}}{\cancel{\rho}\frac{5l}{A/10}} = \frac{l}{A} \times \frac{A/10}{5l}$$

$$= \frac{\cancel{l}}{\cancel{A}} \times \frac{\cancel{A}}{10 \times 5\cancel{l}} = \frac{1}{50}$$

$\frac{R_1}{R_2} = \frac{1}{50}$

$R_2 = 50 \times R_1 = 50 \times 10 = 500\Omega$

2Q. A wire of Resistance 20Ω, its length increases 50% and cross-section Area decreases 2 times then Calculate New Value of Resistance?

$R_1 = 20\Omega$ $\quad l_1 = 1m$ $\quad A_1 = Am^2$

$l_2 = l_1 + l_1 \times 50\%$

$= l_1 + l_1 \times \frac{\cancel{50}}{\cancel{100}\,2}$

$= \frac{2l_1 + l_1}{2}$

$l_2 = \frac{3l_1}{2} = \frac{3l}{2}$

$A_2 = \frac{A_1}{2} = \frac{A}{2}$

$$\frac{R_1}{R_2} = \frac{\cancel{\rho_1}\frac{l_1}{A_1}}{\cancel{\rho_2}\frac{l_2}{A_2}} = \frac{l_1}{A_1} \times \frac{A_2}{l_2} = \frac{l}{A} \times \frac{A/2}{3l/2}$$

$$\frac{R_1}{R_2} = \frac{\cancel{l}}{\cancel{A}} \times \frac{\cancel{A}}{\cancel{2}} \times \frac{\cancel{2}}{3\cancel{l}}$$

$\frac{R_1}{R_2} = \frac{1}{3} \Rightarrow R_2 = 3R_1 = 3 \times 20 = 60\Omega$

3Q. A wire of Resistance 50Ω. Its length increases 200% then Calculate New Value of Resistance?

$R_1 = 50\Omega$, $l_1 = l$

$l_2 = l_1 + l_1 \times 200\%$

$= l_1 + l_1 \times \frac{2\cancel{00}}{1\cancel{00}}$

$l_2 = 3l_1 = 3l$

$R \propto l$

$\frac{R_1}{R_2} = \frac{l_1}{l_2} = \frac{\cancel{l}}{3\cancel{l}}$

$R_2 = 3 \times R_1 = 3 \times 50 = 150\Omega$

Thank You

BASIC ELECTRICAL ENGINEERING

Sem-1st

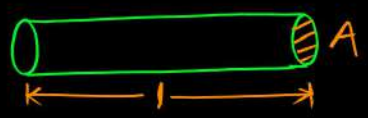
Lec-17

Electrical Engineering

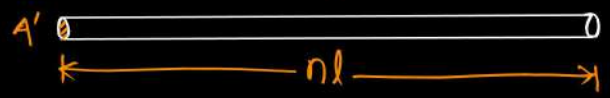
Er. Vijay Pandit

Q. A wire of Resistance 100Ω is stretched (खींचा गया) such that its length becomes 4 time then Calculate New value of Resistance.

Sol^n Volume of wire before stretching, $V = A \times l$



After stretching, Volume of wire, $V' = A' \times nl$



Now, Volume of wire is Constant

So, $V = V'$

$A \times l = A' \times nl$

$A' = \frac{A \times \cancel{l}}{n\cancel{l}} \Rightarrow \boxed{A' = \frac{A}{n}}$

$R_1 = 100\Omega, \; l_1 = l, \; A_1 = A, \; l_2 = 4l, \; A_2 = \frac{A}{4}$

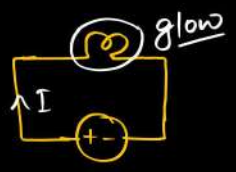
$$\frac{R_1}{R_2} = \frac{\rho_1 \frac{l_1}{A_1}}{\rho_2 \frac{l_2}{A_2}} = \frac{\frac{l}{A}}{\frac{4l}{A/4}} = \frac{l}{A} \times \frac{A/4}{4l} = \frac{\cancel{l}}{\cancel{A}} \times \frac{\cancel{A}}{4 \times 4 \times \cancel{l}} = \frac{1}{16}$$

$$\frac{R_1}{R_2} = \frac{1}{16}$$

$$R_2 = 16R_1 = 16 \times 100 = 1600\Omega$$

* Circuit :-

The Connection of electrical element such that current either to flow or try to flow, is called circuit.



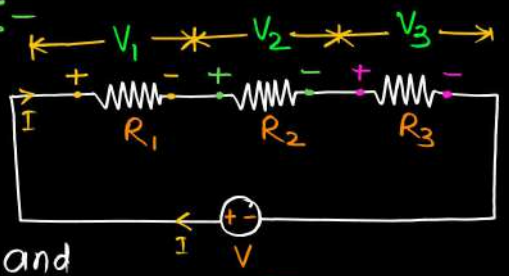
↳ element are connected in Three ways:-

1. Series Connection
2. Parallel Connection
3. Series-Parallel Connection

* Resistance in Series and Parallel :-

Resistance in Series Connection :-

The Connection of element such that +ve terminal of one element is connected with -ve terminal of other element and so on, is called series connection.



$V_1 = \boxed{I} R_1 \propto R_1$

$V_2 = \boxed{I} R_2 \propto R_2$

$V_3 = \boxed{I} R_3 \propto R_3$

Properties of Series Connection.

1. Same current is flowing through all elements.
2. Summation of voltage across individual element is equal to supply voltage

   i.e $V_1 + V_2 + V_3 = V$
3. Voltage across individual element is directly depend on their resistance value

$$V_1 = I R_1$$
$$V_2 = I R_2$$
$$V_3 = I R_3$$

Thank
You

BASIC ELECTRICAL ENGINEERING

Sem-1st

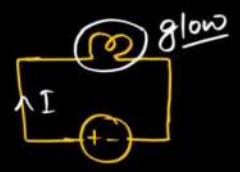
Lec-18

Electrical Engineering

Er. Vijay Pandit

* Circuit :-

The Connection of electrical element such that current either to flow or try to flow, is called circuit.



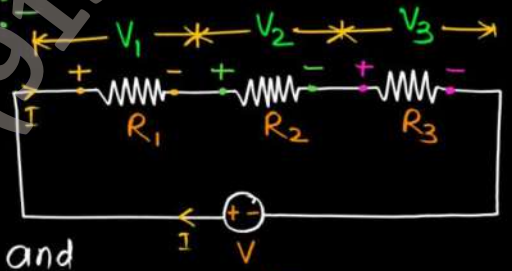
↳ element are connected in three ways:-

1. Series Connection
2. Parallel Connection
3. Series-Parallel Connection

* Resistance in Series and Parallel :-

Resistance in Series Connection :-

The Connection of element such that +ve terminal of one element is connected with -ve terminal of other element and so on, is called series Connection.



$V_1 = I R_1 \propto R_1$

$V_2 = I R_2 \propto R_2$

$V_3 = I R_3 \propto R_3$

Properties of Series Connection.

1. Same current is flowing through all elements.
2. Summation of voltage across individual (अलग-अलग) element is equal to supply voltage

   i.e $V_1 + V_2 + V_3 = V$
3. Voltage across individual element is directly depend on their resistance value

   $V_1 = I R_1$

   $V_2 = I R_2$

   $V_3 = I R_3$

* Equivalent Resistance :-

$V = V_1 + V_2 + V_3$ —— (i)

$V_1 = IR_1$

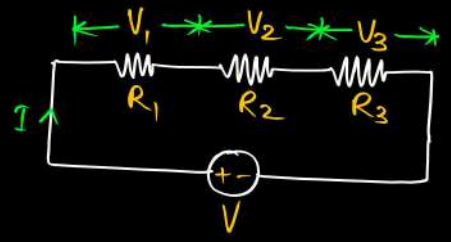
$V_2 = IR_2$

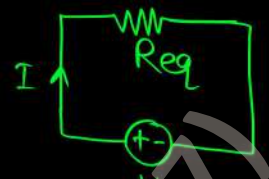
$V_3 = IR_3$

Put this value in eqn (i)

$V = IR_1 + IR_2 + IR_3$

$\Rightarrow \cancel{I}R_{eq} = \cancel{I}(R_1 + R_2 + R_3)$





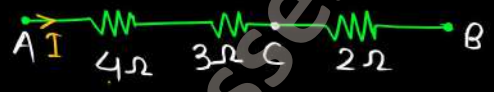
$I = \frac{V}{R_{eq}} \Rightarrow V = I \cdot R_{eq}$

$R_{eq} = R_1 + R_2 + R_3$

Equivalent Resistance in series

$$\boxed{R_{eq} = R_1 + R_2 + R_3 + \cdots + R_n}$$

Q. Find equivalent Resistance of ckt

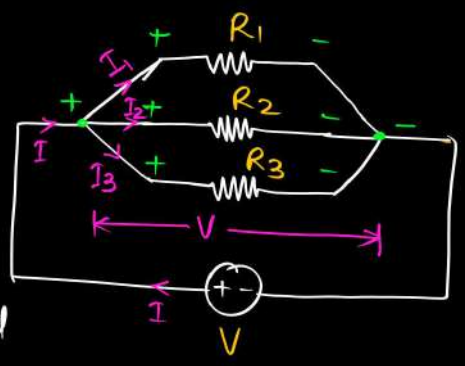


$R_{AB} = 4 + 3 + 2 = 9\Omega$

$R_{AC} = 4 + 3 = 7\Omega$

② Parallel Connection :-

The Connection of elements in which +ve terminal of all elements are connected together at one point and -ve terminal of all elements are Connected together at another point is called Parallel Connection.



$I_1 = \frac{V}{R_1}$

$I_2 = \frac{V}{R_2}$

$I_3 = \frac{V}{R_3}$

Properties of Parallel Connection-

① total supply current is divided into all individual element according to the respective value of Resistance

② Summation of all current flowing through individual element is equal to total supply current

i.e $\boxed{I_1 + I_2 + I_3 = I}$

③ Voltage across all element will be same and equal to supply voltage

i.e $\boxed{V_1 = V_2 = V_3 = V}$

Now,

$I = I_1 + I_2 + I_3$ — (i)

$I_1 = \frac{V}{R_1}$

$I_2 = \frac{V}{R_2}$

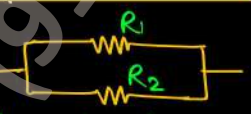
$I_3 = \frac{V}{R_3}$

Put this value in eqⁿ (i)

$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

$\Rightarrow \frac{\cancel{V}}{R_{eq}} = \cancel{V}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$

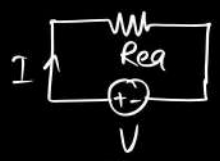
$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$



$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{eq}} = \frac{R_2 + R_1}{R_1 R_2}$

$$\boxed{R_{eq} = \frac{R_1 R_2}{R_1 + R_2}}$$



$I = \frac{V}{R_{eq}}$

Ex-

$R_{eq} = \frac{4 \times 8}{4 + 8}$

$= \frac{\cancel{4} \times 8}{\cancel{12}\ 3}$

$R_{eq} = \frac{8}{3}\ \Omega$

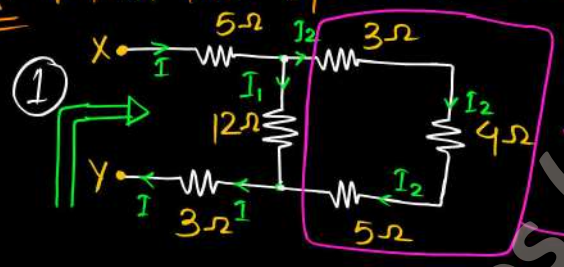
Thank You

Basic Electrical

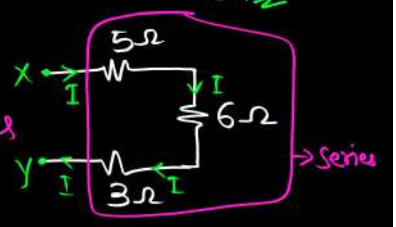
1st Sem

Lec-19.

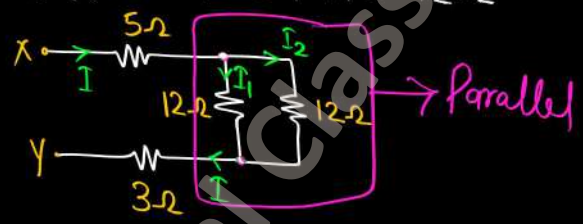
Q. Find the Equivalent Resistance.



$$R_{eq}(12\|12) = \frac{12\times12}{12+12} = \frac{\cancel{12}\times\cancel{12}\,6}{\cancel{24}\,2} = 6\Omega$$

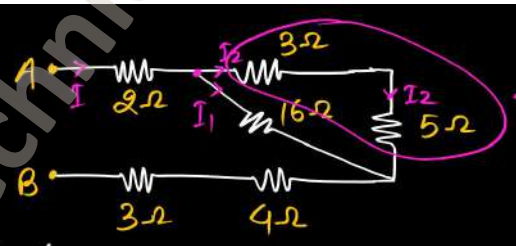


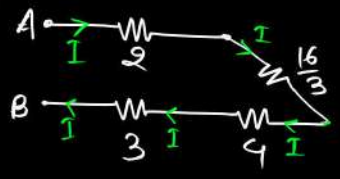
$$R_{eq}(3+4+5) = 3+4+5 = 12\Omega$$



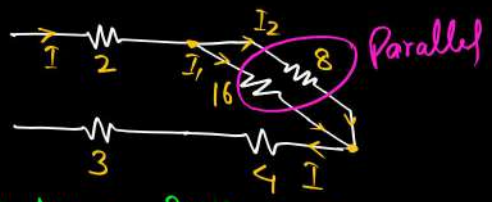
$$R_{xy} = 5+6+3 = 14\Omega$$

Q.





$$R_{eq}(3+5) = 3+5 = 8\Omega$$



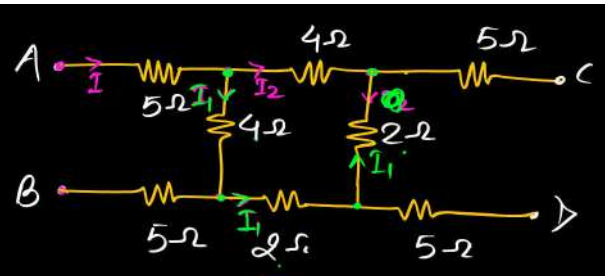
$$R_{eq}(8\|16) = \frac{8\times16}{8+16} = \frac{\cancel{8}\times16}{\cancel{24}\,3} = \frac{16}{3}\Omega$$

$$R_{AB} = 2 + \frac{16}{3} + 4 + 3$$

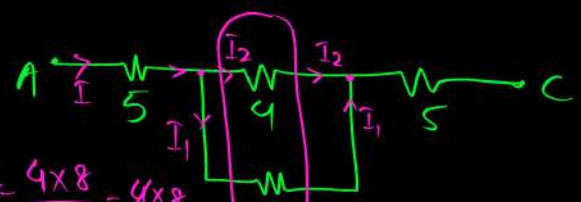
$$= \frac{6+16+12+9}{3}$$

$$= \frac{43}{3}\Omega \text{ Ans.}$$

Q.



R_{AB}, R_{CD} ✓
R_{AC}
R_{BD} ✓
R_{AD} ✓



$R = \frac{4\times 8}{4+8} = \frac{4\times 8}{12} = 8/3$

Parallel

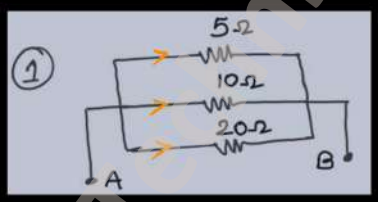
$R_{AC} = 5 + \frac{8}{3} + 5$

$= \frac{38}{3}\,\Omega$

Basic Electrical Engg.

1st sem

Lec-20



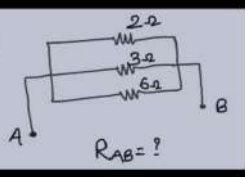
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{5} + \frac{1}{10} + \frac{1}{20}$$

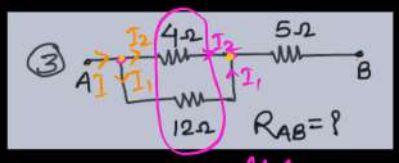
$$\frac{1}{R_{eq}} = \frac{4+2+1}{20} = \frac{7}{20}$$

$$R_{eq} = \frac{20}{7}\,\Omega$$ ✓

(2)

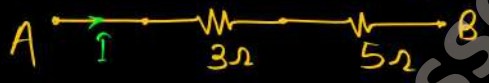


(3)



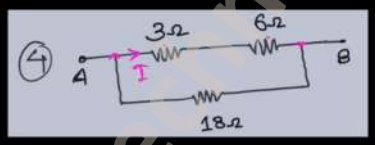
Parallel

$$R_{eq}(4\|12) = \frac{4\times12}{4+12} = \frac{\cancel{4}\times\cancel{12}\,3}{\cancel{16}\,\cancel{4}} = 3\Omega$$

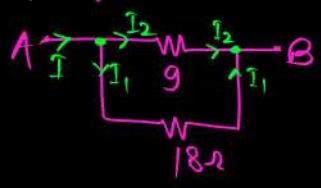


$R_{AB} = 3+5 = 8\Omega$ Ans

(4)

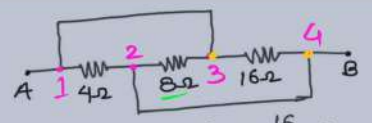


$R_{eq}(3+6) = 3+6 = 9\Omega$

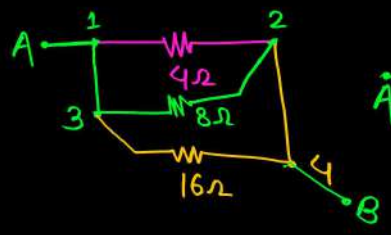


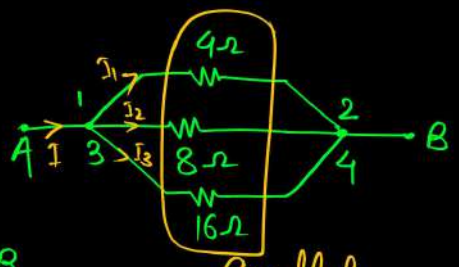
$$R_{AB} = \frac{9\times18}{9+18} = \frac{\cancel{9}\times\cancel{18}\,6}{\cancel{27}\,\cancel{3}} = 6\Omega \text{ Ans}$$

⑤



Ans = $\frac{16}{7}\Omega$





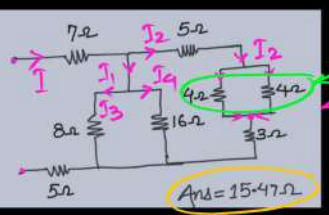
Parallel

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$$

$$\frac{1}{R_{eq}} = \frac{4+2+1}{16} = \frac{7}{16}$$

$$R_{eq} = \frac{16}{7}\Omega$$

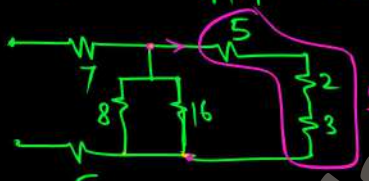
⑥



Ans = 15.47Ω

Parallel

$$R_{eq}(4\|4) = \frac{4\times4}{4+4} = \frac{4\times4}{8} = 2\Omega$$



Series

$$R_{eq} = 5+2+3 = 10\Omega$$

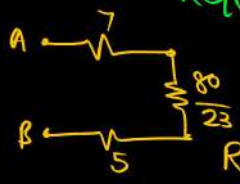
Parallel

$$R_{eq}(8\|16) = \frac{8\times16}{8+16} = \frac{8\times16}{24} = \frac{16}{3}\Omega$$

Parallel

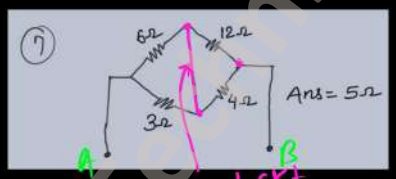
$$R_{eq}(10\|\tfrac{16}{3}) = \frac{10\times\frac{16}{3}}{10+\frac{16}{3}} = \frac{10\times\frac{16}{3}}{\frac{46}{3}}$$

$$= \frac{160}{3}\times\frac{3}{46} = \frac{80}{23}\Omega$$



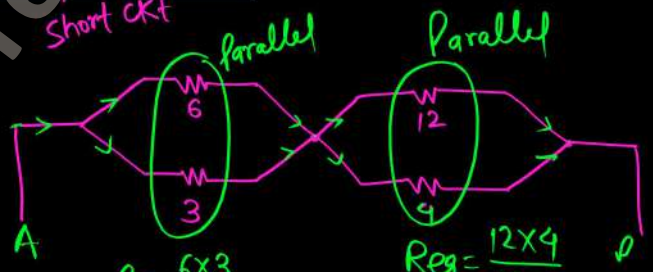
$$R_{eq} = 7 + \frac{80}{23} + 5 = 15.47\Omega$$

⑦



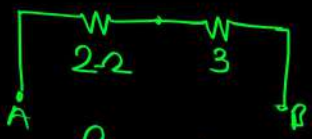
Ans = 5Ω

Short ckt

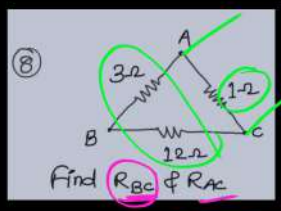


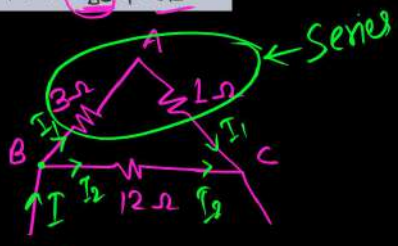
$$R_{eq} = \frac{6\times3}{6+3} = \frac{\cancel{6}^{2}\times3}{\cancel{9}_{3}} = 2\Omega$$

$$R_{eq} = \frac{12\times4}{12+4} = \frac{\cancel{12}^{3}\times4}{\cancel{16}_{4}} = 3\Omega$$

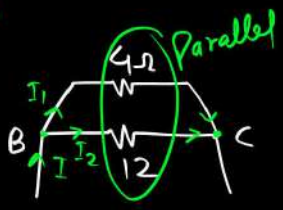


$$R_{AB} = 2+3 = 5\Omega$$





$R_{eq} = 3+1 = 4\Omega$



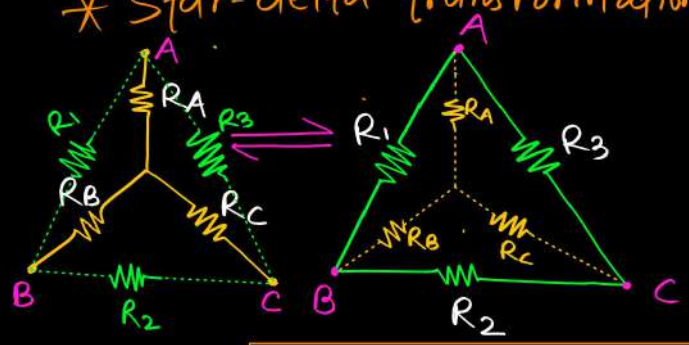
$R_{BC} = \frac{4\times12}{4+12} = \frac{\cancel{4}\times\cancel{12}\times3}{\cancel{16}\,\cancel{4}} = 3\Omega$

Thank you

BEE

Lec-21

* Star-delta transformation -



Star to Delta

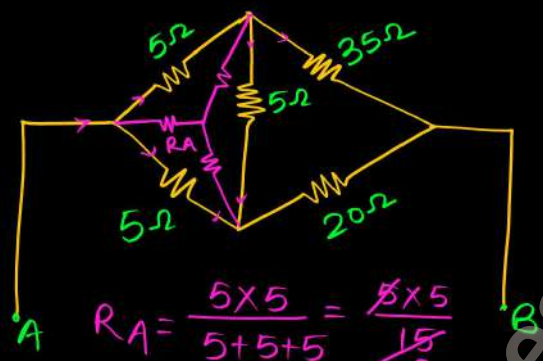
$$R_1 = R_A + R_B + \frac{R_A R_B}{R_C}$$

$$R_2 = R_B + R_C + \frac{R_B R_C}{R_A}$$

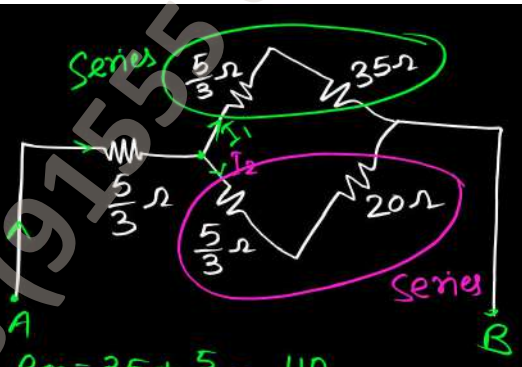
$$R_3 = R_A + R_C + \frac{R_A R_C}{R_B}$$

Delta to star

$$R_A = \frac{R_1 R_3}{R_1 + R_2 + R_3} \qquad R_B = \frac{R_1 R_2}{R_1 + R_2 + R_3} \qquad R_C = \frac{R_2 R_3}{R_1 + R_2 + R_3}$$

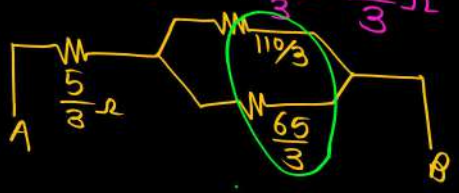


$$R_A = \frac{5 \times 5}{5+5+5} = \frac{\cancel{5} \times 5}{\cancel{15}\,3} = 5/3\ \Omega$$

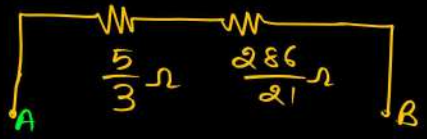


$$R_{eq} = 35 + \frac{5}{3} = \frac{110}{3}\ \Omega$$

$$R_{eq} = 20 + \frac{5}{3} = \frac{65}{3}\ \Omega$$

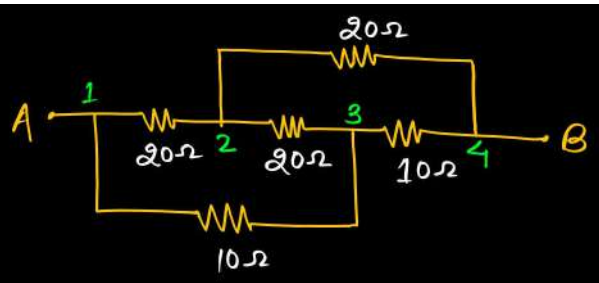


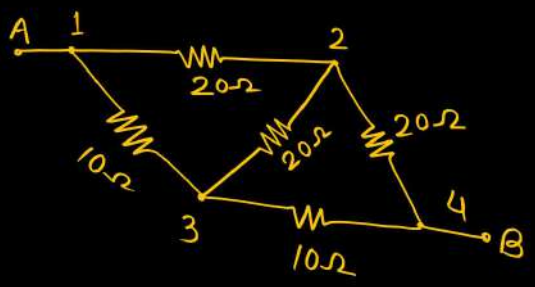
$$R_{eq} = \frac{\frac{110}{3} \times \frac{65}{3}}{\frac{110}{3} + \frac{65}{3}} = \frac{\frac{110}{3} \times \frac{65}{3}}{\frac{175}{3}} = \frac{\overset{22}{\cancel{110}}}{3} \times \frac{\overset{13}{\cancel{65}}}{\cancel{3}} \times \frac{\cancel{3}}{\underset{\underset{7}{\cancel{35}}}{\cancel{175}}} = \frac{22 \times 13}{21} = \frac{286}{21}\ \Omega$$



$$R_{AB} = \frac{5}{3} + \frac{286}{21} = 15.28\ \Omega \quad \underline{\text{Ans.}}$$

Q. H.W





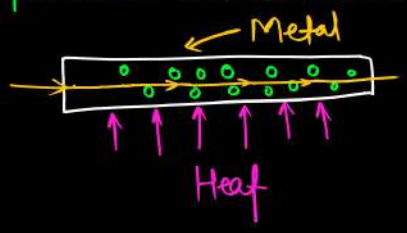
BEE

Lec-22

* Effect of Temperature on Resistance -

Effect of temperature on Resistance vary with material such as Conductor, Semiconductor and Insulator.

① Effect of temperature on Conductor Resistance :-



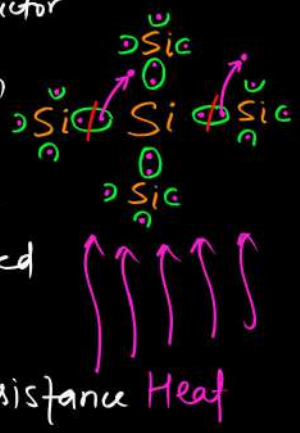
Heat ↑, Resistance ↑

When temperature increases then heat Energy is gained by atoms of Conductor material and starts to Vibrates or oscillates at Relative position therefore Resistance offered by conductor to oppose the Flow of current increases.

↳ Thus Resistance increases in Conductor with increase in temperature. and this is called Positive temperature Coefficient of Resistance

② Effect of temperature on semiconductor Resistance :-

When heat is supplied to the semiconductor then heat energy is gained by electron and due to vibration, Co-valent bonds breakdown and as a Result electrons becomes Free and converted into Free electrons which increases the current carrying Capacity so Resistance decreases.



↳ Resistance decreases in Semiconductor with increase in temperature.

↳ This is called Negative temperature Coefficient of Resistance. (NTCR).

③ Effect of temperature on Insulator Resistance.

BASIC ELECTRICAL ENGINEERING

Sem-1st

Lec-23

Properties of Resistor-

I^2R I^2Rt

Resistors are fundamental components in electronic circuits, and they have several important properties:

$P_1 = 10W$, $P_2 = 20W$

1) Resistance (R): Measured in ohms (Ω), it tells that how much a resistor opposes the flow of electric current.

$A = 100\Omega$ $B = 500\Omega$

2) Power Rating (P): Indicates the maximum power the resistor can dissipate without being damaged, usually measured in watts (W). Exceeding this rating can cause overheating and failure. Size of resistor depends on power rating.

$100k\Omega \pm 5\%$ Tolerance

3) Tolerance: Expressed as a percentage, tolerance indicates how much the actual resistance can vary from the rated value. Common tolerances include ±1%, ±5%, and ±10%.

$95k\Omega$ to $105k\Omega$

4) Temperature Coefficient: This measures how much the resistance changes with temperature. It's important for applications in varying temperature conditions.

5) Voltage Rating: The maximum voltage that can be applied across a resistor without risking breakdown or damage.

6) Noise: Resistors can generate thermal noise, which is particularly relevant in high-precision or high-frequency applications.

7) Construction Type: Resistors can be made from various materials (carbon, metal film, wire wound, etc.), affecting their performance characteristics, stability, and applications.

8) Frequency Response: Some resistors have different behaviors at different frequencies, impacting how they perform in AC circuits.

9) Size and Form Factor: Resistors come in various sizes and shapes (through-hole, surface mount, etc.), influencing their application and placement in circuits.

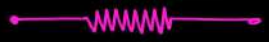
Classification of Resistor-

Resistor is of two types –

1) Fixed Resistor
2) Variable resistor

20KΩ

1) Fixed Resistors:



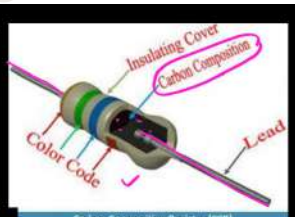
- the resistor which has a constant resistance value is called fixed resistor.
- Fixed resistor is of various types suited for different applications (e.g., carbon, metal film, wire wound).

2) Variable Resistors:

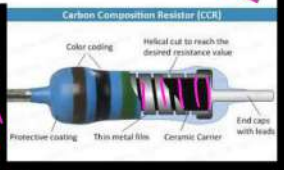
- The resistor which allow for adjustable resistance is called variable resistor.
- Variable resistor include types like potentiometers, rheostats, and digital pots, used for applications where tuning is required.

Types of Fixed Resistor –

1) Carbon Composition Resistors:

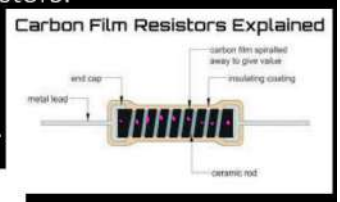


- Made from a mixture of carbon and a binder.
- Inexpensive and widely used.
- Have a relatively high tolerance and are more prone to noise.



2) Metal Film Resistors:

- Constructed from a thin layer of metal oxide.
- Offer better accuracy and stability compared to carbon resistors.
- Typically have lower noise and tighter tolerances. (less)



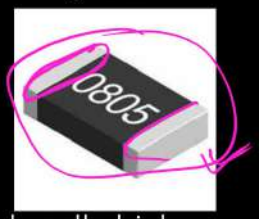
3) Carbon Film Resistors:

- Made from a carbon film deposited on a ceramic substrate.
- Provide good stability and a reasonable tolerance.
- Commonly used in various applications.

4) Thin Film Resistors:

पतला

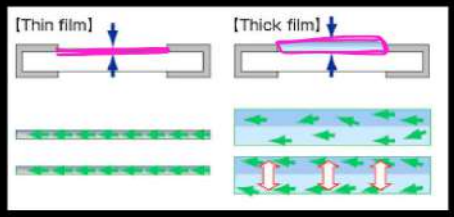
- Similar to metal film but use a thinner layer, providing even greater precision and stability.
- Used in high-frequency applications.

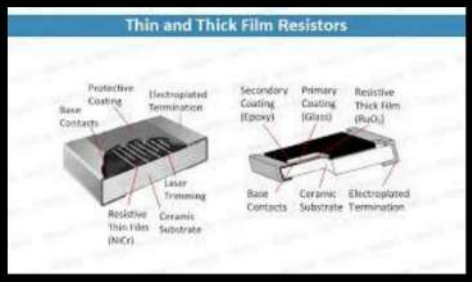


5) Thick Film Resistors:

मोटा

- Made from a thicker layer of resistive material.
- Often used in surface mount technology (SMT) and can handle higher power ratings.



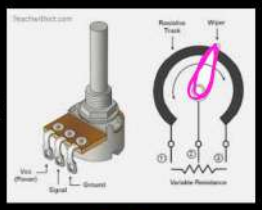


Resistor

Types of Variable Resistor-

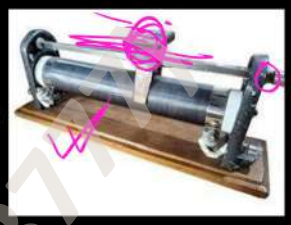
1) Potentiometers:

- A three-terminal resistor with a movable wiper that divides the voltage.
- Used for adjusting levels, such as volume controls in audio devices. (Radio)
- Can be linear (constant resistance) or logarithmic (often used in audio applications).



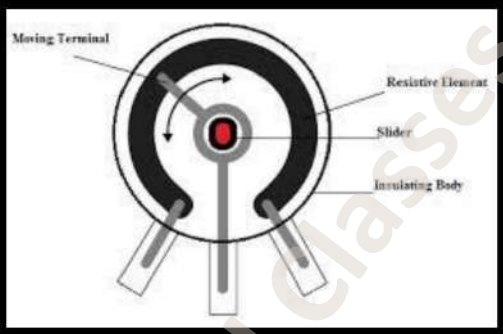
2) Rheostats:

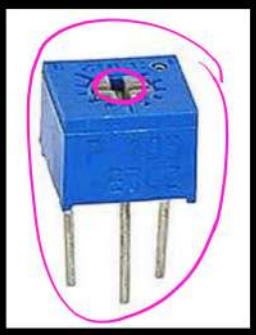
- A type of variable resistor with two terminals, designed to handle higher currents.
- Used for controlling the flow of current in a circuit, such as in dimmer switches and motor speed controls.
- Typically larger and can dissipate more power than potentiometers.



3) Trimmers (Trimpots):

- Small potentiometers used for fine adjustments in a circuit.
- Typically adjusted only once or twice during calibration or setup.
- Used in applications where space is limited.





Thank you

Basic Electrical Engineering

Effect of Electric Current

Electric current can produce several effects, including heating, magnetic, and chemical effects. Here's a brief overview of each:

1. Heating Effect

- **Definition**: When electric current passes through a conductor, it generates heat due to the resistance of the material.

$Heat = I^2Rt$

$\boxed{Heat \propto R}$

Here, I = Current
R = Resistance
t = time

- **Applications**: This effect is utilized in electric heaters, toasters, and incandescent light bulbs.

The heat generated can be calculated using the formula $\boxed{H = I^2Rt}$

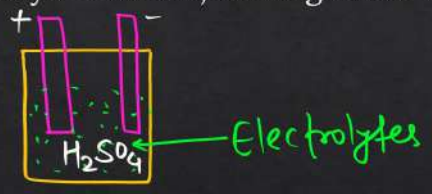
2. Magnetic Effect

- **Definition**: An electric current creates a magnetic field around the conductor. The direction of the magnetic field can be determined using the right-hand rule.

- **Applications**: This effect is the basis for electromagnets, electric motors, and generators. It is also used in devices like relays and transformers.

3. Chemical Effect

Definition: Electric current can cause chemical reactions, a process known as electrolysis. This happens when current passes through an electrolyte solution, leading to the breakdown of compounds.



$H_2O \rightarrow$

विद्युतलेपन

Applications: This effect is used in electroplating, battery charging, and water splitting to produce hydrogen and oxygen.

These effects are fundamental to various technologies and applications in everyday life!

1. Electrical Work

- **Definition**: Electrical work is the measure of energy transferred when electric charge moves through an electric potential difference (voltage).
- **Formula**: The work done W can be calculated using the formula:

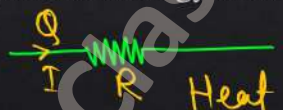
$V = \frac{W}{Q}$

$$W=QV$$

$W = QV = ItV = VIt$

where W is work (in joules), Q is the charge (in coulombs), and V is the voltage (in volts).

- **Explanation**: When electric charge moves through a circuit, it does work against resistance, and this energy is transformed into other forms (like heat or light).



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

Heat
light

2. Electrical Power

Power :- Rate of doing work, $P = \frac{W}{t}$

- **Definition**: Electrical power is the rate at which electrical work is done or energy is transferred in a circuit.
- **Formula**: Power P can be calculated using the formula:

$$P=\frac{W}{t}$$

where P is power (in watts), W is work (in joules), and t is time (in seconds).

$P = \frac{W}{t} = \frac{QV}{t} = \frac{ItV}{t} = VI$

It can also be expressed as: $P=VI$ where I is current (in amperes) and V is voltage (in volts).

$P = VI = V \cdot V/R = \frac{V^2}{R}$ and $P = VI = IR \cdot I = I^2R$

- **Explanation**: Power indicates how quickly energy is used or produced. For example, a 60-watt bulb consumes energy at a rate of 60 joules per second.

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

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

3. Electrical Energy

Energy:- Capacity to do work

- Definition: Electrical energy is the total amount of work done by an electric current over a specific time period.
- Formula: The energy E can be calculated using the formula:

$P = \frac{W}{t}$ Workdone = $E = Pt$

$W = P \times t$

where E is energy (in joules), P is power (in watts), and t is time (in seconds). $W = QV$ or $E = W = QV$

In terms of charge and voltage, it can also be expressed as: $E = QV$

Explanation: Electrical energy is energy which is consumed by electrical devices. It is often measured in kilowatt-hours (kWh) for billing purposes, where 1 kWh is the energy used by a device consuming 1 kilowatt of power over 1 hour.

Other way, $E = Pt = VIt = I^2Rt = \frac{V^2}{R}t$

1 Unit = 1 kWh

Bulb = 10

Watt = 100W/Bulb

Daily = 5 hrs

How much unit Electricity bill in 30 days.

$$KWh = \frac{Watt \times hours}{1000}$$

kWh in 1 days = $\frac{10 \times 100 \times 5}{1000} = 5$ kWh

kWh in 30 days = $5 \times 30 = 150$ kWh

E. Bill = 150 unit

Thanks

BEE
Lec-25

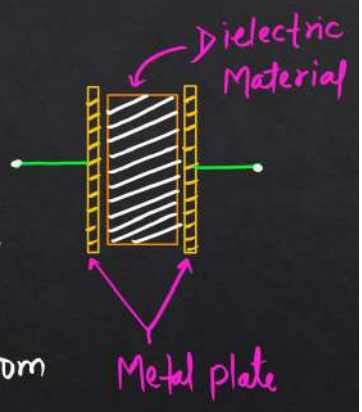
Unit-02
Energy storing elements
- ↳ Capacitor
- ↳ Inductor

* **Capacitor:-** The energy storing element which store charge and energy in electric field, is called capacitor.

Formation of Capacitor:-

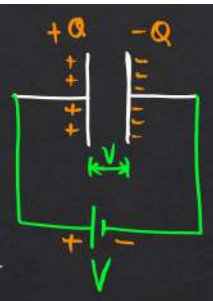
↳ when a dielectric material is inserted b/w two metal plate then Capacitor is Formed.

↳ terminal of Capacitor is taken from Metal plate.



* Capacitance :-

The capacity of capacitor to store the charge per unit applied voltage is called capacitance.



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

$$\boxed{\text{Capacitance}(C) = \frac{\text{Charge}(Q)}{\text{Voltage}(V)}}$$

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

$Q \rightarrow$ Coulomb

$V \rightarrow$ Volt

Unit of Capacitance

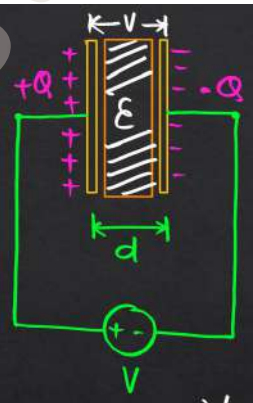
$\hookrightarrow$ Coulomb/Volt or Farad(F)

Expression of Capacitance :-

Lets, A = Area of metal plate

d = distance b/w metal plate

ε = permitivity of dielectric material



Electric Flux density, $D = \frac{\psi}{A}$

Total Flux is due to stored charge, Q

So, $\psi = Q$

$$\therefore \boxed{D = \frac{\psi}{A} = \frac{Q}{A}}$$

$$\frac{V}{d}$$

Electric Field, $E = \frac{V}{d}$

Now, Flux density, $\boxed{D = \varepsilon E}$

$$\frac{Q}{A} = \varepsilon \frac{V}{d}$$

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

ϕ – magnetic Flux

$$\frac{Q}{V} = \frac{\varepsilon A}{d}$$

ψ – Electric Flux

$$\boxed{C = \frac{\varepsilon A}{d}}$$

A = metal plate Area

d = distance b/w metal plate

ε = Permitivity of dielectric material

$$\boxed{C = \frac{\varepsilon_0 \varepsilon_r A}{d}}$$

ε_0 = Absolute permitivity

$\varepsilon_0 = 8.854 \times 10^{-12}$ F/m

ε_r = Relative permitivity

$\varepsilon_r = 1$ (Air)

* Current & voltage equation for Capacitor :-

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

$$Q = CV$$

Capacitor current, $I_c = \frac{dQ}{dt}$

$$= \frac{d(CV)}{dt}$$

$$\boxed{I_c = C\frac{dV}{dt}}$$

$$I_c = C\frac{dV}{dt}$$

$$\frac{1}{C} \times I_c \times dt = dV$$

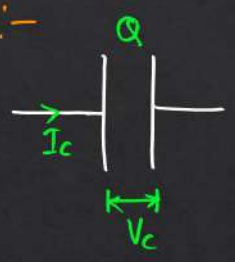
Integrating both side,

$$\int \frac{1}{C} \cdot I_c \cdot dt = \int dV$$

$$\frac{1}{C}\int I_c dt = V$$

$$\boxed{V_c = \frac{1}{C}\int I_c dt}$$

* Expression of Energy stored by Capacitor :-



Energy stored by Capacitor,

Energy = Power × time

$$\boxed{E = P \times t}$$

Lets assume that Capacitor store the small energy dE in small time dt

Now, Energy, $dE = P \times dt$

$$dE = V_c \cdot I_c \times dt$$

$$dE = V_c I_c \times dt$$

$$= V_c \times C \frac{dV_c}{\cancel{dt}} \times \cancel{dt}$$

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

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

$$f(x) = x^n$$

$$\frac{dx^n}{dx} = n \cdot x^{n-1}$$

$$\int x^n \, dx = \frac{x^{n+1}}{n+1}$$

$$dE = C \times V_c \cdot dV_c$$

Integrating both sides,

$$\int dE = \int C \times V_c' \cdot dV_c$$

$$E = C \times \frac{V_c^2}{2}$$

$$\text{Energy, } E = \frac{1}{2} C V_c^2$$

$$E = \frac{1}{2} \times \frac{Q}{V_c} \times V_c^2 = \frac{1}{2} Q V_c$$

$$E = \frac{1}{2} \cdot C \left(\frac{Q}{C}\right)^2 = \frac{1}{2} \cdot \frac{Q^2}{C}$$

Energy stored by capacitor,

$$E = \frac{1}{2} C V^2 = \frac{1}{2} Q V = \frac{1}{2} Q^2/C$$

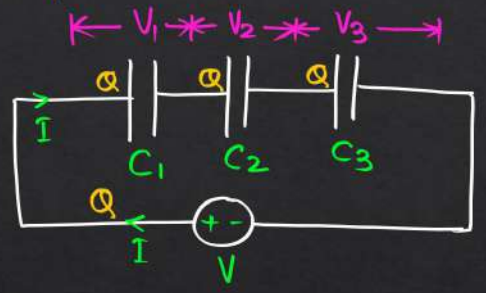
Basic Electrical Engg.

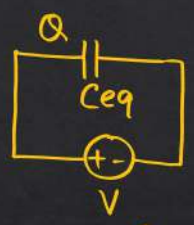
Sem-1st

Electrical Engg

Lec-26

* Capacitor connected in series :-





$$C_{eq} = \frac{Q}{V}$$

$$\boxed{V = \frac{Q}{C_{eq}}}$$

In series ckt, $V = V_1 + V_2 + V_3$ — (i)

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

$$V_1 = \frac{Q}{C_1} \qquad V_2 = \frac{Q}{C_2} \qquad V_3 = \frac{Q}{C_3}$$

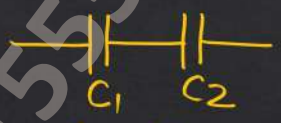
From eqⁿ (1)

$$V = V_1 + V_2 + V_3$$

$$\frac{Q}{C_{eq}} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

$$\frac{\cancel{Q}}{C_{eq}} = \cancel{Q}\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

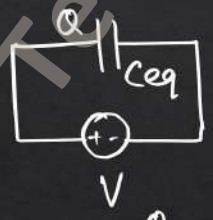


$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{eq}} = \frac{C_2 + C_1}{C_1 C_2}$$

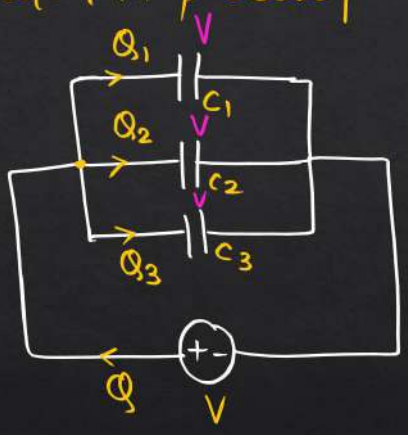
$$\boxed{C_{eq} = \frac{C_1 C_2}{C_1 + C_2}}$$

* Capacitor connected in parallel.



$$C_{eq} = \frac{Q}{V}$$

$$Q = C_{eq} \cdot V$$



$$C_1 = \frac{Q_1}{V}, \quad Q_1 = C_1 V$$

$$C_2 = \frac{Q_2}{V}, \quad Q_2 = C_2 V$$

$$C_3 = \frac{Q_3}{V}, \quad Q_3 = C_3 V$$

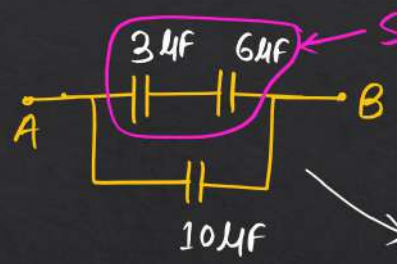
Now From ckt,

$$Q = Q_1 + Q_2 + Q_3$$

$$C_{eq} \cdot V = C_1 V + C_2 V + C_3 V$$

$$C_{eq} \cdot \cancel{V} = \cancel{V}(C_1 + C_2 + C_3)$$

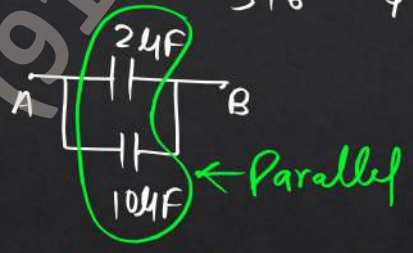
$$\boxed{C_{eq} = C_1 + C_2 + C_3}$$



Series — $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$

$$= \frac{3 \times 6}{3+6} = \frac{18}{9} = 2\mu F$$

$C_{AB} = ?$



$C_{AB} = 2\mu F + 10\mu F = 12\mu F$

* Inductor :-

The energy storing element which stores the energy in magnetic field, is called Inductor.

Inductor

→ opposes the change current

↓

Inductance

$I = 2A$
$= 4A$
$= 5A$
$= 7A$

* Inductance :-

The property of Inductor due to which it opposes the change in current through it, is called Inductance.

In Inductor,

$\phi \propto I$

$\boxed{\phi = LI}$

Here, L = proportional Constant
= Inductance

$\boxed{L = \frac{\phi}{I}}$

For N-turns

$\boxed{L = \frac{N\phi}{I}}$ → Unit of Inductance : Henery (H)

* Voltage & current equation in Inductor :-

Voltage induced in Inductor:

$$V_L = N\frac{d\phi}{dt}$$

$\frac{4x^2+2x+1}{f(x)}$

$$V_L = \frac{d(N\phi)}{dt}$$

$d(x)$

$$V_L = \frac{d(LI)}{dt} \quad \left\{L = \frac{N\phi}{I}\right\}$$

$$\boxed{V_L = L\frac{dI}{dt}}$$

$$V_L = L\frac{dI}{dt}$$

$$\frac{1}{L}\cdot V_L \cdot dt = dI$$

dV

Integrating both sides

$$\int \frac{1}{L} V_L \cdot dt = \int dI$$

$$\frac{1}{L}\int V_L \cdot dt = I_L$$

$$\boxed{I_L = \frac{1}{L}\int V_L dt}$$

* Energy stored by Inductor :-

Energy = Power × time

Lets us assume that Inductor store small amount of energy dE with in small time dt

Energy stored by Inductor = Power × time

$$\Rightarrow dE = P \times dt$$

$$dE = V_L \cdot I_L \times dt$$

$$dE = L\frac{dI_L}{\cancel{dt}} \times I_L \times \cancel{dt}$$

$$dE = L \cdot I_L \cdot dI_L$$

Integrating both sides

$$\int dE = \int L \cdot I_L \cdot dI_L$$

$$E = L \int I_L^1 \cdot dI_L$$

$$E = L \times \frac{I_L^2}{2}$$

$$\boxed{\text{Energy} = \frac{1}{2} L I_L^2}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1}$$

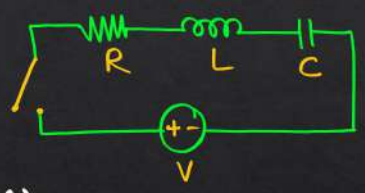
Basic Electrical Engg.

Unit-03 Lec-27

Basic of DC & AC circuit :-

* Circuit :-

The Connection of electrical elements such that Form the Close path in which current either Flow or try to Flow, is Called Circuit.



* Active element :-

↳ The electrical element which can transfer the energy for long duration of time is called Active element.

eg- Battery, Generator etc

↳ The element which can amplify the signal or power is called Active element

eg- transistor, Diode etc.

* Passive element :-

↳ The element which takes the power from the source is called Passive element.

eg- Resistor, Inductor, Capacitor etc.

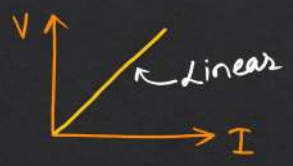
↳ The element which can not be able to amplify the signal or power, is called Passive element

eg- Resistor, Inductor, Capacitor etc.

* Linear element :-

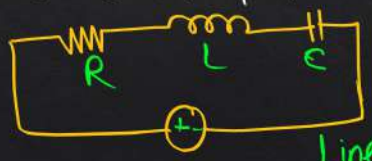
The element which follow the ohm's law, is called Linear element

eg- Resistor, Inductor, Capacitor etc



* Linear ckt :-

The electrical ckt in which only linear elements are connected, is called linear ckt

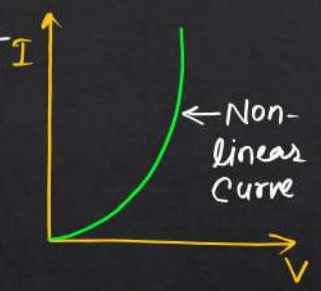


Linear ckt

* Non-linear element :-

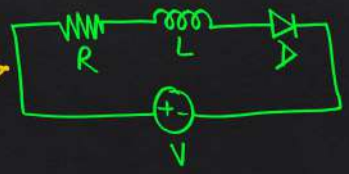
The element which does not follow the ohm's law, is called Non-linear element.

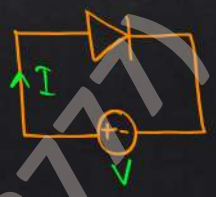
eg- Diode,



* Non-linear ckt :- The electrical ckt in which non-linear elements are connected, is called Non-linear ckt.

Non-linear ckt →

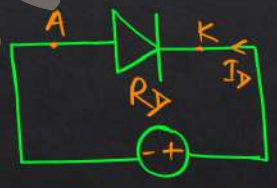




* Unilateral element :-

The element whose parameter is changed with change in direction of current, is called Unilateral element. eg- Diode.

Forward Biasing
(R_D = low)

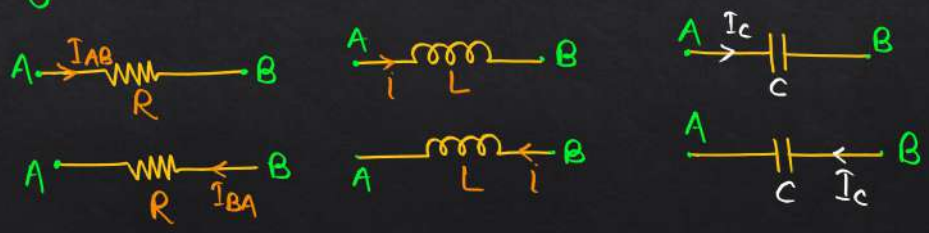


Reverse Biasing
(R_D = Very High)

* Bilateral element :-

The element whose parameter does not change with change in direction of current, is called Bilateral element.

eg- Resistor, Inductor, Capacitor etc



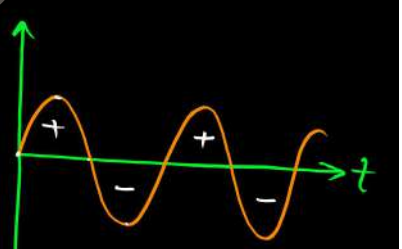
AC Fundamental
(AC ckt)

- BEE → U-3
- FEEE → U-2

Terminology :-

* Alternating quantity :-

The quantity whose magnitude and direction changed with time regularly is called alternating quantity.



$V = V_m \sin\omega t$

instantaneous Value

* Instantaneous Value :-

$\theta = 90^\circ$

$V = 100 \sin 90^\circ$

$= 100 \times 1$

$\boxed{V = 100V}$

→ Instantaneous Value at the instant of $\theta = 90^\circ$

$V = 100 \sin\theta$

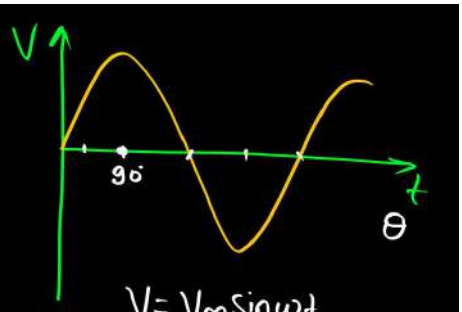
at $\theta = 30^\circ$

$V = 100 \sin 30$

$= 100 \times \frac{1}{2}$

$\boxed{V = 50V}$

→ at $\theta = 30^\circ$



$V = V_m \sin\omega t$

$= V_m \sin\theta$

Instantaneous value is represented by Small letter. eg- i, v, p.

Instantaneous value :-

The magnitude of Alternating quantity at any instant is called Instantaneous value.

* Waveform :-

$i = 50 \sin\theta$

$\theta = 30,\ i = 50 \times \sin 30 = 50 \times \frac{1}{2} = 25A$

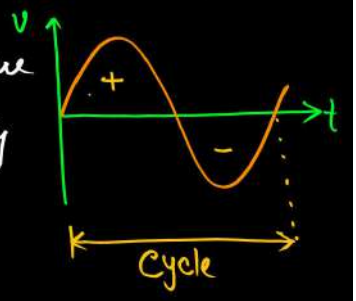
$\theta = 90,\ i = 50 \times \sin 90 = 50A$

$\theta = 180,\ i = 50 \times \sin 180 = 0$

The graph or curve obtained by plotting the instantaneous value of alternating quantity, is called waveform.

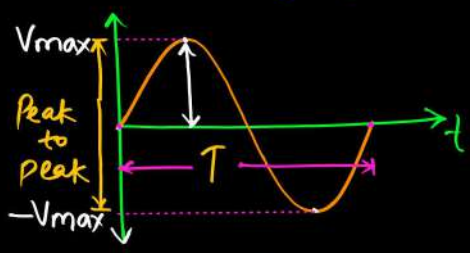
* Cycle :-

One complete set of +ve value and -ve value of alternating quantity is called cycle.



* Amplitude or peak value or maximum value (V_m) :-

The maximum value obtained by alternating quantity, is called Peak value or Amplitude or maximum value.



$$\boxed{\text{Peak to Peak value} = V_{max} + V_{max} = 2V_{max}}$$

* Time period (T):-

Time taken in second by alternating quantity to complete one cycle, is called time period.

↳ It is denoted by 'T'.

* Frequency (f):-

The number of cycle completed by alternating quantity per second is called Frequency.

↳ It is denoted by 'f'.

↳ It's unit is cycle per second (c/s) or Hertz

* Relation b/w T & f

time taken to complete f cycle = 1 second.

" " " " 1 cycle = $\frac{1}{f}$ second

Time taken to complete one cycle = T second.

$$\boxed{T = \frac{1}{f}} \quad \boxed{f = \frac{1}{T}}$$

AC circuit

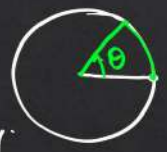
1st Sem.

BEE + FEEE

2 Nov 24

* Angular velocity :-

The rate of change of angular displacement, is called Angular velocity.



↳ It is denoted by ω

$$\text{Angular velocity} = \frac{\text{Angular displacement}}{\text{time}}$$

$$\boxed{\omega = \frac{\theta}{t}}$$

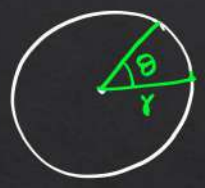
$\theta \rightarrow$ Radian

$t \rightarrow$ Second

$\omega \rightarrow$ Unit = Rad/sec.

$$\boxed{\omega = \frac{\theta}{t}}$$

$\frac{1}{T} = f$



Angular displacement covered in one complete cycle $= 2\pi$

Time taken to complete one cycle = 1 Time period $= T$

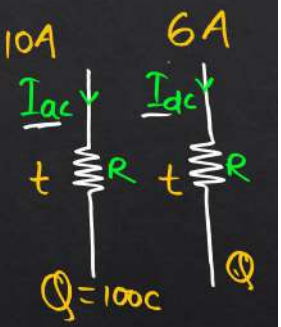
$\therefore$ angular velocity, $\omega = \frac{\theta}{t} = \frac{2\pi}{T}$

$$\boxed{\omega = \frac{2\pi}{T} = 2\pi f}$$

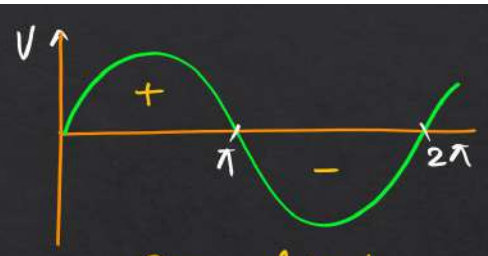
$$\omega = \frac{2\pi}{T} = 2\pi f$$

$$\boxed{T = \frac{2\pi}{\omega}}$$

* Average value :-

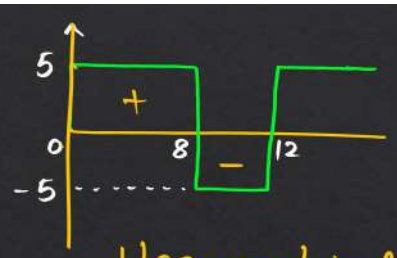


The Average value of alternating current is that DC current which when flowing through same ckt for same time then transfer the same charge as it is transfered by AC current for same through the same ckt.



Symmetrical wave

Avg. value is always Calculated for Half cycle.

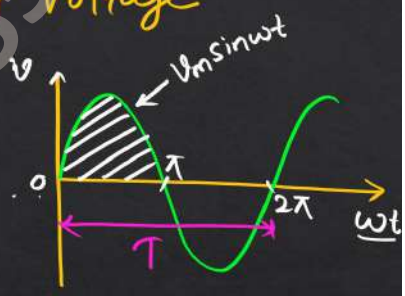


Unsymmetrical wave

Avg. value is Calculated for Full cycle.

Q. Find the Average value of Sinusoidal Voltage

$$\text{Average value} = \frac{\text{Area of curve under half cycle}}{\text{half cycle time}}$$



$V = V_m \sin\omega t$

$T = 2\pi$

$$\text{Average value} = \frac{\int_0^{\pi} V_m \sin\omega t \, d(\omega t)}{T/2}$$

$$= \frac{2}{T} V_m \int_0^{\pi} \sin\omega t \cdot d(\omega t)$$

$$= \frac{2V_m}{T}\left[-\cos\omega t\right]_0^{\pi}$$

$$= \frac{2V_m}{T}\left[-\cos\omega t\right]_0^{\pi}$$

$$= \frac{2V_m}{T}\left\{-(\cos\pi - \cos 0)\right\}$$

$$= \frac{2V_m}{T}\left\{-(-1-1)\right\}$$

$$= \frac{2V_m}{T} \times 2$$

$$= \frac{2V_m}{\pi} = \frac{2V_m}{\pi} = \frac{V_m}{\pi/2} = 0.637\,V_m$$

$$V_{avg} = 0.637\,V_m$$

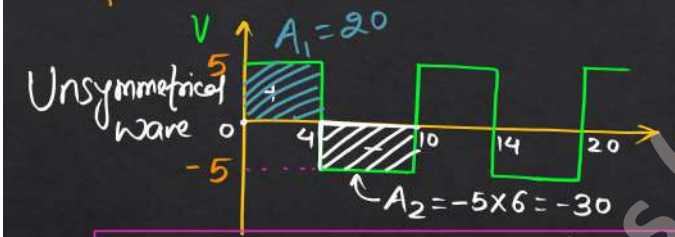
AC Circuit

1st Sem.

BEE + FEEE (3)

4 Nov 24

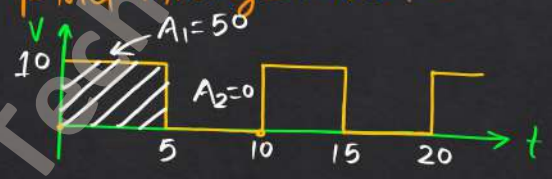
Q. Calculate the Average value of given waveform



$$\boxed{\text{Average value} = \frac{\text{Area of curve under Full cycle}}{\text{time for Full cycle.}}}$$

$$V_{avg} = \frac{|20-30|}{10} = \frac{10}{10} = 1$$

Q. Find Average value :-



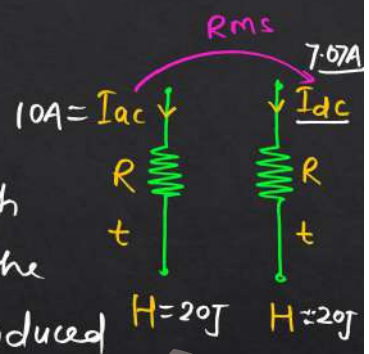
Wave : Unsymmetrical.

$$\text{Avg. value} = \frac{\text{Area of curve under Full cycle}}{\text{time for Full cycle}}$$

$$= \frac{50+0}{10} = 5$$

* RMS (Root mean square) value :-

RMS value of alternating current is defined as that value of dc current which when flowing through same ckt for same then produces the same amount of heat as it is produced by AC current when flowing through same ckt for same time.



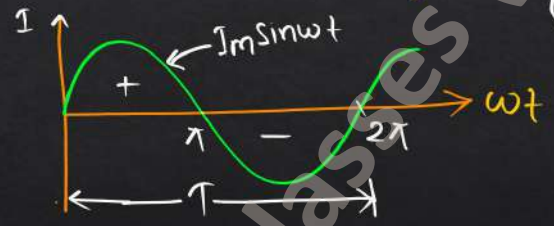
RMS = Root mean square value

$$\boxed{RMS = \sqrt{\text{Avg. of square value}}}$$

Ques. Find RMS value of Sinusoidal Current.

$I_m \sin\omega t$

$V_m \sin\omega t$



$i = I_m \sin\omega t$

RMS value,

$$I_{rms} = \sqrt{\frac{\int_0^{\pi} I_m^2 \sin^2\omega t \cdot d(\omega t)}{T/2}}$$

$$= \sqrt{\frac{1}{T/2} I_m^2 \int_0^{\pi} \sin^2\omega t \cdot d(\omega t)}$$

$$= \sqrt{\frac{2I_m^2}{T} \int_0^{\pi} \frac{1-\cos 2\omega t}{2} \cdot d(\omega t)}$$

$$= \sqrt{\frac{\cancel{2}I_m^2}{\cancel{2}T}\left\{\int_0^{\pi} 1 \cdot d(\omega t) - \int_0^{\pi} \cos 2\omega t \, d(\omega t)\right\}}$$

$$= \sqrt{\frac{I_m^2}{T}\left\{[\omega t]_0^{\pi} - \left[\frac{\sin 2\omega t}{2}\right]_0^{\pi}\right\}}$$

$$= \sqrt{\frac{I_m^2}{T}\left\{(\pi - 0) - \left(\frac{\cancel{\sin 2\pi}^{\,0} - \cancel{\sin 0}^{\,0}}{2}\right)\right\}}$$

$$= \sqrt{\frac{I_m^2}{2\cancel{T}} \times \cancel{T}}$$

$$= \sqrt{\frac{I_m^2}{2}}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} = 0.707\, I_{max}$$

BEE + FEEE

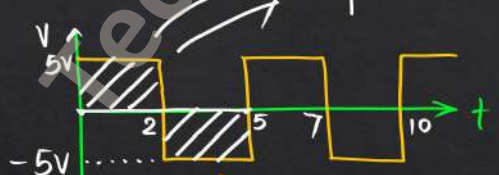
4

AC Ckt

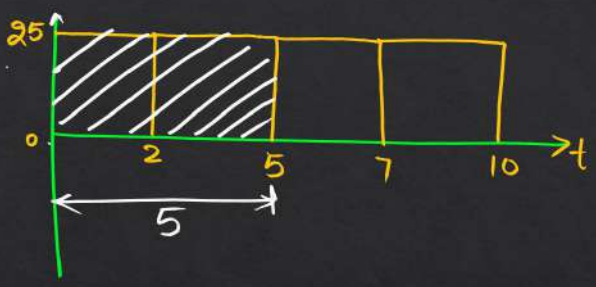
1st Semester

RMS value

square wave



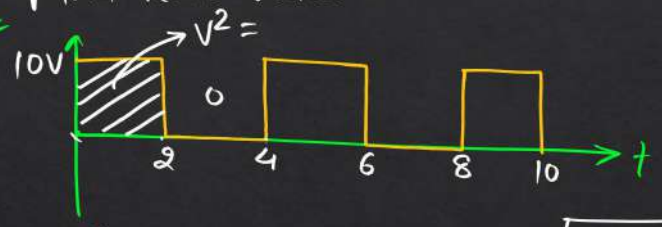
$(-5)^2 = 25$



RMS Value $= \sqrt{\text{Avg. value of square wave}}$

$$= \sqrt{\frac{25 \times \cancel{5}}{\cancel{5}}} = \sqrt{25} = 5 \text{ Volt}$$

Q. Find Rms value :-

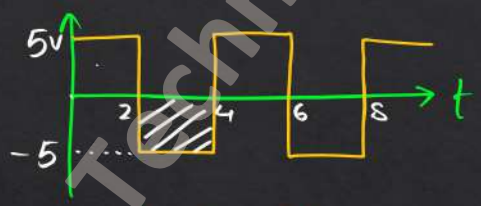


Sol^n:- RMS value $= \sqrt{\dfrac{(\cancel{100}^{25} \times 2) + 0}{\cancel{4}}}$

$= \sqrt{50} = \sqrt{25 \times 2} = 5\sqrt{2}$

Note:- For Rms value -

1. Symmetrical wave :- Calculated over either Full cycle or Half cycle.
2. Unsymmetrical wave :- Calculated over Full cycle only.



(Full cycle)

RMS value $= \sqrt{\dfrac{(25 \times 2) + (25 \times 2)}{4}} = \sqrt{\dfrac{25\cancel{100}}{\cancel{4}}} = \sqrt{25} = 5V$

RMS value (Half cycle) $= \sqrt{\dfrac{25 \times \cancel{2}}{\cancel{2}}} = \sqrt{25} = 5$ Volt

* Form Factor (K_F) :-

The Ratio of RMS value and Average value of a wave is called Form Factor.

$$\boxed{\text{Form Factor}(K_f) = \frac{\text{RMS Value}}{\text{Avg. value}}}$$

For Sinusoidal wave,

$$\text{Form Factor, } K_F = \frac{0.707 I_{max}}{0.637 I_{max}} = 1.11$$

* Peak Factor (K_P) :-

The ratio of Maximum value or Peak value and RMS value of a wave is called Peak Factor.

$$\boxed{\text{Peak Factor}(K_p) = \frac{\text{Maximum Value}}{\text{RMS Value}}}$$

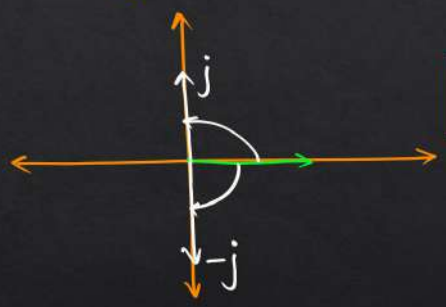
For sinusoidal wave,

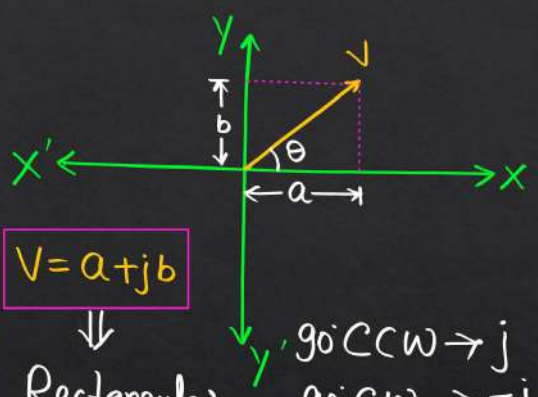
$$\text{Peak Factor, } K_p = \frac{\cancel{I_{max}}}{\cancel{I_{max}}/\sqrt{2}} = \sqrt{2} = 1.414$$

It is also called Crest Factor or Amplitude Factor.

* Representation of Phasor :-

① Rectangular Form.





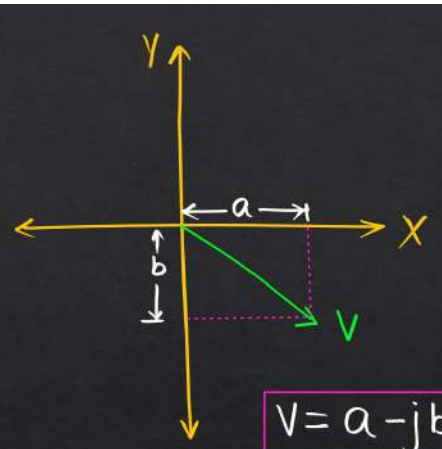
$$\boxed{V = a + jb}$$

⇓

Rectangular Form.

90° CCW → j

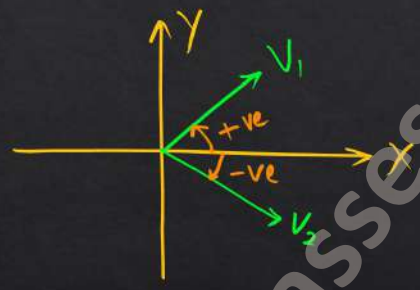
90° CW → −j

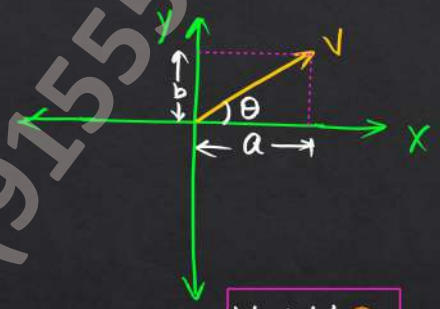


$$\boxed{V = a - jb}$$

↳ Rectangular Form.

② Polar Form :-

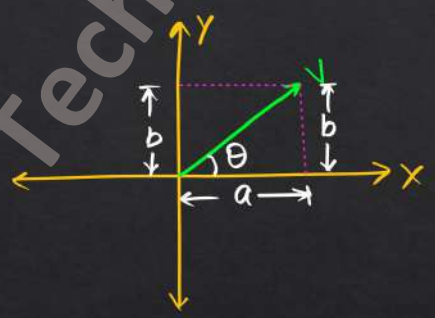




$$\boxed{V = V\angle\theta}$$

↳ Polar Form.

* Conversion :-



$V = a + jb$

For magnitude, $|V| = \sqrt{a^2 + b^2}$

$\theta = \tan^{-1}\left(\frac{b}{a}\right)$

In Polar Form,

$V = V\angle\theta$

$$\boxed{V = \sqrt{a^2+b^2}\,\angle\tan^{-1}\left(\frac{b}{a}\right)}$$

Example - $V = 3 + j4$

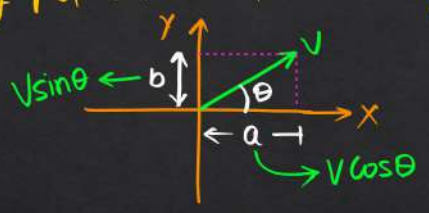
$|V| = \sqrt{(3)^2 + (4)^2} = \sqrt{25} = 5$

$\theta = \tan^{-1}\left(\frac{4}{3}\right) = 53.13$

In Polar Form,

$V = 5\angle 53.13^\circ$ Ans.

Polar Form to Rectangular Form -



Polar Form, $V = V\angle\theta$

a = X-Component = $V\cos\theta$

b = Y-Component = $V\sin\theta$

Rectangular Form, $\bar{V} = a + jb$

$\bar{V} = V\cos\theta + jV\sin\theta$

$\boxed{\bar{V} = V(\cos\theta + j\sin\theta)}$ → Trigonometric Form

$\boxed{\bar{V} = V\angle\theta}$

Example - Polar Form : $\bar{V} = 20\angle 30^\circ$

Rectangular Form :

$\bar{V} = V(\cos\theta + j\sin\theta)$

$\boxed{V = 20(\cos 30^\circ + j\sin 30^\circ)}$ → Trigonometric Form.

$= 20\left(\frac{\sqrt{3}}{2} + j\frac{1}{2}\right)$

$= 10\sqrt{3} + j10$

$\boxed{V = 17.3 + j10}$ Ans.

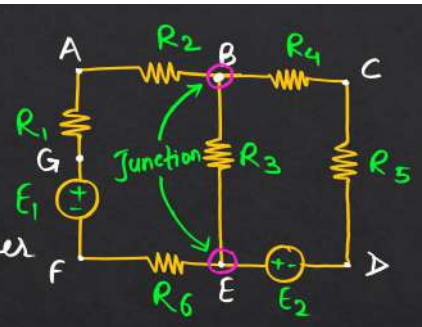
Basic Electrical

Lec-32

- Node
- Branch
- Mesh
- Loop

* Node :-

The point in a ckt at which atleast two elements are connected together is called Node.



↳ Total No. of Nodes = 7 (Node : A, B, C, D, E, F, G)

* Junction :- The point in a ckt at which atleast three elements are connected together, is called Junction.

↳ Total No. of Junction = 2 (Junction : B & E)

Note- All Junctions are Said to be Node but reverse is not true.

* **Branch** :- The element or Combinations of elements Connected b/w two Junction, is Called branch.

↳ No. of Branch : 3 (BAGFE, BE, BCDE)

* **Loop** :- The close path in a ckt is called Loop.

No. of Loop = 3 (ABCDEFGA, ABEFGA, BCDEB)

* **Mesh** :- The Loop in which no any inner loop, is called Mesh.

No. of Mesh = 2 (ABEFGA, BCDEB).

Note :- All mesh are Said to be Loop but Reverse is not true.

* **Kirchhoff's law** :-

→ ① Kirchhoff's Current Law (KCL)

→ ② Kirchhoff's Voltage law (KVL)

① **Kirchhoff's current Law (KCL)** :-

It states that " The algebric Summation of all current meeting at a point in a ckt is equal to zero ".

Sign Convense :-

① Incoming Current = +ve/−ve

② Outgoing Current = −ve/+ve

At point 'p'

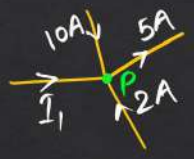
$+I_1 + (-I_2) + (-I_3) + I_4 + (-I_5) = 0$

$I_1 + I_4 = I_2 + I_3 + I_5$

$\sum$ Incoming Current = $\sum$ Outgoing Current

Note- KCL is based on Conservation of charge

Q.



$I_1 = ?$

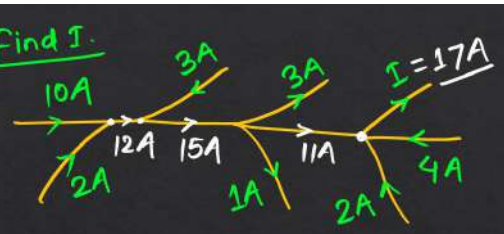
Apply KCL at Point 'P'

$I_1 + 2 - 5 + 10 = 0$

$\Rightarrow I_1 + 7 = 0$

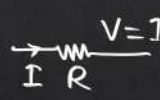
$\boxed{I_1 = -7A}$

Q. Find I.



* Kirchhoff's Voltage law (KVL):-

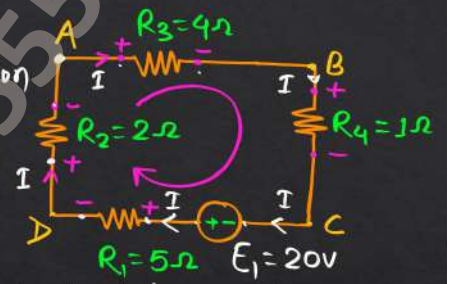
It states that "The algebric summation of all voltage in a loop is equal to zero."



Sign Converse:-

(+) ⟶ (−) : Voltage drop = −ve / +ve

(−) ⟶ (+) : Voltage Rise = +ve / −ve



KVL in Loop 'ABCDA'

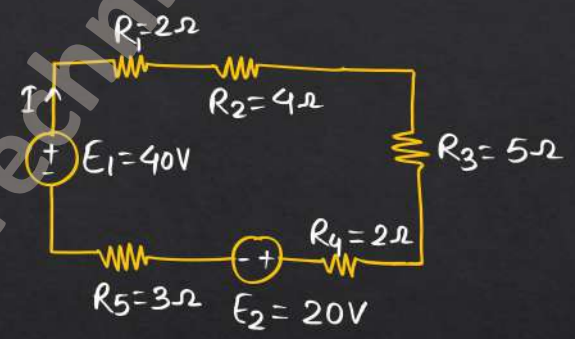
$-IR_3 + (-IR_4) + E_1 + (-IR_1) + (-IR_2) = 0$

$\Rightarrow \boxed{E_1 = IR_1 + IR_2 + IR_3 + IR_4}$

$I = \frac{E_1}{R_1 + R_2 + R_3 + R_4} = \frac{20}{12} = \frac{5}{3}$

Note- KVL is based on Conservation of Energy.

Q. H.W

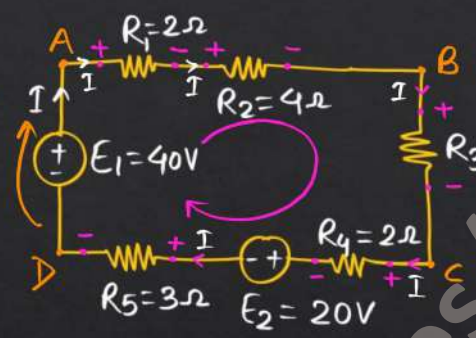


Find the value of I by using KVL.

Basic Electrical

Lec-33

Q. H.W



Find the value of I by using KVL.

Apply KVL in Loop ABCDA

$$-IR_1 + (-IR_2) + (-IR_3) + (-IR_4) + (-E_2) + (-IR_5) + E_1 = 0$$

$$\Rightarrow E_1 - E_2 = IR_1 + IR_2 + IR_3 + IR_4 + IR_5$$

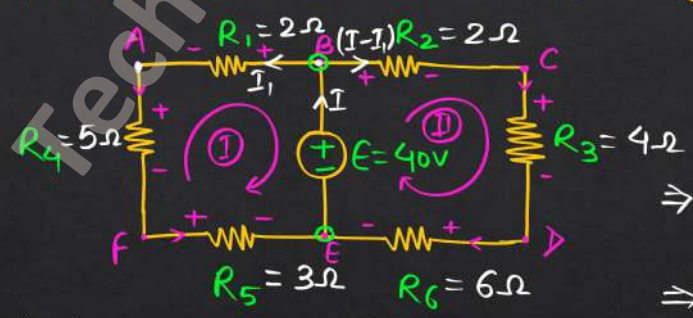
$$\Rightarrow 40 - 20 = I(2+4+5+2+3)$$

$$\Rightarrow 20 = I(16)$$

$$\Rightarrow I = \frac{\cancel{20}\,5}{\cancel{16}\,4}$$

$$I = \frac{5}{4} = 1.25\,A$$

Q. Find current in all Branch by using KVL & KCL.



Apply KVL in Loop I

$$+I_1R_1 + (-E) + I_1R_5 + I_1R_4 = 0$$

$$\Rightarrow I_1(R_1 + R_4 + R_5) = E$$

$$\Rightarrow I_1(2+5+3) = 40$$

$$\Rightarrow I_1 \times 10 = 40$$

$$\boxed{I_1 = \frac{40}{10} = 4A}$$

In Loop II

$$-(I-I_1)\cdot R_2 + \{-(I-I_1)R_3\} + \{-(I-I_1)\cdot R_6\} + E = 0$$

$$\Rightarrow -IR_2 + I_1R_2 - IR_3 + I_1R_3 - IR_6 + I_1R_6 + E = 0$$

$$\Rightarrow I(-R_2 - R_3 - R_6) + I_1(R_2 + R_3 + R_6) + E = 0$$

$$\Rightarrow I(-2-4-6) + 4(2+4+6) + 40 = 0$$

$$\Rightarrow -12I + 48 + 40 = 0$$

$$\Rightarrow 88 = 12I$$

$$\boxed{I = \frac{88}{12} = \frac{22}{3}\,A}$$

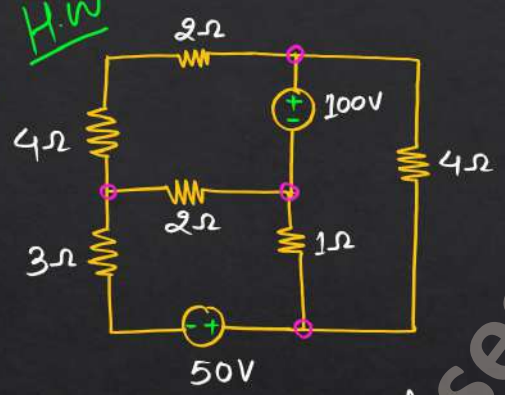
Current in branch BAFE, $I_1 = 4A$

" " " EB, $I = \frac{22}{3} A$

" " " BCDE, $(I - I_1) = \frac{22}{3} - 4 = \frac{22-12}{3} = \frac{10}{3} A$

H.W

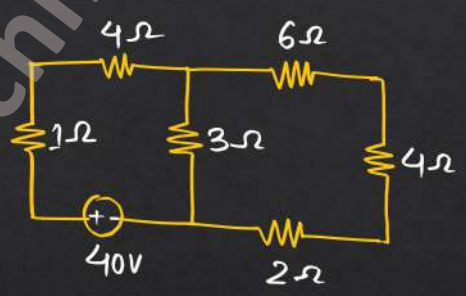
1.Q.



Find Branch current by using KCL & KVL

H.W

2.Q.

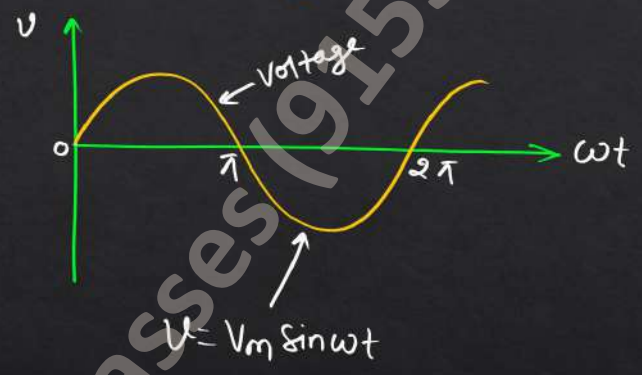


Find current in all Branch By using KCL & KVL

Basic Electrical

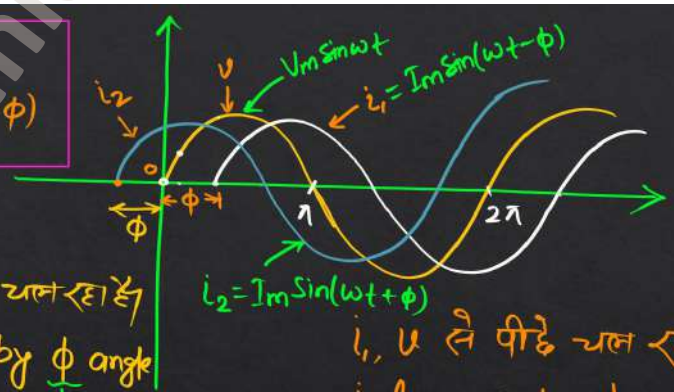
Lec-34

* Phase and phase angle.



Lagging

$i_1 = I_m \sin(\omega t - \phi)$



Leading

$i_2 = I_m \sin(\omega t + \phi)$

i_2, v से आगे चल रहा है।

i_2 leads V by ϕ angle

↳ phase angle

i_1, v से पीछे चल रहा है।

i_1 lags v by ϕ angle

↳ phase angle

↳ Phase Angle :- The angle with which any phasor quantity lags or leads by other phasor is called phase angle

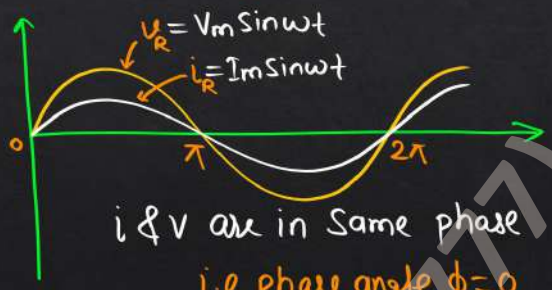
Phase Representation,

$$\boxed{v = V_m \sin(\omega t \pm \phi)}$$

For leading = +ve
For Lagging = −ve

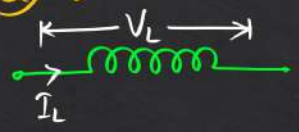
① Resistance :-

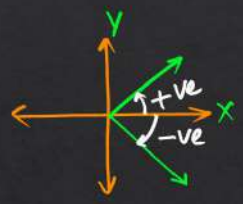
V_R & I_R in same phase
$\phi = 0$

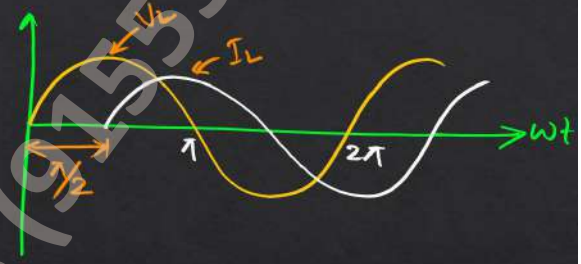


i & v are in Same phase
i.e phase angle $\phi = 0$

② Inductor :-



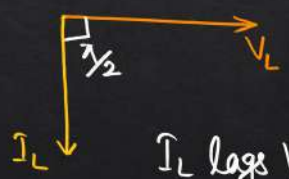




$$\begin{cases} V_L = V_m \sin\omega t \\ I_L = I_m \sin(\omega t - \pi/2) \end{cases}$$

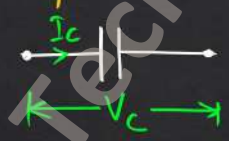
↳ For pure Inductor (No Resistor)

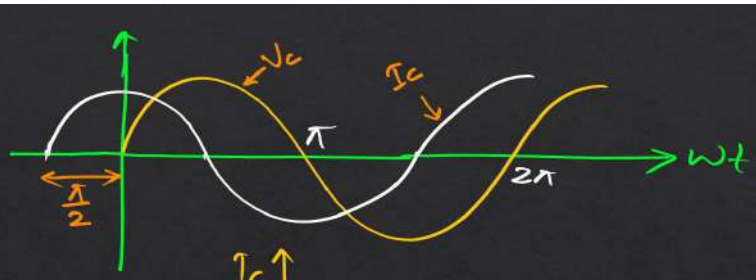
* In pure Inductor, current (I_L) lags by voltage (V_L) by phase angle $\pi/2$ (90°).



I_L lags V_L by $\pi/2$

③ Capacitor :-



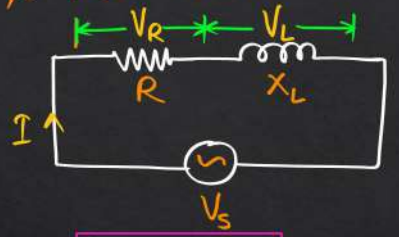


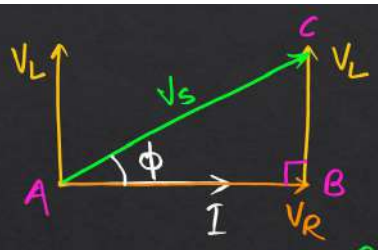
$$\begin{cases} V_C = V_m \sin\omega t \\ I_C = I_m \sin(\omega t + \pi/2) \end{cases}$$

* In pure Capacitor, Current (I_C) leads the voltage (V_C) by $\pi/2$ (90°) angle.

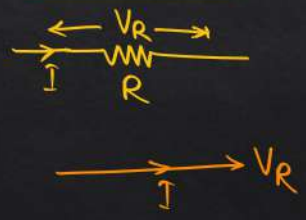
I_C leads V_C by $\frac{\pi}{2}$

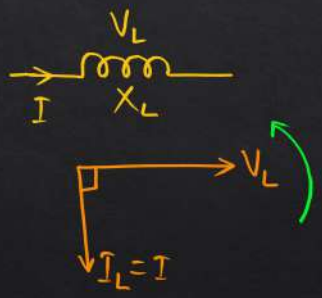
* RL Ckt :-



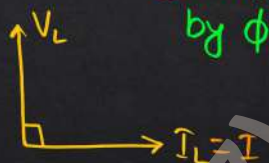


$$\boxed{\bar{V}_s = \bar{V}_R + \bar{V}_L}$$





* In RL Ckt, current lags V by $\phi < 90^\circ$



In ΔABC

$$AC = \sqrt{AB^2 + BC^2}$$

$$\boxed{V_s = \sqrt{V_R^2 + V_L^2}}$$

$$V_R = IR$$

$$V_L = IX_L$$

X_L = Inductive Reactance

$$X_L = 2\pi f L$$

$$V_s = \sqrt{(IR)^2 + (IX_L)^2}$$

$$= \sqrt{I^2R^2 + I^2X_L^2}$$

$$= \sqrt{I^2(R^2 + X_L^2)}$$

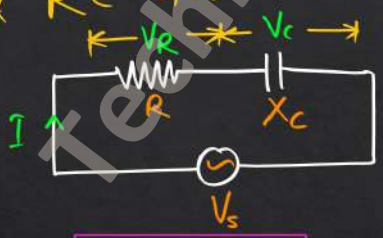
$$V_s = I \cdot \sqrt{R^2 + X_L^2}$$

$$\boxed{I = \frac{V_s}{\sqrt{R^2 + X_L^2}} = \frac{V_s}{Z}}$$

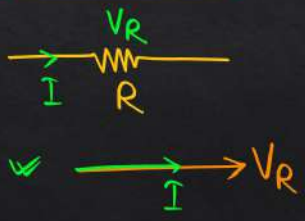
Z = Impedance

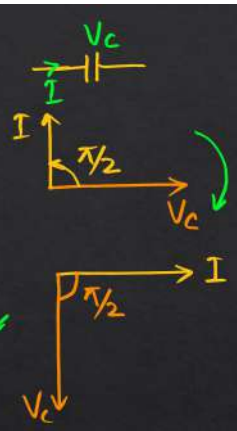
$$\boxed{Z = \sqrt{R^2 + X_L^2}}$$

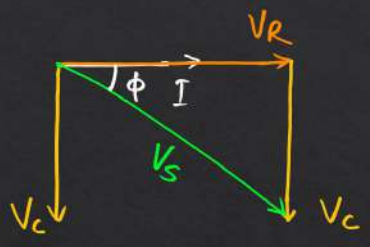
* RC Ckt :-



$$\boxed{\bar{V}_s = \bar{V}_R + \bar{V}_c}$$







In RC Ckt, Current leads Voltage by phase angle $\phi < 90^\circ$

Now,

$$V_s = \sqrt{V_R^2 + V_C^2}$$

$$= \sqrt{(IR)^2 + (IX_C)^2}$$

$$= \sqrt{I^2(R^2 + X_C^2)}$$

$$V_s = I\sqrt{R^2 + X_C^2}$$

$$I = \frac{V_s}{\sqrt{R^2 + X_C^2}} = \frac{V_s}{Z}$$

Z = Impedance

$$Z = \sqrt{R^2 + X_C^2}$$

X_C = Capacitive Resistance

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

Magnetic circuit

Sem-1st (BEE+FEEE)

13 NOV 2024

BEE

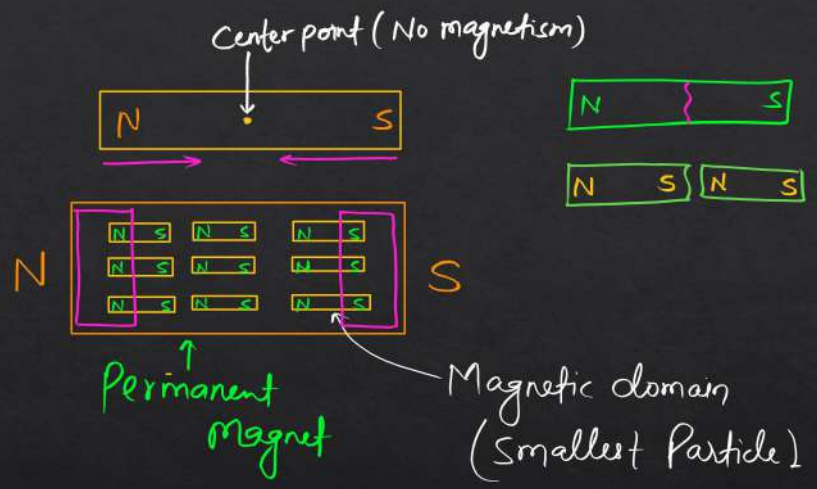
U-4: Magnetic ckt

U-5: Electromagnetic In

CSE - FEEE

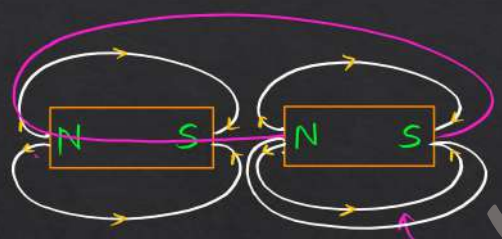
U-3: Magnetic ckt & Electromagneti Induction

* Magnet :-



Properties of magnet -

1. pole can not be seperated.
2. Magnetism at center point of magnet is zero.
3. Magnetic strength decreases as moves toward center from pole.
4. Nature of Force b/w two same pole (N-N or S-S) is Repulsive.
5. Nature of Force b/w two opposite pole (N-S) is attractive.



magnetic line of Force
↓
Magnetic Flux

10^8

* Magnetic Flux :-

↳ The magnetic line of Forces is called Magnetic Flux.

↳ It is denoted by ϕ

↳ Unit of magnetic Flux is weber (Wb).

↳ 1 weber = 10^8 Maxwell = 10^8 Magnetic line of Forces

↳ Magnetic Flux is analogous to Electric Current.

* Magnetic Flux density :- (Analogous to current density)

↳ Magnetic flux passes through per unit area, is called magnetic flux density

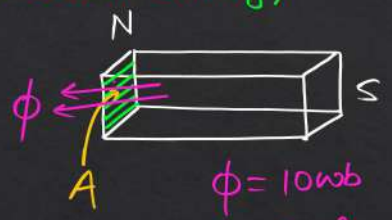
↳ It is denoted by 'B'.

↳ Magnetic flux density, $B = \frac{\text{Flux}}{\text{Area}}$ → Flux → weber, Area → m^2

↳ Unit : weber/m^2 (wb/m^2) or Tesla.

$1\ wb/m^2 = 1\ Tesla$

↳ It is a vector quantity.



$\phi = 10\ wb$

$A = 2\ m^2$

$B = \frac{\phi}{A} = \frac{10}{2} = 5\ wb/m^2$

* MMF (Magnetomotive Force) :-

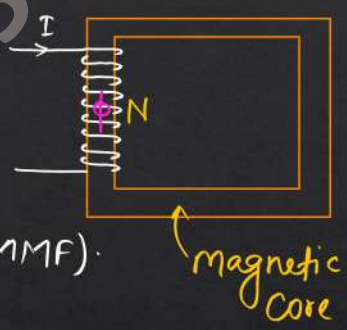
↳ The magnetic pressure which set up or produces magnetic flux inside the magnetic core is called Magnetomotive Force (MMF).

↳ MMF = No. of turns × current

$MMF = NI$

↳ Unit : Ampere-turn (AT)

↳ MMF is analogous to EMF (Electromotive Force)



* Reluctance (S) :-

↳ The opposition offered by magnetic ckt to flow or set up the magnetic flux, is called Reluctance.

↳ It is denoted by S.

* Law of Reluctance :-

① Reluctance is directly proportional to length of magnetic ckt i.e $S \propto l$

② Reluctance is inversally proportional to X-section area of magnetic ckt. i.e $S \propto \frac{1}{A}$

By Combining above Relation,

$$S \propto \frac{l}{A}$$

$$\boxed{S = \frac{1}{\mu} \times \frac{l}{A}}$$

Here, $\frac{1}{\mu}$ = proportional Constant

μ = Permeability of material

↳ Reluctance is analogous to Resistance

$$\boxed{\text{Reluctance}(S) = \frac{\text{MMF}}{\text{Flux}}}$$

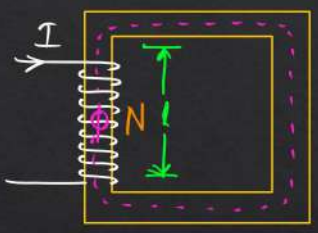
MMF → AT

Flux → Weber

↳ Unit = AT/Wb

* Magnetic Field strength / Magnetising Force

↳ Magnetomotive Force per unit length of magnetic core required to produce the flux, is called Magnetic Field strength or magnetising Force



MMF = NI

↳ It is denoted by 'H'

$$\boxed{\text{Magnetic Field strength / Magnetising Force}(H) = \frac{NI}{l}}$$

↳ Unit = AT/m

Magnetic Circuit

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BEE + FEEE

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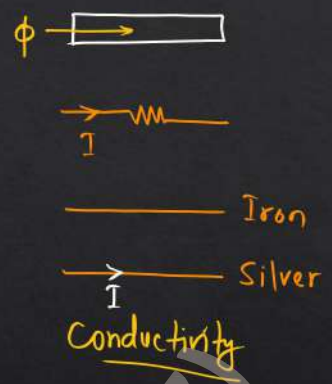
* Permeability :-

The ability of magnetic material to allow the passes of magnetic Flux through it, is called Permeability.



Less Flux — less permeability

more Flux — High permeability

Types of Permeability –

① Permeability of Free space or air :-

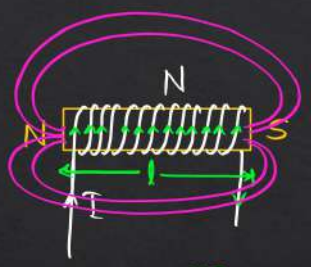
↳ Permeability in air or free space is called Permeability of Free space or air.

↳ It is denoted by μ_0

$$\boxed{\mu_0 = 4\pi \times 10^{-7}\ H/m}$$

② Permeability of material :-

Permeability of material is defined as the ratio of Magnetic Flux density inside the core to the magnetising Force.



$$H = \frac{NI}{l}$$

$$B = \frac{\phi}{A}$$

Permeability of material, $\mu = \dfrac{\text{Magnetic Flux density}}{\text{Magnetising Force}}$

↳ Unit = Henery | meter (H/m).

$$\boxed{\mu = \frac{B}{H}}$$

$$\boxed{B = \mu H}$$

$$\boxed{B = \mu_0 \mu_r H}$$

Here, $\boxed{\mu = \mu_0 \mu_r}$

μ_r = Relative permeability

③ Relative Permeability :-

The ratio of permeability of material and Permeability of Free space is called Relative Permeability.

$$\underbrace{\text{Relative Permeability}}_{\text{Unitless (No Unit)}} = \frac{\text{Permeability of material}}{\text{Permeability of Free space}}$$

$$\boxed{\mu_r = \frac{\mu}{\mu_0}} \qquad \boxed{\mu = \mu_0 \mu_r}$$

Relative Permeability For Air

$$\mu_r = \frac{\mu}{\mu_0} = \frac{4\pi \times 10^{-7}}{4\pi \times 10^{-7}} = 1$$

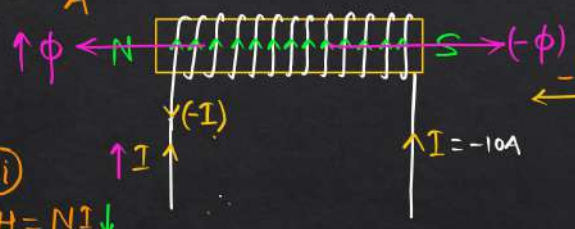
$$\boxed{\mu_{r(air)} = 1}$$

* Magnetisation curve (B-H curve) :-

$B = \frac{\phi}{A}$

(i) $\uparrow H = \frac{NI}{l} \uparrow$, $\uparrow B = \mu H \uparrow$

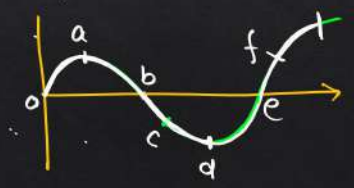
$\boxed{B \propto H}$

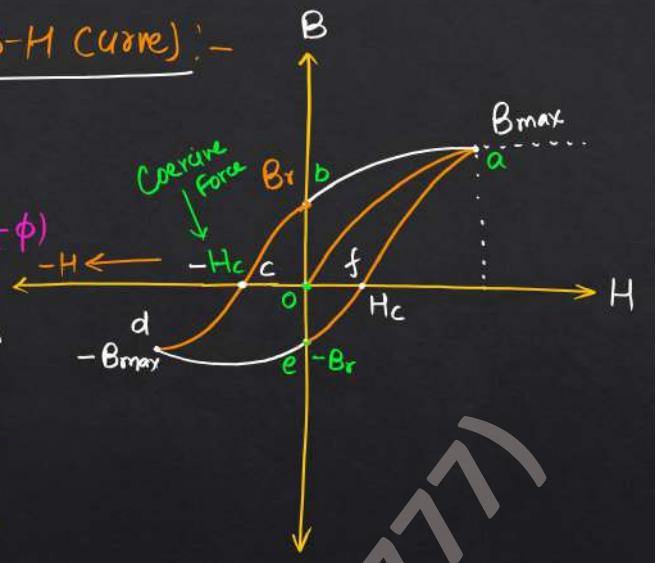


(ii)

$\downarrow H = \frac{NI}{l} \downarrow$

$\downarrow B = \mu H \downarrow$





↳ The curve drawn b/w magnetising force and magnetic flux density of a material subjected under one cycle of magnetisation, is called Magnetisation curve or B-H curve.

↳ When current increases then value of H increases and so B increases.

↳ The point at which magnetic flux density becomes max^m or constant, is called saturation point.

↳ Thus curve 'oa' is obtained.

↳ To demagnetise the core, current value decreases from max^m value so H and hence B also decreases but when H becomes zero, B has some +ve value (ob). this is called Residual magnetism (B_r).

↳ Thus curve obtaind is 'ab'.

↳ The property of material due to which residual magnetism is available in material is called Retentivity.

↳ To Completely demagnetise the core, we have to supply current in Reverse direction i.e -ve value current.

↳ Due to Reverse current, Reverse magnetising Force is applied which reduces the Residual magnetism and at point c, residual magnetism becomes zero. i.e Core is Completely demagnetised. (B=0)

↳ magnetising Force required to demagnetise the Core is called coercive Force.

↳ Point 'c' is Coercive Force point

↳ Now Reverse current increases, so B increases upto max^m value in reverse direction (- Bmax). {cd-curve}

↳ To reduces the magnetism, we have reduce the the current in reverse direction.

↳ Due to decreasing current in reverse direction -H becomes zero at point 'e' but Residual magnetism (-Br) is available. {de-curve}

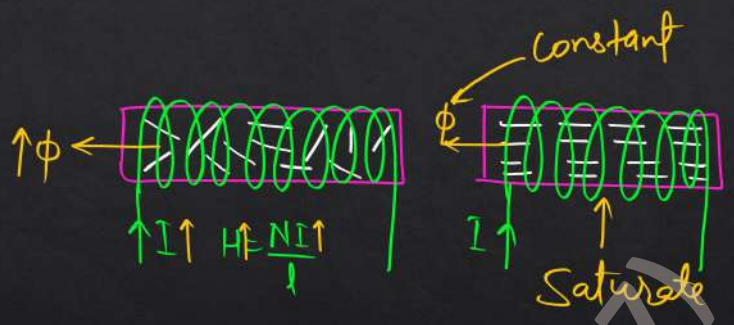
↳ Again Completely demagnetise the core, current is supplied such that magnetising Force reduces the residual magnetism and finally demagnetise in

Similar way as before

↳ Thus curve obtained is efa.

↳ Hysteresis Loop :-

When B-H curve is drawn then H lags behind B, so curve for one cycle of magnetisation, is created as a loop this loop called Hysteresis Loop.



Magnetic circuit

BEE + FEEE

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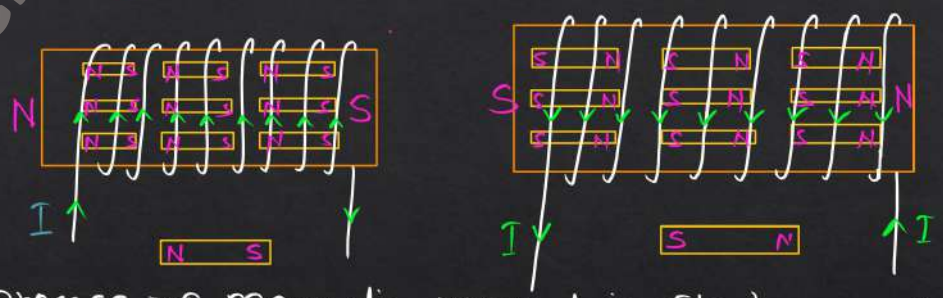
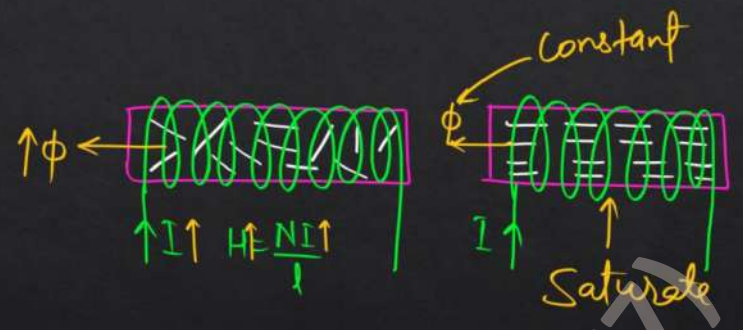
15 Nov 2024

* Magnetic Hysteresis :-



The process of magnetic reversal in Electromagnet due to supply the current or magnetisation Force in Reverse direction, is called Magnetic Hysteresis.



↳ Area of Hysteresis loop indicates the amount of losses as Hysteresis i.e Hysteresis loss of material

① If Hysteresis loop area is more then Hysteresis loss is more and

② If Hysteresis loop area is small then Hysteresis loss is less.

Magnetic Ckt:-

* Calculation of Ampere Turn (AT):-

Flux, $\phi = \frac{MMF}{Reluctance}$

$\phi = \frac{NI}{l/\mu_0\mu_r A}$

$\phi \times \frac{l}{\mu_0\mu_r A} = NI$

$NI = \phi \times \frac{l}{\mu_0\mu_r A}$

$= (\phi/A) \times \frac{l}{\mu_0\mu_r}$

$= \frac{B}{\mu_0\mu_r} \times l$

$\boxed{NI = H \times l}$

$\boxed{AT = H \times l}$

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

$S = \frac{l}{\mu_0\mu_r A}$

$B = \mu H$

$\frac{B}{\mu} = H$

$\frac{B}{\mu_0\mu_r} = H$

Rough work

Ampere turn (AT) = Magnetising force applied in ckt of length l × length of magnetic ckt l.

* magnetic ckt :- The loop of magnetic material in which magnetic flux either setup or try to set up, is called magnetic ckt.

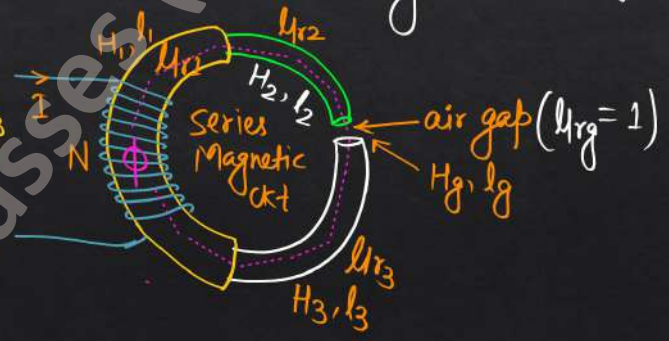
* Types of magnetic ckt
  - ① series ckt
  - ② Parallel ckt

* Series ckt :-

The magnetic ckt in which same flux passes through all magnetic material connected in magnetic ckt, is called series magnetic ckt

Total MMF $= H_1 \times l_1 + H_2 \times l_2 + H_g \times l_g + H_3 \times l_3$

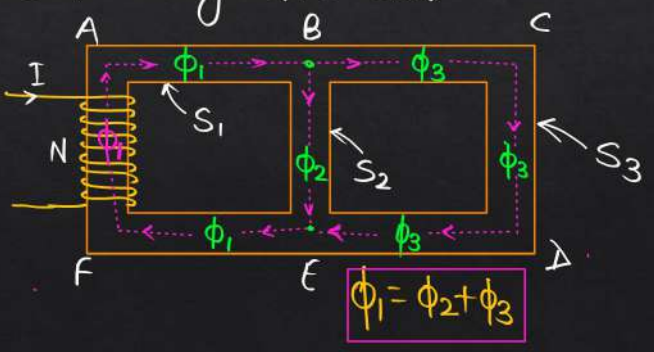
$$NI = H_1 l_1 + H_2 l_2 + H_3 l_3 + H_g l_g$$



* Parallel Magnetic ckt :-

↳ The magnetic ckt in which magnetic flux divided according the magnetic material is called Parallel magnetic ckt

Parallel Path = 3
- BAFE = S_1
- BE = S_2
- BCDE = S_3



$$\phi_1 = \phi_2 + \phi_3$$

MMF Required in ckt,

$$NI = \phi_1 S_1 + \phi_3 S_3$$

or $$NI = \phi_1 S_1 + \phi_2 S_2$$

* Comparison between Electric ckt and magnetic ckt.

Electric ckt	Similarity	Magnetic ckt
① The ckt in which electric current passes, is called Electric ckt		① The ckt in which magnetic flux passes is called magnetic ckt.
② Electric Current		② Magnetic Flux
③ EMF (Electromotive Force)		③ MMF (Magnetomotive Force)
④ Resistance $(R) = \rho \frac{l}{A}$		④ Reluctance $(S) = \frac{l}{\mu A}$
⑤ Conductivity		⑤ Permeability
⑥ Conductance		⑥ Permeance
⑦ EMF → Electric pressure		⑦ MMF → magnetic pressure
⑧ Voltage drop $= I \cdot R$		⑧ mmf drop $= \phi \cdot S$
⑨ Current density $(\bar{J}) = \frac{I}{A}$		⑨ Flux density $(\bar{B}) = \frac{\phi}{A}$
⑩ Electric Field Intensity $E = \frac{V}{d}$		⑩ Magnetic Field Intensity, $H = \frac{NI}{l}$

Disimilarity

① Electric current can not flow through Air	① magnetic flux is setup even in air or passes through air.
② Different type of Electric Insulator is available.	② No any Magnetic Insulator is available.

Magnetic Circuit

Numericals

1st Semester.

BEE+FEEE

(8) 16 Nov 2024

CASIO Fx-991EX Calculator Model

Er. Vijay Pandit

Q1. A magnetic pole face has a rectangular section having dimensions 200 mm by 100 mm. If the total flux emerging from the pole is 150 μWb, calculate the flux density.

Ans- 0.0075 T or 7.5 mT

Sol^n:- Given:

Flux, $\phi = 150\,\mu Wb$

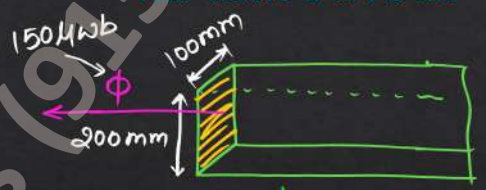
$\phi = 150 \times 10^{-6}$ Wb

Flux density = ?

Pole Face Area, $A = 200 \times 10^{-3} \times 100 \times 10^{-3}$

$= 2 \times 10^{4} \times 10^{-6}$

$= 2 \times 10^{-2}\ m^2$



Flux density,

$B = \frac{\phi}{A} = \frac{\cancel{150}^{75} \times 10^{-6}}{\cancel{2} \times 10^{-2}}$

$= 75 \times 10^{-6} \times 10^{2}$

$= 75 \times 10^{-4}$

$= 0.0075\,T$

$B = 75 \times 10^{-4}$

$= 75 \times 10^{-3} \times 10^{-1}$

$= 75 \times 10^{-1}\ mT$

$= 7.5\ mT$

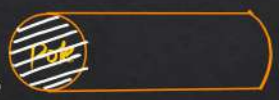
$B = 0.0075\,T = 7.5\,mT$ Ans

Q2. The maximum working flux density of a lifting electromagnet is 1.8 T and the effective area of a pole face is circular in cross-section. If the total magnetic flux produced is 353 mWb, determine the radius of the pole face Ans-250 mm

Solⁿ:-

Flux density, $B = 1.8\,T$

Flux, $\phi = 353\,mWb = 353 \times 10^{-3}\,Wb$



$B = \frac{\phi}{A}$

$\Rightarrow A = \frac{\phi}{B} = \frac{353 \times 10^{-3}}{1.8} = \frac{353}{1800}\,m^2$

Pole Face Area, $A = \pi r^2$

radius, $r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{353/1800}{\pi}} = 0.24984\,m$

$r = 0.24984 \times 10^3\,mm$

$r = 249.84\,mm$ Ans.

Home work

Solve Remaining question

Q3. A magnetizing force of 8000 A/m is applied to a circular magnetic circuit of mean diameter 30 cm by passing a current through a coil wound on the circuit. If the coil is uniformly wound around the circuit and has 750 turns, find the current in the coil. Ans- current I = 10.05 A

Q4. A flux density of 1.2 T is produced in a piece of cast steel by a magnetizing force of 1250 A/m. Find the relative permeability of the steel under these conditions. Ans- 764

Q5. Determine the magnetic field strength and the mmf required to produce a flux density of 0.25 T in an air gap of length 12 mm.

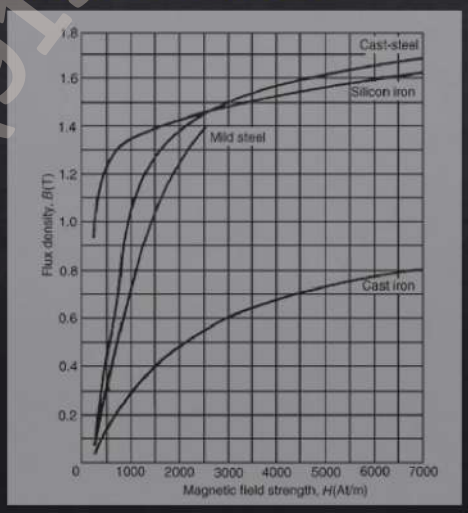
Ans- Magnetic field strength =198 940 AT/m mmf =2387 AT

Q6. A coil of 300 turns is wound uniformly on a ring of non-magnetic material. The ring has a mean circumference of 40 cm and a uniform cross sectional area of 4 cm2. If the current in the coil is 5 A, calculate (a) the magnetic field strength, (b) the f lux density and (c) the total magnetic flux in the ring. Ans- H=3750 AT/m, B=4.712 mT, Flux=1.885 μWb

Q7. An iron ring of mean diameter 10 cm is uniformly wound with 2000 turns of wire. When a current of 0.25 A is passed through the coil a flux density of 0.4 T is set up in the iron. Find (a) the magnetizing force and (b) the relative permeability of the iron under these conditions. Ans- H=1592 AT/m, B=200 T

Q8. A uniform ring of cast iron has a cross-sectional area of 10 cm2 and a mean circumference of 20 cm. Determine the mmf necessary to produce a flux of 0.3 mWb in the ring. The magnetization curve for cast iron is given in figure.

Ans- 200 AT



Q9. Determine the reluctance of a piece of mumetal of length 150 mm and cross-sectional area 1800 mm2 when the relative permeability is 4000. Find also the absolute permeability of the mumetal. Ans- 16580 AT/Wb, 5.027×10^{-3} H/m

Q10. A mild steel ring has a radius of 50 mm and a cross sectional area of 400 mm2. A current of 0.5 A flows in a coil wound uniformly around the ring and the flux produced is 0.1 mWb. If the relative permeability at this value of current is 200 find (a) the reluctance of the mild steel and (b) the number of turns on the coil.

Ans- (a) 3.125×10^6 AT/Wb (b) 625

Electromagnetism

FEEE → Unit : 3 (Magnetic ckt + Electromagnetism)

1st Semester

BEE → Unit : 5 (last)

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17/11/2024

Magnetic Circuit

Numericals

1st Semester.

Er. Vijay Pandit

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Ans- 0.0075 T or 7.5 mT

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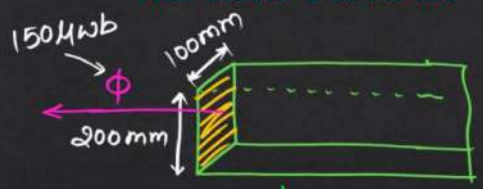

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$B = 75 \times 10^{-4}$

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$= 75 \times 10^{-1}\ mT$

$= 7.5\ mT$

$B = 0.0075T = 7.5\ mT$ Ans

Q2. The maximum working flux density of a lifting electromagnet is 1.8 T and the effective area of a pole face is circular in cross-section. If the total magnetic flux produced is 353 mWb, determine the radius of the pole face Ans-250 mm

Solⁿ:

Flux density, $B = 1.8T$

Flux, $\phi = 353\ mWb = 353 \times 10^{-3}$ Wb

$B = \frac{\phi}{A}$

$\Rightarrow A = \frac{\phi}{B} = \frac{353 \times 10^{-3}}{1.8} = \frac{353}{1800}\ m^2$

Pole Face Area, $A = \pi r^2$

radius, $r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{353/1800}{\pi}} = 0.24984m$

$r = 0.24984 \times 10^{3}$ mm

$r = 249.84$ mm

Ans.

Q3. A magnetizing force of 8000 A/m is applied to a circular magnetic circuit of mean diameter 30 cm by passing a current through a coil wound on the circuit. If the coil is uniformly wound around the circuit and has 750 turns, find the current in the coil. Ans- current I = 10.05 A

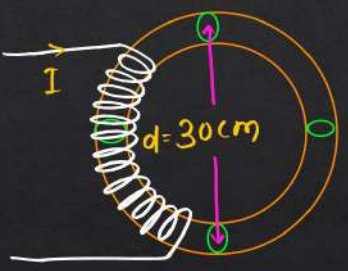
Solⁿ:-

$H = 8000\ AT/m$

$N = 750$

$I = ?$

$d = 30cm$



length of ckt, $l = \pi D = \pi \times 30 \times 10^{-2}\ m$

Now, $H = \frac{NI}{l}$

$\therefore I = \frac{H \times l}{N}$

$= \frac{8000 \times \pi \times 30 \times 10^{-2}}{750}$

$\boxed{I = 10.05A}$ Ans.

Q4. A flux density of 1.2 T is produced in a piece of cast steel by a magnetizing force of 1250 A/m. Find the relative permeability of the steel under these conditions. Ans- 764

Solⁿ given:-

$B = 1.2T$

$H = 1250 AT/m$

$\mu_r = ?$

$\mu_0 = 4\pi \times 10^{-7} H/m$

$B = \mu H$

$B = \mu_0 \mu_r H$

$\mu_r = \frac{B}{\mu_0 H} = \frac{1.2}{4\pi \times 10^{-7} \times 1250}$

$\mu_r = 763.94$

$\boxed{\mu_r = 764}$

Q5. Determine the magnetic field strength (H) and the mmf required to produce a flux density of 0.25 T in an air gap of length 12 mm.

Ans- Magnetic field strength =198 940 AT/m mmf =2387 AT

Solⁿ:- $l_g = 12mm$

$B_g = 0.25T$

$H = ?$

$mmf = NI = ?$

$B = \mu H$

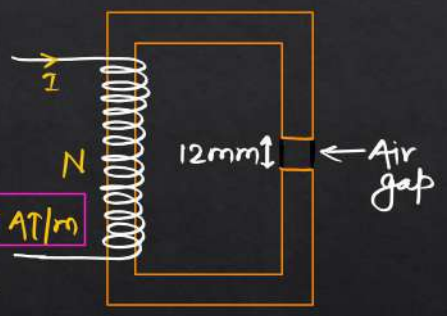
$B = \mu_0 \mu_r H$

$H = \frac{B}{\mu_0 \mu_r}$

$= \frac{0.25}{4\pi \times 10^{-7} \times 1}$

$\boxed{H = 198943.67\ AT/m}$

$H = \frac{NI}{l} = \frac{mmf}{l}$



$mmf = H \times l = 198943.67 \times 12 \times 10^{-3} = 2387.32$

$\boxed{mmf = 2387.32\ AT}$

Q6. A coil of 300 turns is wound uniformly on a ring of non-magnetic material. The ring has a mean circumference of 40 cm and a uniform cross sectional area of 4 cm2. If the current in the coil is 5 A, calculate (a) the magnetic field strength, (b) the f lux density and (c) the total magnetic flux in the ring. Ans- H=3750 AT/m, B=4.712 mT, Flux=1.885 μWb

Q7. An iron ring of mean diameter 10 cm is uniformly wound with 2000 turns of wire. When a current of 0.25 A is passed through the coil a flux density of 0.4 T is set up in the iron. Find (a) the magnetizing force and (b) the relative permeability of the iron under these conditions. Ans- H=1592 AT/m, $\mu_r = 200$

Solⁿ given

$d = 10cm$

$N = 2000$

$I = 0.25A$

$B = 0.4T$

(a) $H = ?$

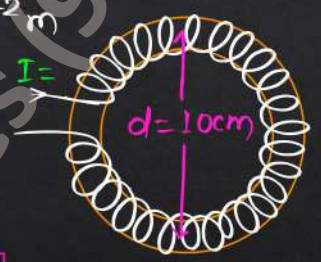
(b) $\mu_r = ?$

$l = \pi D = \pi \times 10 \times 10^{-2} m$

$H = \frac{NI}{l}$

$= \frac{2000 \times 0.25}{\pi \times 10 \times 10^{-2}}$

$H = 1592 AT/m$



$B = \mu_0 \mu_r H$

$\mu_r = \frac{B}{\mu_0 H}$

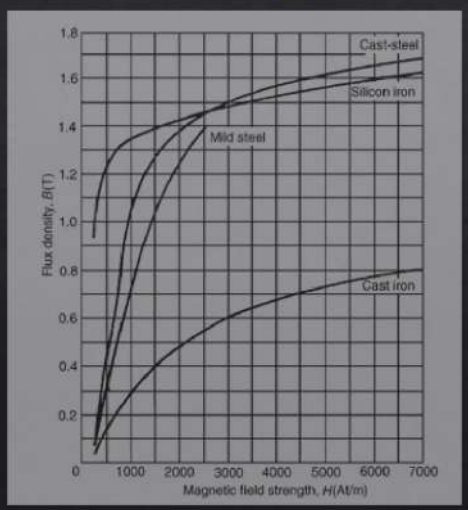
$= \frac{0.4}{4\pi \times 10^{-7} \times 1592}$

$= 199.94$

$\mu_r = 200$

Q8. A uniform ring of cast iron has a cross-sectional area of 10 cm2 and a mean circumference of 20 cm. Determine the mmf necessary to produce a flux of 0.3 mWb in the ring. The magnetization curve for cast iron is given in figure.

Ans- 200 AT



Q9. Determine the reluctance of a piece of mumetal of length 150 mm and cross-sectional area 1800 mm2 when the relative permeability is 4000. Find also the absolute permeability of the mumetal. Ans- 16580 AT/Wb, 5.027×10^{-3} H/m

Q10. A mild steel ring has a radius of 50 mm and a cross sectional area of 400 mm2. A current of 0.5 A flows in a coil wound uniformly around the ring and the flux produced is 0.1 mWb. If the relative permeability at this value of current is 200 find (a) the reluctance of the mild steel and (b) the number of turns on the coil.

Ans- (a) 3.125×10^{6} AT/Wb (b) 625

Electromagnetism

1st Semester

BEE → Unit = 5

BEE + FEEE

18 Nov 2024

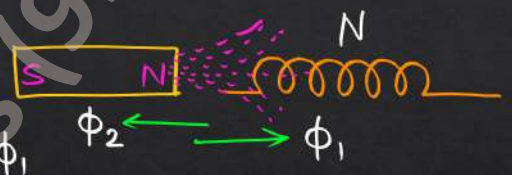
FEEE → Unit = 3

* Electromagnetic Induction :-

The phenomenon of Production of emf and hence current in a coil or Conductor whenever Flux linkage changed through the coil or Conductor, is called Electromagnetic Induction.

* Electromagnetic Induction (EMI) :-

Flux linkage, $\psi = N\phi$



Initial Flux linkage, $\psi_1 = N\phi_1$

Final Flux linkage $= \psi_2 = N\phi_2$

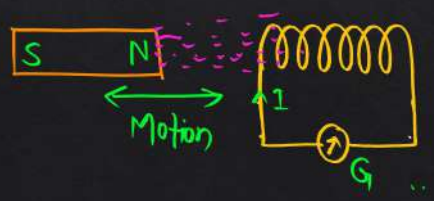
Change in Flux linkage, $\Delta\psi = \psi_1 - \psi_2 = N\phi_1 - N\phi_2$

* Faraday's law of Electromagnetic Induction :-

↳ Faraday's gives two law regarding to E.M.I -

① Whenever Flux linkage changed through the coil or conductor then emf and hence current is produced in that coil or conductor.

Note :- Relative motion must be occurs b/w magnet and coil or Conductor



(ii) Magnitude of induced emf is directly proportional to Rate of change of Flux linkage through the coil or conductor.

i.e $\boxed{\text{Induced emf, } e \propto \text{Rate of change of Flux linkage}}$

Initial Flux linkage, $\psi_1 = N\phi_1$

Final Flux linkage, $\psi_2 = N\phi_2$

Induced emf, $e \propto \dfrac{N\phi_2 - N\phi_1}{t}$

$$e = K\,\frac{N\phi_2 - N\phi_1}{t}$$

K = Proportional Constant

$$e = K\,\frac{N\phi_2 - N\phi_1}{t}$$

$$e = 1 \cdot \frac{N(\phi_2 - \phi_1)}{t}$$

Here K = 1 (In S.I unit)

In differentiation Form

$$\boxed{e = N\frac{d\phi}{dt}} \Rightarrow \text{Magnitude}$$

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

→ Lenz's law

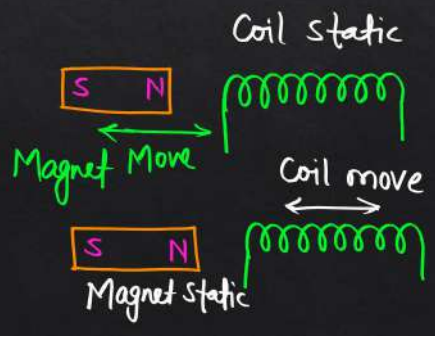
* Lenz's law :-

It states that "the direction of Produced voltage and current in coil or conductor is in such a direction so that it opposes the cause of Production."

* Induced EMF :-

→ ① Statically Induced emf

→ ② Dynamically Induced emf



Electromagnetism

1st Semester

BEE → Unit = 5

BEE + FEEE

FEEE → Unit = 3

19 Nov 2024

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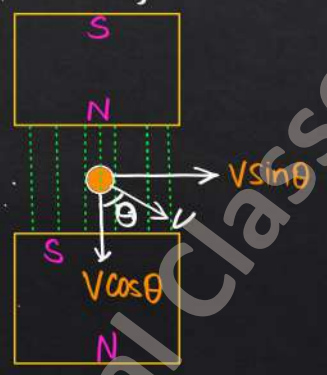
① Dynamically Induced emf :—

When Coil or Conductor is moving and magnetic Pole is static then induced emf is called Dynamically Induced emf.



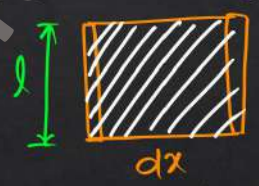
Lets assume that Conductor moves at an angle θ with Flux and Cover the distance dx in Small time dt

Velocity, $V = \frac{dx}{dt}$

Flux density = B wb/m²

length of conductor = l

Area Covered by Conductor in dt time = l×dx



Small amount of Flux cut by Conductor is time dt,

$$d\phi = B \times \text{Area covered in } dt \text{ time}$$

$$= B \times l \times dx$$

Induced emf, $e = N\frac{d\phi}{dt}$

$$= 1 \times \frac{B \times l \times dx}{dt}$$

$$= B \times l \times \left(\frac{dx}{dt}\right)$$

$$\boxed{e = Blv}$$

Voltage induced when conductor is moving at θ angle is given by $\boxed{e = Blv\sin\theta}$

Note:-

1. When conductor is moving parallel to magnetic flux (i.e $\theta = 0^\circ$) then Induced emf will be 0.

$$e = Blv\sin\theta$$
$$e = Blv\sin 0^\circ$$
$$\boxed{e = 0}$$

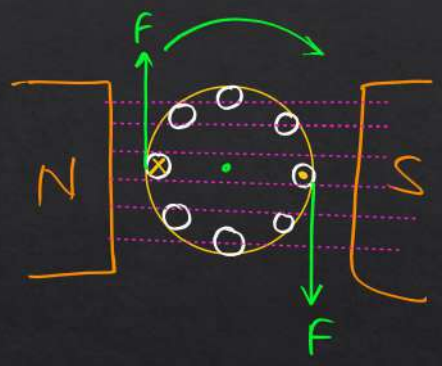
2. When conductor is moving perpendicular to magnetic flux (i.e $\theta = 90^\circ$) then induced emf will be max^m.

$$e = Blv\sin\theta \qquad \boxed{e = e_{max} = Blv}$$
$$e = Blv\sin 90^\circ$$
$$[e = Blv]_{max}$$

↳ Direction of Dynamically induced emf is given by Fleming's Right hand Rule.

* Fleming's Right hand Rule :-

Fleming's Right hand Rule states that "whenever three finger of Right hand, thumb, Fore Finger and middle finger are stretched perpendicular to each other and if thumb in the direction of Conductor movement (Force) and Fore Finger in the direction of magnetic field (Flux) then middle Finger will give the direction of Induced emf and current.



② Statically Induced emf :-

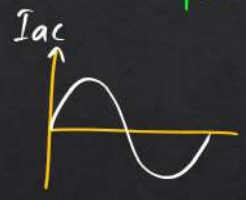
When coil or Conductor is static (स्थिर) and magnetic pole is moving then induced emf is called statically induced emf

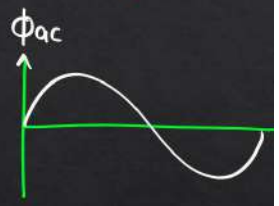
Types of Statically Induced emf

- ① Self Induced emf
- ② Mutually Induced emf

* Self Induced emf :-

The emf induced in a coil or Conductor due to change in its own Flux, is called Self induced emf





Self induced emf Formula :-

$\phi \propto i$

$$\boxed{\phi = Li}$$

Here, L = proportional Constant
= Self Inductance

$$\boxed{L = \frac{\phi}{i}}$$

Now, For N turns

$N\phi \propto i$

$N\phi = Li$

$$\boxed{L = \frac{N\phi}{i}}$$

Self induced emf, $e_{self} = N\dfrac{d\phi}{dt}$

$= \dfrac{d(N\phi)}{dt}$

$= \dfrac{d(Li)}{dt}$

$$\boxed{e_{self} = L\frac{di}{dt}}$$

L = Self Inductance or Inductance.

Electromagnetism

1st Semester

BEE + FEEE

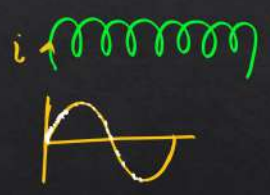
(12) 20 NOV 2024

* Self Inductance / Inductance (L) :-

The property of element which opposes the change of current through it, is called Self Inductance or Inductance.

↳ It is denoted by L

↳ It's Unit is Henry (H).



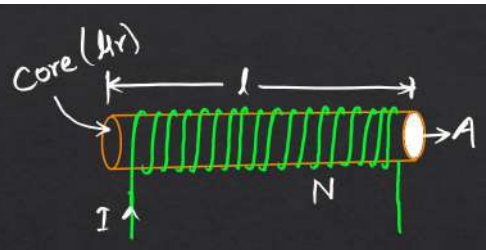
$N\phi \propto i$

$N\phi = Li$

$$\boxed{L = \frac{N\phi}{i}}$$

$$\text{Flux} = \frac{\text{mmf}}{\text{Reluctance}}$$

$$\phi = \frac{NI}{l/\mu_0\mu_r A} = \frac{NI \times \mu_0\mu_r A}{l}$$



Now, Inductance, $L = \frac{N\phi}{I}$

$$= \frac{N}{\cancel{I}}\left(\frac{N\cancel{I} \times \mu_0\mu_r A}{l}\right)$$

$$\boxed{L = \frac{\mu_0\mu_r N^2 A}{l}}$$

$$L = \frac{\mu_0\mu_r N^2 A}{l}$$

$$L = \frac{N^2}{\frac{l}{\mu_0\mu_r A}} = \frac{N^2}{\text{Reluctance}}$$

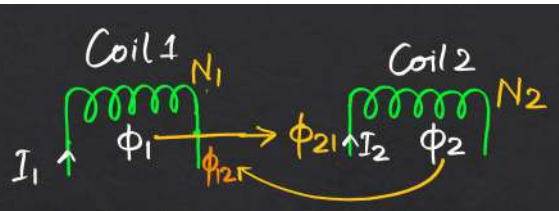
$$\boxed{L = \frac{N^2}{\text{Reluctance}}}$$

$$\boxed{\text{Self Inductance}(L) = \frac{N\phi}{I} = \frac{\mu_0\mu_r N^2 A}{l} = \frac{N^2}{\text{Reluctance}}}$$

* Mutually Induced emf :-

The emf induced in a coil or conductor due to change in Flux linkage of neighbouring Coil, is called Mutually Induced emf

↳ In Coil A ac current is given so Variable Flux is setup and that Variable Flux linked with Coil B and produces the emf in Coil B. this emf is called mutually induced emf.



In Coil 2

Mutual Inductance, $M = \dfrac{N_2 \phi_{21}}{I_1}$

$$\boxed{N_2 \phi_{21} = M I_1}$$

Mutually Induced emf, $e_M = N \dfrac{d\phi}{dt}$

$$= \frac{d(N\phi)}{dt}$$

$$e_M = \frac{d(N_2 \phi_{21})}{dt}$$

$$= \frac{d(M I_1)}{dt}$$

$$\boxed{e_{M_2} = M \frac{dI_1}{dt}}$$

$$M = \frac{N_1 \phi_{12}}{I_2}$$

$$\boxed{e_{M_1} = M \frac{dI_2}{dt}}$$

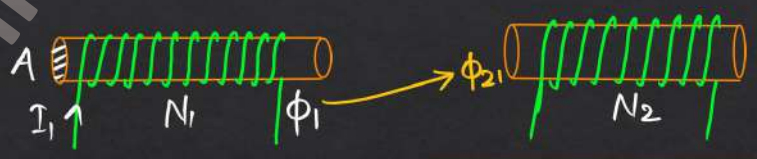
Mutual Inductance :-

The property of neighbouring coil due to which it opposes change in current in neighbouring coil, is called Mutual Inductance

↳ It is denoted by M.

↳ It's unit is Henry (H).

Mutual Inductance, $\boxed{M = \dfrac{N_2 \phi_{21}}{I_1} = \dfrac{N_1 \phi_{12}}{I_2}}$



$$\phi_{21} = \frac{N_1 I_1}{l / \mu_0 \mu_r A}$$

$$M = \frac{N_2 \phi_{21}}{I_1}$$

$$M = \frac{N_2}{\cancel{I_1}} \left(\frac{N_1 \cancel{I_1}}{l / \mu_0 \mu_r A} \right)$$

$$\boxed{M = \frac{\mu_0 \mu_r N_1 N_2 A}{l}}$$

$$M = \frac{N_1 N_2}{l / \mu_0 \mu_r A} = \frac{N_1 N_2}{\text{Reluctance}}$$

$$\boxed{M = \frac{N_1 N_2}{\text{Reluctance}}}$$

$$\text{Mutual Inductance, } M = \frac{N_2\phi_{21}}{I_1} = \frac{\mu_0\mu_r N_1 N_2 A}{l} = \frac{N_1 N_2}{\text{Reluctance}}$$

* Coupling Factor :-

Self Inductance,

$$L_1 = \frac{N_1\phi_1}{I_1}$$

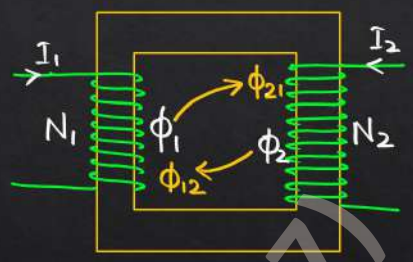
$$L_2 = \frac{N_2\phi_2}{I_2}$$

$\phi_1 = 10\,wb$

$\phi_{21} = 8\,wb$

$\phi_{21} = \underbrace{0.8}_{\text{Coupling Factor}}\,\phi_1$

$$\boxed{\phi_{21} = K\phi_1}$$



$$\boxed{\phi_{12} = K\phi_2}$$

Mutual Inductance,

$$M = \frac{N_2\phi_{21}}{I_1} = \frac{N_2 K\phi_1}{I_1}$$

$$\left(\frac{M}{K}\right) = \frac{N_2\phi_1}{I_1} \quad \text{—— (i)}$$

and $$M = \frac{N_1\phi_{12}}{I_2} = \frac{N_1 K\phi_2}{I_2}$$

$$\left(\frac{M}{K}\right) = \frac{N_1\phi_2}{I_2} \quad \text{—— (ii)}$$

Multiplying eqn ① & ②

$$\frac{M}{K} \times \frac{M}{K} = \frac{N_2\phi_1}{I_1} \times \frac{N_1\phi_2}{I_2}$$

$$\left(\frac{M}{K}\right)^2 = \frac{N_1\phi_1}{I_1} \times \frac{N_2\phi_2}{I_2}$$

$$\left(\frac{M}{K}\right)^2 = L_1 \times L_2$$

$$\frac{M}{K} = \sqrt{L_1 L_2}$$

$$K = \frac{M}{\sqrt{L_1 L_2}}$$

$$\boxed{\text{Coupling Factor, } K = \frac{M}{\sqrt{L_1 L_2}}}$$

$$\boxed{0 \le K < 1}$$

$K = 1$: Critical Coupling (Ideal Coupling)

$K < 1$: Loose Coupling

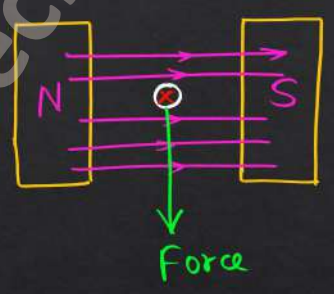
Electromagnetism

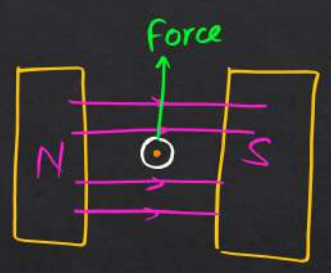
* Fleming's Left hand Rule:-

It states that " Three finger of left hand, Thumb, Forefinger and middle finger are stretched such that they are mutually perpendicular and if Forefinger in the direction of magnetic field (Flux) and middle finger in the direction of current then Thumb will give the direction of Force."

Current dirn
↑
FRH Rule

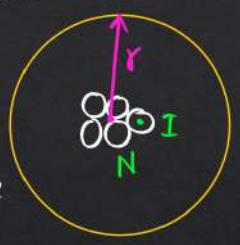
Thumb → Force
✓ Forefinger → Flux
✓ Middle → Current





* Ampere's law :-

It states that "when an unit N-Pole is moving once around the closed path enclosed the current carrying conductor then workdone is equal to the product of No. of conductor and current enclosed by that close path."



$$\boxed{\oint H_r \cdot dr = NI}$$

$$\oint H_r \cdot dr = NI$$

$$H_r \cdot \oint dr = NI$$

$$H_r \times 2\pi r = NI$$

$$\boxed{H_r = \frac{NI}{2\pi r}}$$

Magnetising Force, $\boxed{H = \frac{NI}{2\pi r}}$

Magnetic Flux density, $B = \mu H$

$$\boxed{B = \frac{\mu NI}{2\pi r}}$$

26 Dec ✓ 27

CSE-FEEE : Unit = 3 (Finish) 4 & 5

BEE = Syllabus Finish

- → Revision
- → Crash Course
- → PYQ
- → VVI Ques.