# Module No. 1

1. What is current? What is voltage?
   Flow of electrons is called electric current.
   voltage is the difference in electric potential between two points

2. What is resistance, inductance and capacitance?
   Resistance : The property of material by virtue of which it opposes or resists the flow of current is known as resistance.
   Inductance :
   Capacitance : The amount of charge that can be stored inside a capacitor at a given voltage is called Capacitance.

3. What are the types of sources?
   There are two classes of sources, namely,
   (i) Independent source
      There are two types of independent sources:
      (i) Independent voltage source
      (ii) Independent current source
   (ii) Dependent source
      The dependent sources are of four kinds depending on whether the control variable is a voltage or current and the source controlled is a voltage source or current source.
      (i) Voltage Controlled Voltage Source (VCVS)
      (ii) Voltage Controlled Current Source (VCCS)
      (iii) Current Controlled Voltage Source (CCVS)
      (iv) Current Controlled Current Source (CCCS)

4. What is network and circuit?
   A network is a collection of interconnected components that perform a specific function.
   A circuit is a closed path within a network through which electric current can flow.

5. What is linear and non-linear network?
   A linear network is one whose parameters are constant, i.e., they do not change with voltage and current.
   A non-linear network is one where the parameters of the network are not constant and can change with changes in voltage and current.

6. What are active and passive elements?
   An **active element** supplies power to an electric circuit, and hence has the ability to electrically control the flow of charge.Batteries, generators, operational amplifiers, etc are active elements.
   A **passive element** can only receive energy, which it can either dissipate or absorb. Resistor capacitor and inductor are passive elements.

7. What is Ohm's Law?
   It states that the potential difference across any two points on a conductor is directly proportional to the current flowing through it, provided the physical conditions, viz., material length, cross sectional area and temperature of the conductor remain constant.
   $V \propto I$
   $V = R\,I$
   where R is the resistance between two points of the conductor.

8. What is the effect of temperature on resistance?
   The resistance increases as the temperature increases in conductors and decreases with the increasing temperature in insulators.

9. What is series and parallel circuit?
   Two resistors are said to be connected in series when the same current flows through each resistor.
   Two resistors are said to be connected in parallel when the potential difference across each resistor is the same.

10. What is KVL and KCL?
    KCL: "The algebraic sum of the currents meeting at a node of electrical circuit is zero or at any node sum of incoming current is always equal to sum of outgoing
    KVL: "The algebraic sum of the product of current and corresponding resistance in a closed circuit is equal to the electromotive force in that circuit"

11. What is source transformation and source shifting?
    Source Transformation: A voltage source with a series resistor can be converted into an equivalent current source with a parallel resistor. Conversely, a current source with a parallel resistor can be converted into a voltage source with a series resistor, this is called source transformation.
    Source Shifting: It is a technique used to simplify a circuit by changing the position of a source within the circuit.

12. What is superposition, Norton Thevenin and Superposition theorem?
    **Norton's Theorem:** It states that 'Any two terminals of a network can be replaced by an equivalent current source and an equivalent parallel resistance.' The constant current is equal to the current which would flow in a short circuit placed across the terminals. The parallel resistance is the resistance of the network when viewed from thes open-circuited terminals after all voltage and current sources have been removed and replaced by internal resistances.
    **Thevenin's Theorem**: It states that 'Any two terminals of a network can be replaced by an equivalent voltage source and an equivalent series resistance. The voltage source is the voltage across the two terminals with load, if any, removed. The series resistance is the resistance of the network measured between two terminals with load removed and constant voltage source being replaced by its internal resistance (or if it is not given with

zero resistance, i.e., short circuit) and constant current source replaced by infinite resistance, i.e., open circuit.'

**Superposition Theorem**: It states that 'In a linear network containing more than one independent sources, the resultant current in any element is the algebraic sum of the currents that would be produced by each independent source acting alone, all the other independent sources being represented meanwhile by their respective internal resistances.'



## Module No. 2

1. What is RMS value?

   It is defined as that value of steady current (direct current) which will do the same amount of work in the same time or would produce the same heating effect as when the alternating current is applied for the same time.

2. What is average value?

   The average value of an alternating quantity is defined as the arithmetic mean of all the values over one complete cycle.

3. Explain the significance of form factor and peak factor.

   It is defined as the ratio of rms value to the average value of the given quantity.

   Form factor ($k_f$) = $\frac{RMS\ value}{Average\ value}$

   Crest or Peak or Amplitude Factor It is defined as the ratio of maximum value to rms
   value of the given quantity.

   Peak factor ($k_p$) = $\frac{Maximum\ value}{RMS\ value}$

4. Explain Generation of Single Phase AC voltage with equation.

   **Generation of single-phase voltage:** A single-phase system utilizes single winding. When the winding is rotated in an anticlockwise direction with constant angular velocity $\boldsymbol{\omega}$ rad/s in a uniform magnetic field, a voltage is induced in the winding.

   The equation of the induced voltage in the winding is given by

$v_R = V_m \sin\boldsymbol{\theta}$

5. What is phasor and what is its significance?

   A phasor is **a rotating vector representing a quantity, such as an alternating current or voltage, that varies sinusoidally**. A phasor representation is a simple way of reducing the complexities of handling single frequency circuits.

6. What is the range of Power Factor?

   The value of power factor ranges from 0 to 1.

7. Write down the voltage and current equation for inductive load and capacitive load?

   For inductive load:

   $V = V_m \sin(\omega t)$ ….(Voltage $Eq^n$)

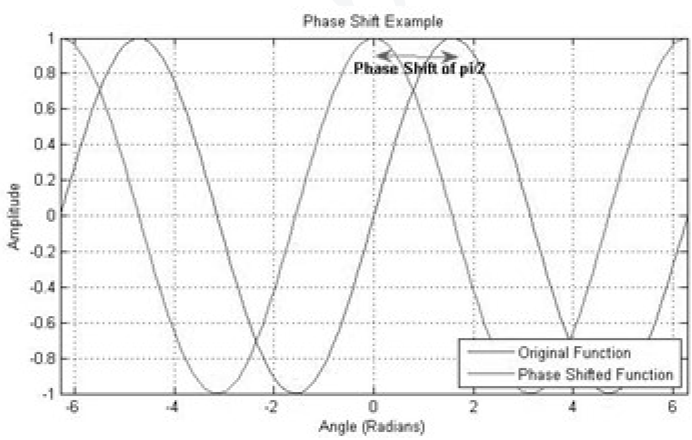
   $I = I_m \sin\left((\omega t) - \frac{\pi}{2}\right)$ ….(Current $Eq^n$)

   For capacitive load:

   $V = V_m \sin(\omega t)$ ….(Voltage $Eq^n$)

   $I = I_m \sin\left((\omega t + \frac{\pi}{2}\right)$ ….(Current $Eq^n$)

8. Explain phase difference with the help of wave form and phasor diagram?




This term is used to compare the phases of two alternating quantities.

Two alternating quantities are said to be in phase when they reach their maximum and zero values at the same time.

Their maximum value may be different in magnitude.

A leading alternating quantity is one which reaches its maximum or zero value earlier compared to the other quantity.

A lagging alternating quantity is one which attains its maximum or zero value later than the other quantity.

A plus (+) sign, when used in connection with the phase difference, denotes 'lead' whereas. a minus (–) sign denotes 'lag'.

9. Prove power consumed by capacitive and inductive load is zero ?

I. For Inductive load Instantaneous powers p is given by
$p = vi$
$p = V_m \sin \omega t \, I_m \sin \left(\omega t - \frac{\pi}{2}\right)$
$p = - V_m I_m \sin \omega t \cos \omega t$
$p = -\frac{Vm\,Im}{2} \sin 2\omega t$
The average power for one complete cycle, P = 0.
Hence, power consumed by purely inductive circuit is zero.

II. For Capacitive load Instantaneous powers p is given by
$p = vi$
$p = V_m \sin \omega t \, I_m \sin \left(\omega t + \frac{\pi}{2}\right)$
$p = V_m I_m \sin \omega t \cos \omega t$
$p = \frac{Vm\,Im}{2} \sin 2\omega t$
The average power for one complete cycle, P = 0.
Hence, power consumed by purely capacitive circuit is zero.

10. Explain resonance in case of series and parallel resonance ?
A circuit containing reactance is said to be in resonance if the voltage across the circuit is in phase with the current through it. At resonance, the circuit thus behaves as a pure resistor and the net reactance is zero.

11. Application of resonance ?
Current is maximum,power is maximum, efficiency is also maximum in case of resonance and hence…

Resonant circuits (series or parallel) are used in many applications such as selecting the desired stations in radio and TV receivers. A series resonant circuit is used as voltage amplifier. A parallel resonant circuit is used as current amplifier. A resonant circuit is also used as a filter.

12. Significance of half power frequencies ?

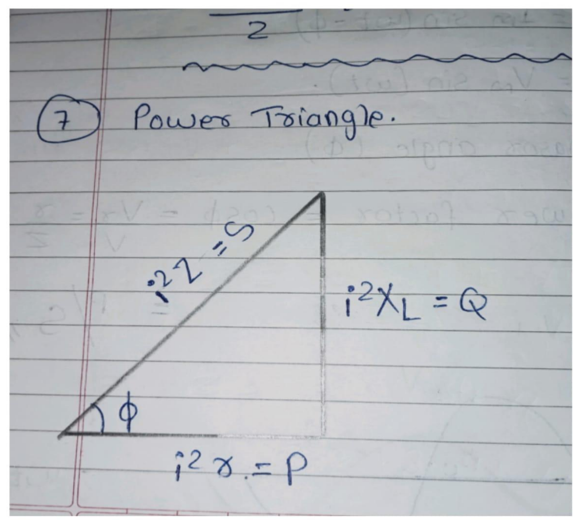
Half power points frequencies for a given LCR are the frequencies for which the power in the circuit is half of the maximum power in the circuit. The current in the circuit at maximum power is also maximum.

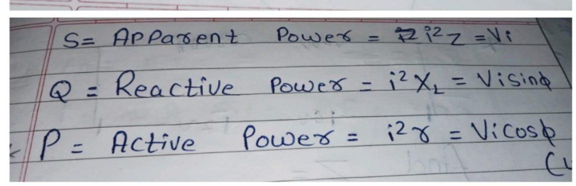
$f_1 = f_0 - \frac{R}{4\pi L}$ $\qquad$ $f_2 = f_0 + \frac{R}{4\pi L}$

13. Difference between series and parallel resonance ?

The major difference between series resonance and parallel resonance is that a series resonance results in the minimum impedance and maximum current flow in the circuit, while a parallel resonance results in maximum impedance and minimum current flow in the circuit.

14. Draw power triangle and explain each power in detail ?




**Power Triangle** is the representation of a right angle triangle showing the relation between active power, reactive power and apparent power.

When each component of the current that is the active component (Icosϕ) or the reactive component (Isinϕ) is multiplied by the voltage V, a power triangle is obtained

The power which is actually consumed or utilized in an AC Circuit is called True power or **Active Power** or real power. It is measured in kilowatt (kW).

The power which flows back and forth that means it moves in both the direction in the circuit or reacts upon it, is called **Reactive Power**. The reactive power is measured in kilovolt-ampere reactive (kVAR).

The product of root mean square (RMS) value of voltage and current is known as **Apparent Power.** This power is measured in KVA.

15. Advantages of AC over DC ?
    - AC is less expensive and easy to generate than DC.
    - AC can be transmitted across long distances without much energy loss, unlike DC.
    - The power loss during transmission in AC is less when compared to DC.

# Module No. 3

1. Explain Three phase generation?
   A three-phase system utilizes three separate but identical windings that are displaced by 120 electrical degrees from each other. When these three windings are rotated in an anticlockwise direction with constant angular velocity in a uniform magnetic field, the voltages are induced in each winding which have the same magnitude and frequency but are displaced 120 electrical degrees from one another.

2. Why three phase, why not more than three generation is useful?
   The drawback of more phases is that the transmission towers have to sustain more loads of conductors. Thus, the cost of the electrical system increase. The three-phase system delivers three times the power of a single phase. The 6 phase adds twice the power of the 3 phase.

3. Application of three phases.
   Three-phase alternating current (AC) power is commonly used to deliver electricity to data centers as well as commercial and industrial buildings that house power-hungry machinery. There's good reason for that, because 3-phase power can deliver more power with greater efficiency, as opposed to single-phase AC power.

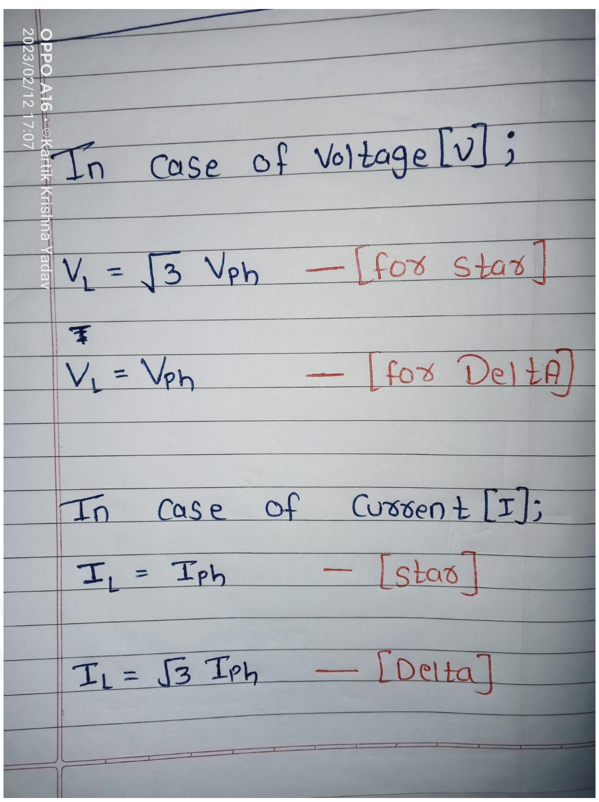
4. Advantages of three phase system.
    - 1. In a single-phase system, the instantaneous power is fluctuating in nature. However, in a three-phase system, it is constant at all times.
    - 2. The output of a three-phase system is greater than that of a single-phase system.
    - 3. Transmission and distribution of a three-phase system is cheaper than that of a single-phase system.
    - 4. Three-phase motors are more efficient and have higher power factors than single-
    - phase motors of the same frequency.
    - 5. Three-phase motors are self-starting whereas single-phase motors are not self- starting.

5. Define: Phase Voltage, Phase Current, Line Voltage, Line Current
   **Phase Voltage:** The voltage induced in each winding is called the phase voltage.
   **Phase Current:** The current flowing through each winding is called the phase current.
   **Line Voltage:** The voltage available between any pair of terminals or lines is called the line voltage.
   **Line Current:** The current flowing through each line is called the line current.

6. Explain Phase Sequence.
   The sequence in which the voltages in the three phases reach the maximum positive value is called the phase sequence or phase order

7. What is Symmetrical System?
   **Symmetrical or Balanced System:** A three-phase system is said to be balanced if the (a) voltages in the three phases are equal in magnitude and differ in phase from one another by 120°, and
   (b) currents in the three phases are equal in magnitude and differ in phase from one another by 120°.

8. Relation between star and delta ?




**(Note:- This is for 3-phase star and delta connection).**

9. Draw the phasor diagram for inductive/ capacitive load for star or delta ?

VIVA me tujhe draw karne kon bolega.

10. Prove power in case of delta is three times power in case of star ?

Let a balanced load be connected in star having impedance per phase as $Z_{ph}$.

For a star-connected load,

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

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{V_L}{\sqrt{3}Z_{ph}}$$

$$I_L = I_{ph} = \frac{V_L}{\sqrt{3}Z_{ph}}$$

$$P_Y = \sqrt{3}\, V_L I_L \cos\phi$$

$$= \sqrt{3} \times V_L \times \frac{V_L}{\sqrt{3}Z_{ph}} \times \cos\phi$$

$$= \frac{V_L^2}{Z_{ph}} \cos\phi$$

For a delta-connected load,

$$V_{ph} = V_L$$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{V_L}{Z_{ph}}$$

$$I_L = \sqrt{3}\; I_{ph} = \sqrt{3}\frac{V_L}{Z_{ph}}$$

$$P_\Delta = \sqrt{3}\; V_L I_L \cos\phi$$

$$= \sqrt{3} \times V_L \times \sqrt{3}\; \frac{V_L}{Z_{ph}} \times \cos\phi$$

$$= 3\,\frac{V_L^2}{Z_{ph}} \cos\phi$$

$$= 3P_Y$$

$$P_Y = \frac{1}{3}P_\Delta$$

Thus, power consumed by a balanced star-connected load is one-third of that in the case of a delta-connected load.

11. Advantages of two wattmeter measurement over three and single wattmeter measurement ?

Both balanced and unbalanced load can be balanced using this method
In a star connected load, it is optional to connect neutral point and wattmeter

In a delta, connected load connections need not be opened to connect wattmeter

3 phase power can be measured using two wattmeter's

Both power and power factor is determined on a balanced load condition.

12. Equations of inductive and capaitive load for two wattmeter measurement ?
    Nahi mila

13. Effect of power factor on wattmeter readings ?
    For a lagging power factor load,

    Case I: $\theta = 0°$,
    pf = $\cos\theta = 1$
    $W_1 = V_L I_L \cos 30°$
    $W_2 = V_L I_L \cos 30°$
    Hence, both wattmeter readings are equal and positive. For all power factors between 0.5 to 1, both wattmeter readings are positive.

    Case II: $\theta = 60°$,
    pf = $\cos\theta = 0.5$ (lagging)
    $W_1 = V_L I_L \cos 30°$
    $W_2 = 0$
    Hence, wattmeter W 1 reading is positive and wattmeter W 2 reading is zero.
    For all power factors between 0 to 0.5 (lagging), wattmeter W 1 reading is positive and wattmeter W 2 reading is negative.

    Case III: $\theta = 90°$,
    pf = $\cos\theta = 0$
    $W_1 = 0.5 V_L I_L$
    $W_2 = -0.5 V_L I_L$
    Hence,
    W 1 = –W 2
    Negative reading indicates that the pointer deflects in negative direction i.e., to the left of zero. The readings can be converted to positive by interchanging either current coil or

voltage coil terminals.

14. Prove total current in balance star is zero ?

In star connection, three similar ends (start or finish) of the three windings are joined together at a common point.
This point is known as star point or neutral point.
The three conductors meeting at star point are replaced by a single conductor known as neutral conductor (or neutral).
Star connection is also known as Y or Wye connection.

If the voltage of a star-connected alternator is applied across a balanced load, the neutral wire will carry three load currents which are exactly equal in magnitude but 120deg.. out of phase with each other.
Hence, their vector sum is zero.

i.e. IR + IB + IY = 0,
or IN = 0.

15. Prove total voltage in balance delta is zero ?
    Nahi mila

# NOTE:- MODULE NO. 4 IS INCOMPLETE

## Module No.4

1. What is transformer and what are the types of transformer ?

A **transformer** is a device used in the power transmission of electric energy.
The transmission current is AC.
It is commonly used to increase or decrease the supply voltage without a change in the frequency of AC between circuits.
The transformer works on basic principles of electromagnetic induction and mutual induction.

**Types of Transformers:-**

a. *Based on voltage levels*-
   Step-up Transformer & Step-down Transformer.
b. *Based on medium of core*-
   Air core Transformer & Iron core Transformer.
c. *Based on winding*-
   Autotransformer.
d. *Based on install location*-

Power Transformers, Distribution Transformers, Measurement Transformers, Protection Transformers.

**{ NOTE :- Since it is not in our syllabus, we did not learned about these types in much detail }.**

2. What is mutual induction ?

**Mutual induction** is defined as the property of the coils that enables it to oppose the changes in the current in another coil. With a change in the current of one coil, the flow changes too thus inducing EMF in the other coil. This phenomenon is known as mutual induction.

3. What is the core and its material used ?
4. What are the types of transformer winding and material used ?
5. What is emf equation of transformer ?

   As the primary winding is excited by a sinusoidal alternating voltage, an alternating current flows in the winding producing a sinusoidally varying flux f in the core.

   $\phi = \phi_m \sin \omega t$
6. What is transformation ratio ?

The **transformation ratio** is defined as the ratio of the number of turns in the secondary coil to the number of turns in the primary coil of the transformer.

It is defined as the ratio of output voltage to the input voltage of the transformer.

Mathematically,

Transformation ratio (K)= **N2/N1**

Also,

Transformation ratio (K)=**V2/V1**

7. What is ideal and practical transformer ?

An **ideal transformer** is a theoretical model of transformer with no energy losses in it.
For an ideal transformer, the core losses (i.e. hysteresis loss and eddy current loss) are zero.

A **practical transformer** is one which has energy losses in it.
A practical transformer has finite core losses

8. Explain phasor diagram of transformer on no load and full load ?

**Phasor diagram of a transformer on no load :**

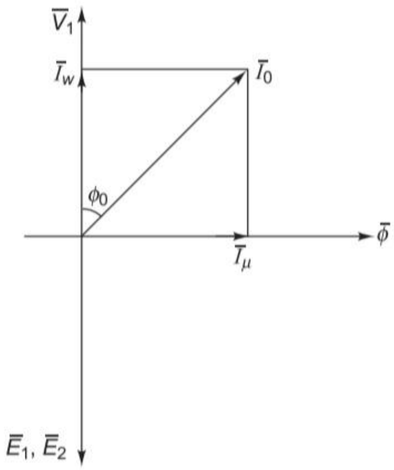



**Fig. 6.8** *Phasor diagram*

***Phasor Diagram*** Since the flux $\phi$ is common to both the windings, $\phi$ is chosen as a reference phasor. From emf equation of the transformer, it is clear that $E_1$ and $E_2$ lag the flux by 90°. Hence, emfs $E_1$ and $E_2$ are drawn such that these lag behind the flux $\phi$ by 90°. The magnetising component $I_\mu$ is drawn in phase with the flux $\phi$. The applied voltage $V_1$ is drawn equal and opposite to $E_1$ as $V_1 \approx E_1$. The active component $I_w$ is drawn in phase with voltage $V_1$. The phasor sum of $I_\mu$ and $I_w$ gives the no-load current $I_0$.

**Phasor diagram of a transformer on load ; pls review pg no 562 from bee text book its too complex**

9. What is equivalent circuit of transformer ?

10. What is voltage regulation ?
    **voltage regulation** is a measure of change in the voltage magnitude between the sending and receiving end of a component, such as a transmission or distribution line.

11. What are the various parameters we can get from oc and sc test ?
    **The purpose of Open Circuit (oc)test is to determine:-**
    (i) iron loss or core loss (Wi)
    (ii) magnetising
    resistance R0, and
    (iii) magnetising reactance X0.

    **The purpose of Short circuit (SC) test is to determine :-**
    (i) full-load copper loss,
    (ii) equivalent resistance
    R01 or R02.
    (iii) equivalent reactance X01 or X02.

12. What is the efficiency of the transformer ?

Efficiency is defined as the ratio of output power to input power.

# Module No. 5

1. What is back emf ?
When field winding is excited and armature conductors are connected across the supply, it experiences a mechanical force whose direction is given by Fleming's left-hand rule. Because of this force, the armature starts rotating. It cuts the magnetic field and an emf is induced in the armature winding. As per Lenz's law, this induced emf acts in the opposite direction to the armature supply voltage. This emf is known as back emf ($E_b$ ).

2. Principal of DC generator and motor ?
**Working Principle of a DC Generator:** When armature conductors are rotated externally in the magnetic field produced by field windings, an emf is induced in it according to Faraday's laws of electromagnetic induction. This emf causes a current to flow which is alternating in nature. It is converted in unidirectional current by the commutator.

**Working Principal of a Motor:** When field winding is excited and armature conductors are connected across the supply, it experiences a mechanical force whose direction is given by Fleming's left-hand rule. Because of this force, the armature starts rotating. It cuts the magnetic field and an emf is induced in the armature winding. As per Lenz's law, this induced emf acts in the opposite direction to the armature supply voltage. This emf is known as back emf (E b ).

3. Difference between lap type and wave type winding ?
**Lap Winding:**
    A. In this arrangement, the armature conductors are connected in series through commutator segments in such a way that the armature winding is divided into as many parallel paths as the number of poles. If there are Z conductors and P poles,
    B. there will be P parallel paths, each containing Z/P conductors in series.
    C. The total emf is equal to the emf generated in any one of the parallel paths. The total armature current divides equally among the different parallel paths.
    D. It is used in low-voltage high-current machines.

**Wave Winding:**

A. In this arrangement, the armature conductors are connected in series through commutator segments in such a way that the armature winding is divided into two
B. parallel paths irrespective of the number of poles. If there are Z conductors, conductors$\frac{Z}{2}$ will be in series in each parallel path.
C. The total emf is equal to the emf generated in any one of the parallel paths. The total armature current divides equally between two parallel paths.
D. It is used in high-voltage low-current machines.

4. Emf equation of dc motor ?

For a dc motor , magnitude of the back emf is given by the same equation of a dc generator

Back emf $= \frac{\phi Z N}{60} \frac{P}{A}$ volts

5. Classification of DC motor ?

**Shunt-wound Machines** In this type of dc machines, field winding is connected in parallel with the armature.
**Series-wound Machines** In this type of machines, the field winding is connected in series with the armature.
**Compound-wound Machines** Compound machines carry both the shunt and series field windings.

The compound machines are further classified into long shunt and short shunt, depending upon the direction of current flow in the two types of field windings.

6. Classification of DC machine ?

Depending upon the method of excitation of field winding, dc machines are classified into
**<u>two classes:</u>**
**(i) Separately excited machines ;**
In a separately excited machine, the field winding is provided with a separate dc source to supply the field current

**(ii) Self-excited machines ;**
In case of self-excited dc machines, no separate source is provided to drive the field current, but the field current is driven by its own emf generated across the armature terminals
when the machine works as a generator. Self-excited machines are further classified into three types, depending upon the method in which the field
winding is connected to the armature.
(a) Shunt-wound machines

(b) Series-wound machines
(c) Compound-wound machines

7. Voltage and current relationship of DC machine ?

**In Generator**:-
When the machine runs as a generator, the generated emf(Eg) must be sufficient to supply both the terminal voltage (V) and the internal voltage drop. Voltage and current relationships for different types of generators are as follows:

$E_g = V + I_a R_a$
…( For shunt generators)

$E_g = V + I_a (R_a + R_s)$
…(For series generator)

$E_g = V + I_a R_a + I_L R_s$
…( For short shunt )

$E_g = V + I_a (R_a + R_s)$
…(For long shunt)

**In Motor:-**
When the dc machine runs as a motor, the applied voltage (V) across its terminals must be sufficient to overcome the back emf (Eb) and supply the internal voltage
drop. Voltage and current relationships for different types of motors are as follows:

$E_b = V – I_a R_a$
…(For shunt motor)

$E_b = V – I_a (R_a + R_s)$
…(For series motor)

$E_b = V – I_a R_a – I_L R_s$
…(For Short Shunt )

$E_b = V – I_a (R_a + R_s)$
…(For long shunt )