ELEMENTS OF ELECTRICAL ENGINEERING

Department of Electrical & Electronics Engineering

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CONSTRUCTION OF THREE-PHASE INDUCTION MOTOR & ITS TYPES ; CONCEPT OF ROTATING MAGNETIC FIELD

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ELEMENTS OF ELECTRICAL ENGINEERING

Difference of DC Motor and Induction Motor

DC MOTOR	*INDUCTION MOTOR*
Power is conducted directly to the armature through brushes and commutator. Hence they are **Conduction Motor.**	Rotor will not get the electric power by conduction, instead by induction. Hence they are called as **Induction Motor.**

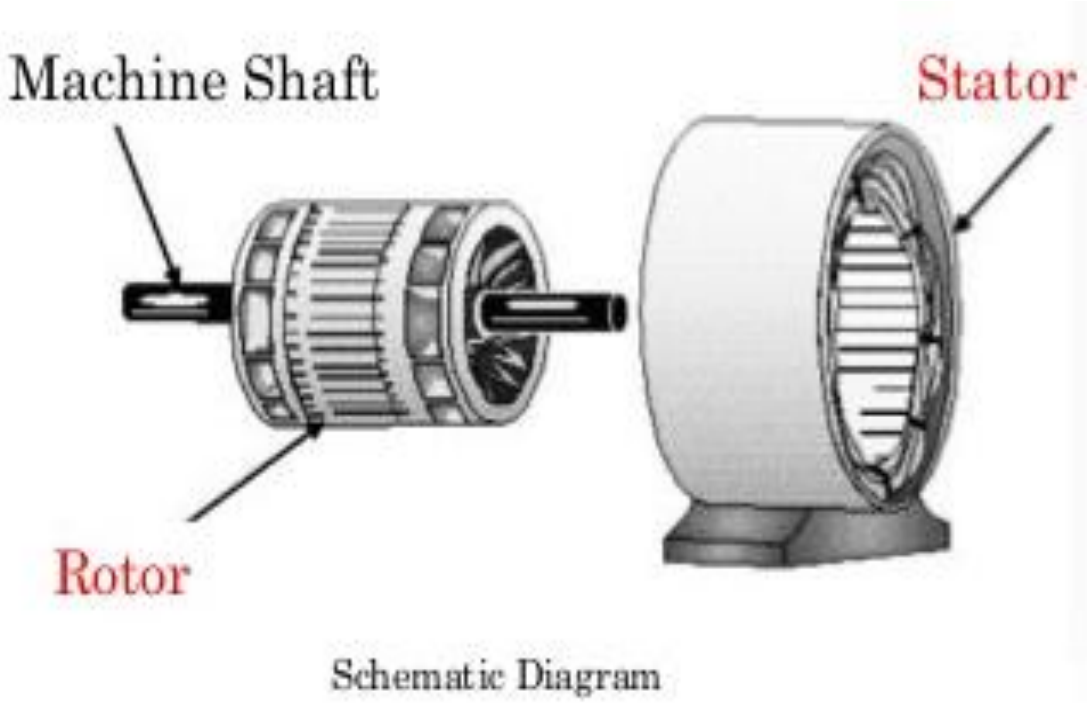
Advantages of 3Φ Induction Motor

- They are simple and rugged.
- Its cost is low and it is reliable.
- It has high efficiency.
- Maintenance cost is less.
- It is self-starting motor.
- It can be manufactured with characteristics to suit most industrial requirements.
- They are the most widely used electric motors in industry.

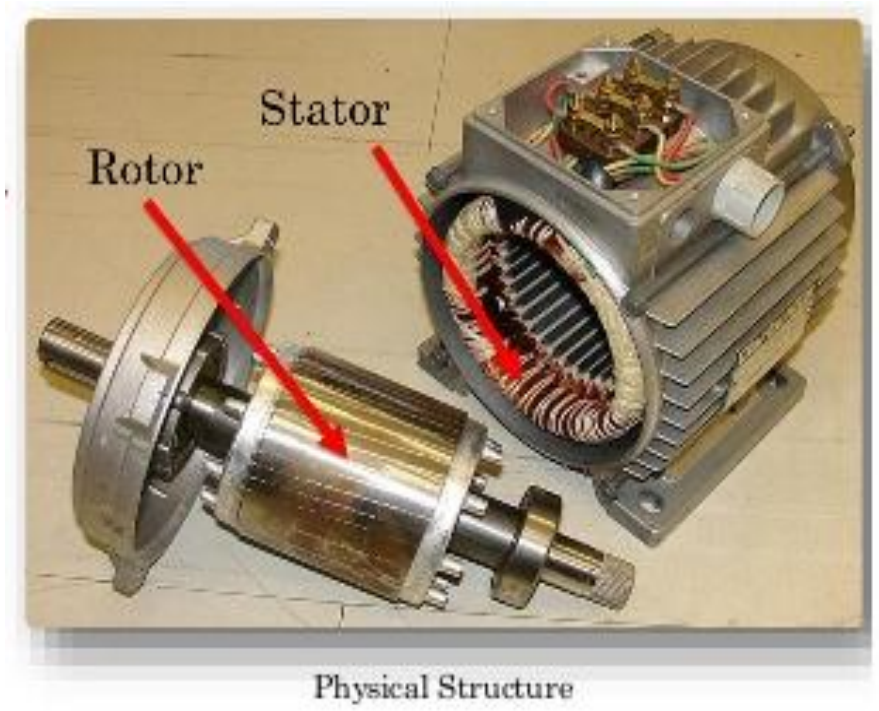
3Φ Induction Motor Construction

Induction motor has 2 main parts :

Rotating part (Rotor)
Stationary part (Stator)



Schematic Diagram

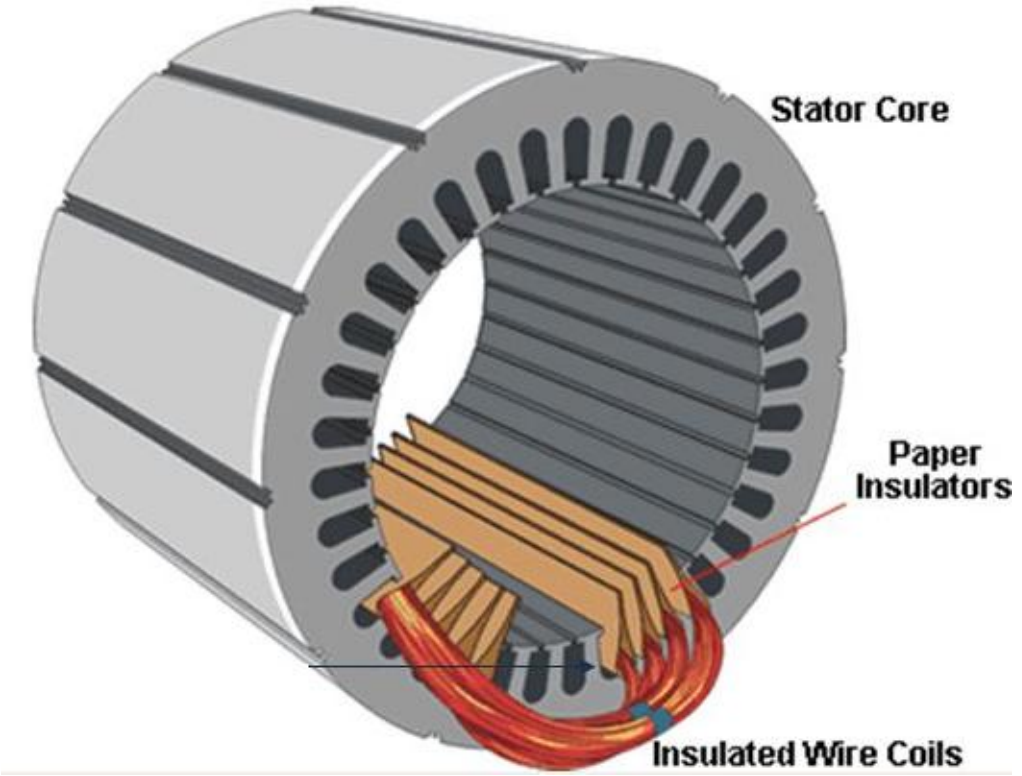


Physical Structure

3Φ Induction Motor Construction

Stator

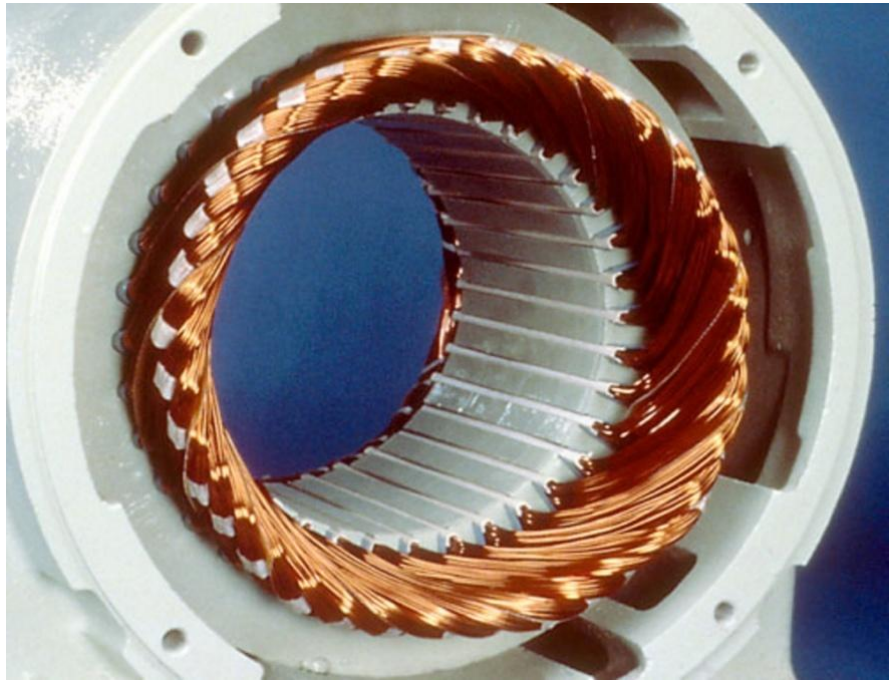
It consist of laminated cylindrical core having slots at the inner periphery.
Insulated stator conductors are placed inside the slots

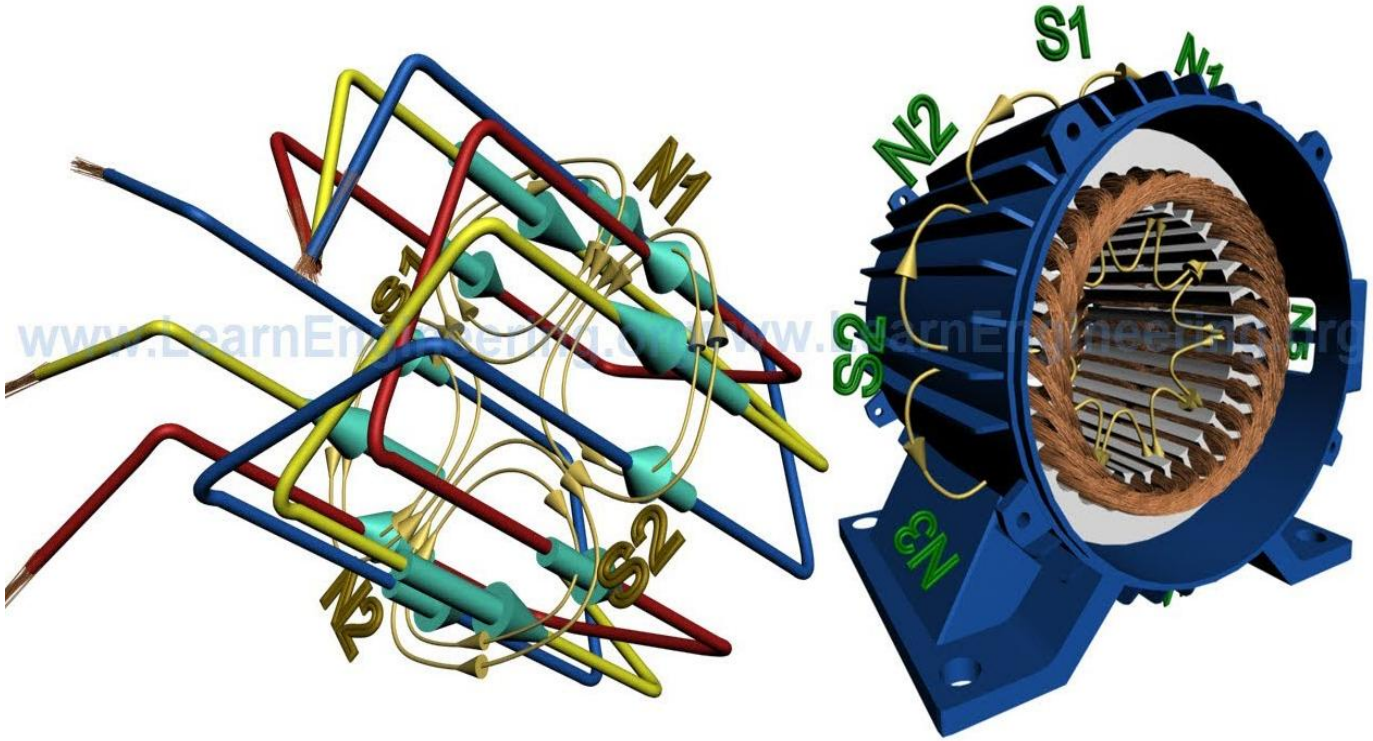


Stator

The conductors are either in star or delta to form 3Φ winding.

It is been excited by 3Φ supply





Construction of Induction Motors

Rotor

❖ Squirrel Cage Rotor

- Rotor winding is composed of copper bars embedded in the rotor slots and **shorted at both the ends by end rings**
- Simple, low cost, robust, low maintenance

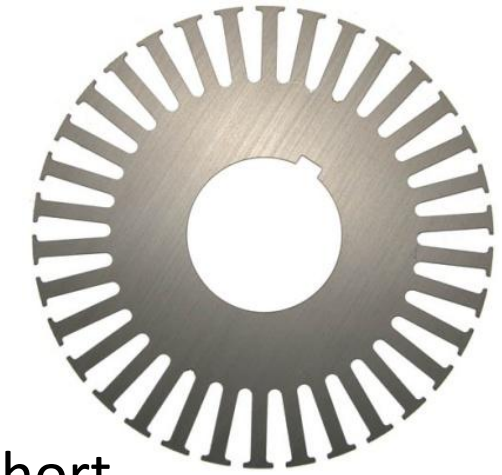
❖ Phase wound Rotor/Slip Ring Rotor

- Rotor windings are wound by wires. The winding terminals can be **connected to external circuits through the slip rings and brushes.**
- More expensive

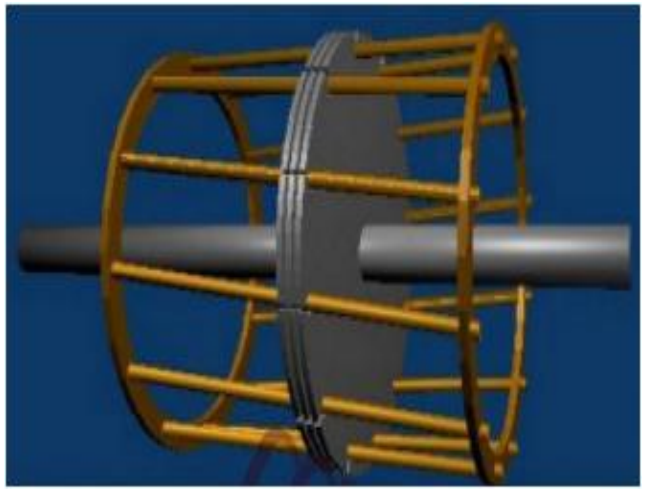
Construction of Induction Motors

Squirrel Cage Rotor

- It consist of laminated cylindrical core having slots at the outer periphery.



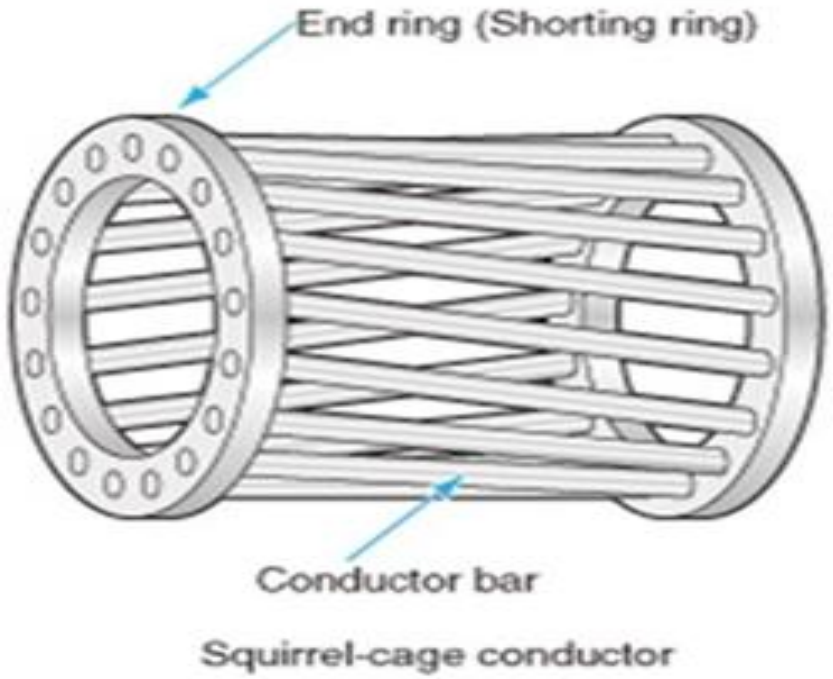
- Copper/aluminum bar conductors are placed in the slots and short circuited at each end by copper/aluminum rings called as short circuiting rings



Construction of Induction Motors

Squirrel Cage Rotor

- The rotor windings are **permanently short** circuited & its not possible to add any external resistance

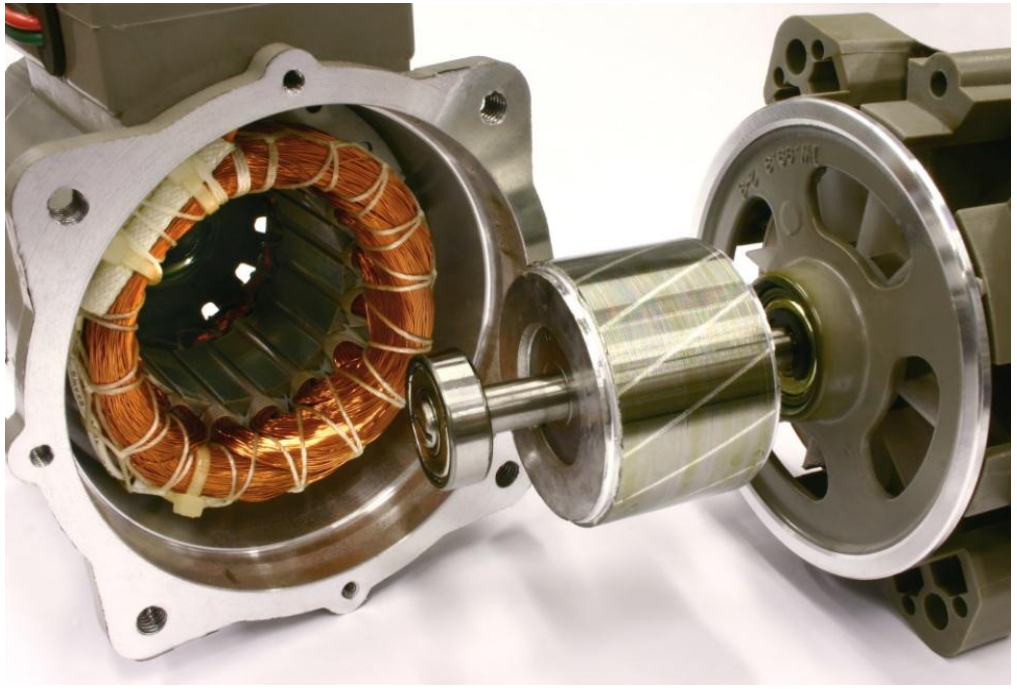


Construction of Induction Motors

Squirrel Cage Rotor

- The rotor slots are not parallel to the shaft but skewed to
  - Reduce humming
  - Reduce magnetic locking of stator and rotor.

Rotor

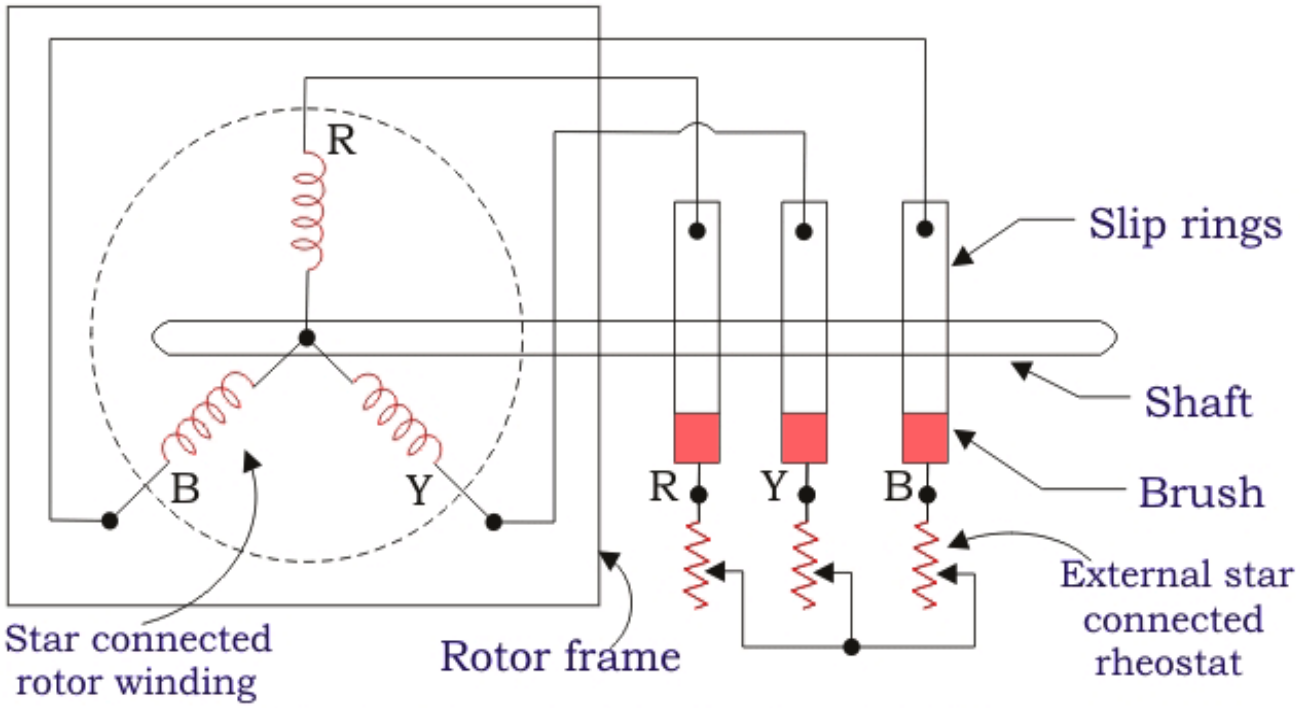


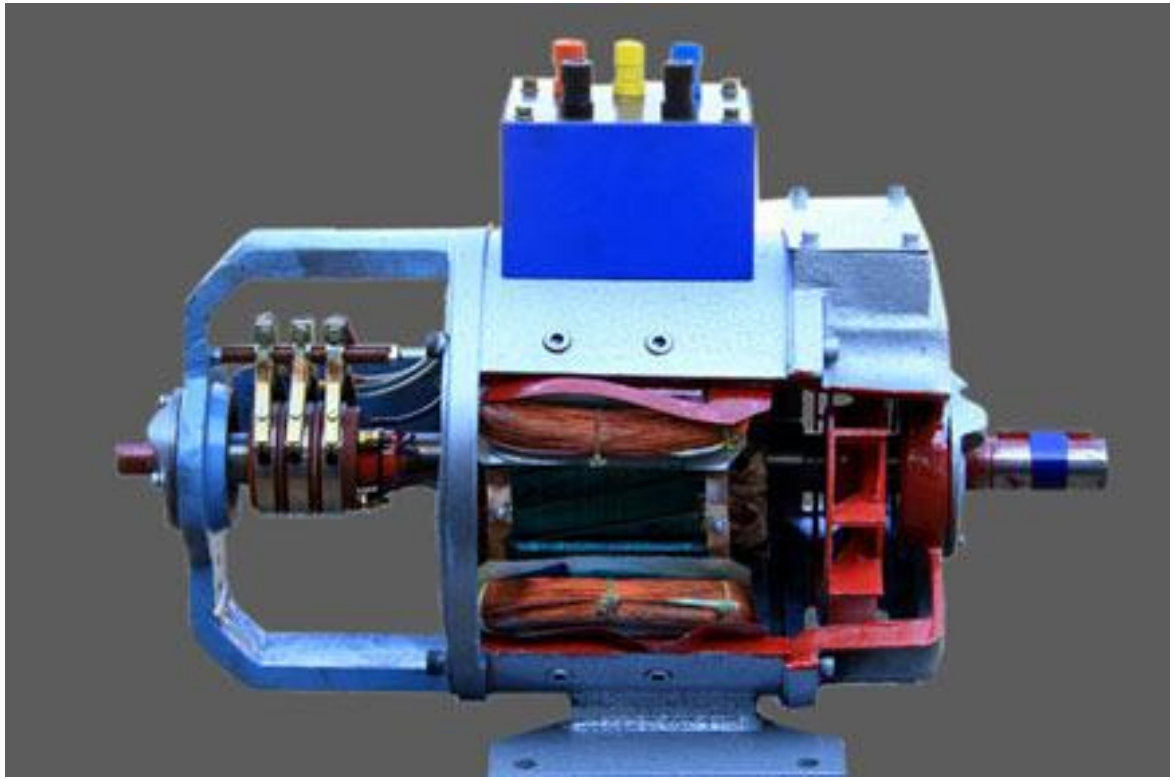
Phase wound Rotor

- It is also called as slip ring rotor.
- It consist of laminated cylindrical core having slots at the outer periphery & carries 3Φ insulated windings.

Phase wound Rotor

The 3 finish terminals are connected together forming a star point & the 3 star terminals are connected to 3 slip rings fixed on the shaft.





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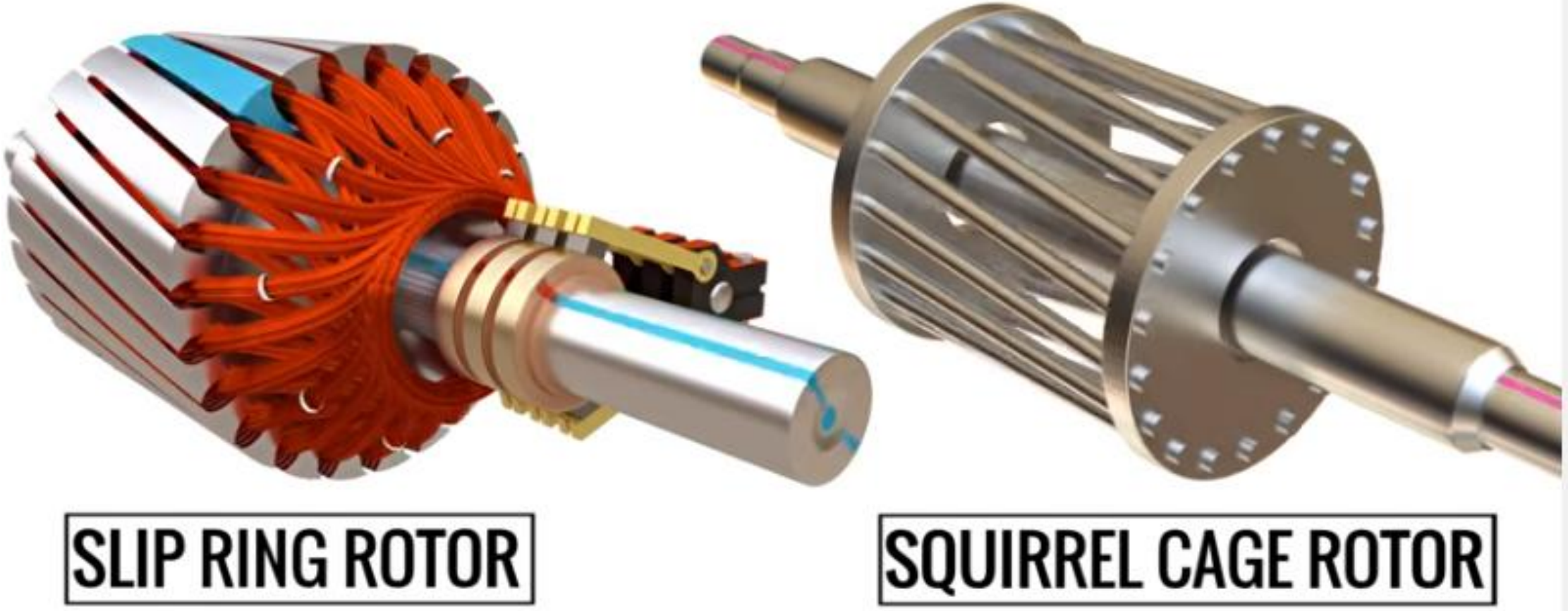
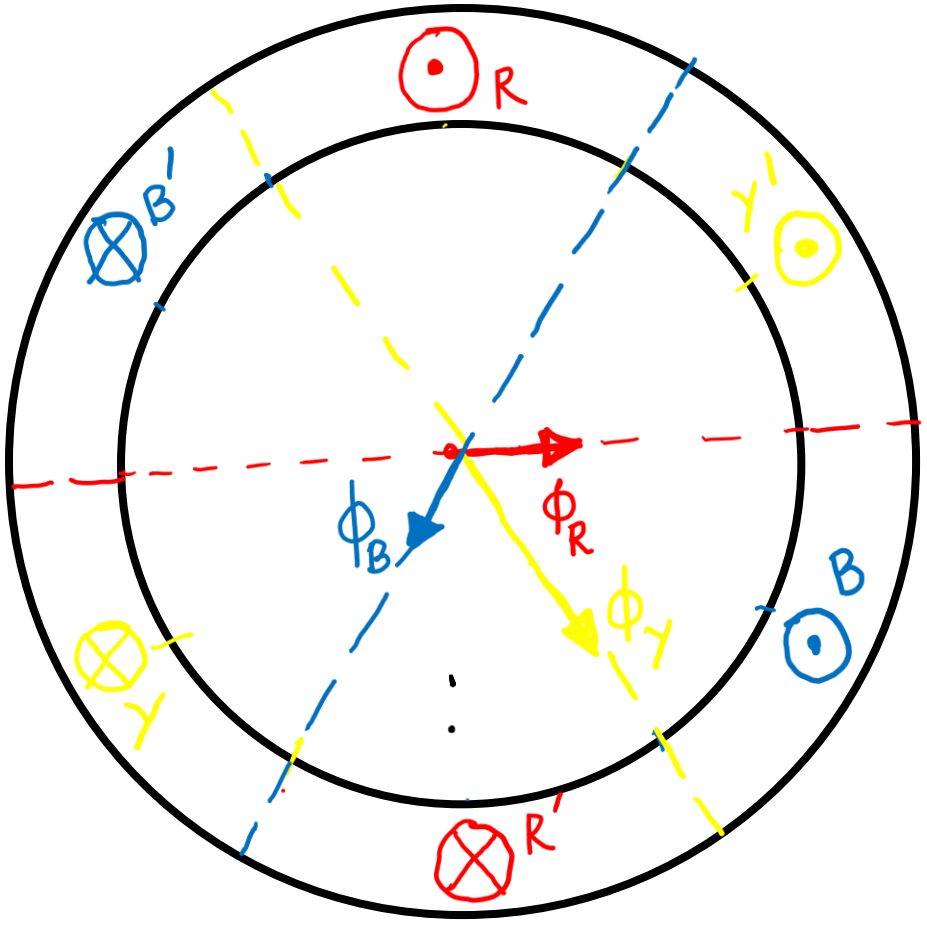
Construction of Induction Motors



Concept of Rotating Magnetic Field in a Induction Motor



$$i_R = I_m \sin \omega t$$

$$i_Y = I_m \sin(\omega t - 120^\circ)$$

$$i_B = I_m \sin(\omega t - 240^\circ)$$

At $\omega t = 30^\circ$

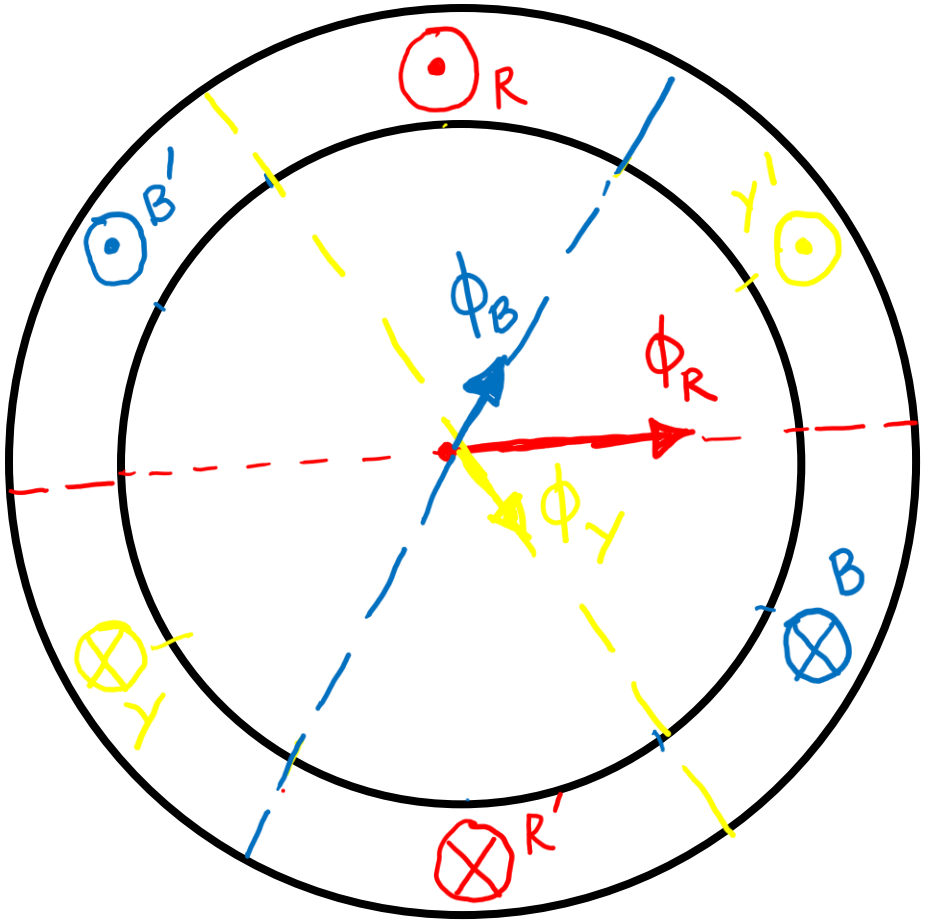
$$i_R = \frac{I_m}{2} \; ; \quad i_Y = -I_m \; ; \quad i_B = \frac{I_m}{2}$$

$$\phi_R = \frac{\phi_m}{2} \angle 0^\circ \; ; \quad \phi_Y = \phi_m \angle -60^\circ \; ;$$

$$\phi_B = \frac{\phi_m}{2} \angle -120^\circ$$

$$\Rightarrow \phi_{eff} = \phi_R + \phi_Y + \phi_B = \frac{3}{2} \phi_m \angle -60^\circ$$

Concept of Rotating Magnetic Field in a Induction Motor



$$i_R = I_m \sin\omega t$$
$$i_Y = I_m \sin(\omega t - 120^\circ)$$
$$i_B = I_m \sin(\omega t - 240^\circ)$$

At $\omega t = 90^\circ$

$$i_R = I_m \; ; \; i_Y = -\frac{I_m}{2} \; ; \; i_B = -\frac{I_m}{2}$$

$$\Rightarrow \phi_R = \phi_m \angle 0^\circ \; ; \; \phi_Y = \frac{\phi_m}{2} \angle -60^\circ$$

$$\& \; \phi_B = \frac{\phi_m}{2} \angle 60^\circ$$

$$\Rightarrow \phi_{eff} = \phi_R + \phi_Y + \phi_B = \frac{3}{2}\phi_m \angle 0^\circ$$

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Text Book & References

Text Book:

1. "Basic Electrical Engineering" S.K Bhattacharya, 1st Edition Pearson India Education Services Pvt. Ltd., 2017
2. "Basic Electrical Engineering", D. C. Kulshreshta, 2nd Edition, McGraw-Hill. 2019
3. "Special Electrical Machines" E G Janardanan, PHI Learning Pvt. Ltd., 2014

Reference Books:

1. "Engineering Circuit Analysis" William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023

2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.

THANK YOU

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