

Practical-3

Aim: To study basic principle and construction of 3- ϕ induction motor.

Introduction:-

- The three phase induction motor is the most widely used electrical motor.
- Almost 80% of the mechanical power used by industries is provided by three phase induction motors because of its simple and rugged construction, low cost, good operating characteristics, the absence of commutator and good speed regulation. In three phase induction motor, the power is transferred from stator to rotor winding through induction.

Construction:-

Like any other type of electrical motor induction motor, a 3 phase induction motor is constructed from two main parts, namely the rotor and stator:

1.Stator: As its name indicates stator is a stationary part of induction motor. A stator winding is placed in the stator of induction motor and the three phase supply is given to it.

2.Rotor: The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft.

Stator of Three Phase Induction Motor

- The stator of the three-phase induction motor consists of three main parts :
 - 1.Stator frame,
 - 2.Stator core,
 - 3.Stator winding or field winding.

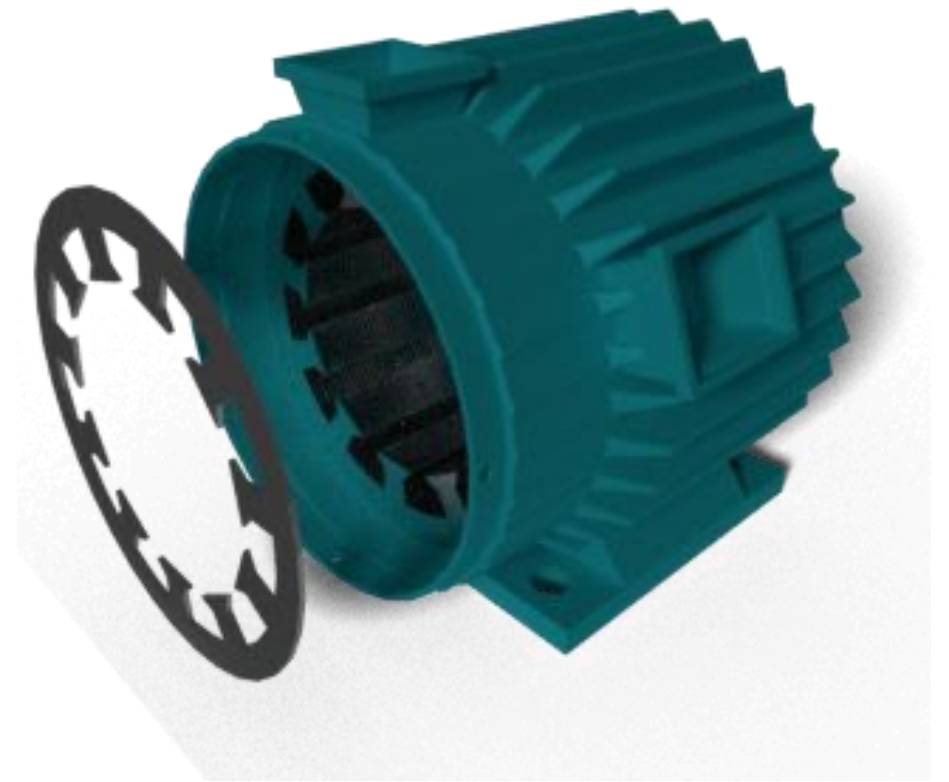
Stator frame

- It is the outer part of the **three phase induction motor**.
- Its main function is to support the stator core and the field winding. It acts as a covering, and it provides protection and mechanical strength to all the inner parts of the induction motor.
- The frame is made up of fabricated steel. The frame of three phase induction motor should be strong and rigid as the air gap length of three phase induction motor is very small.



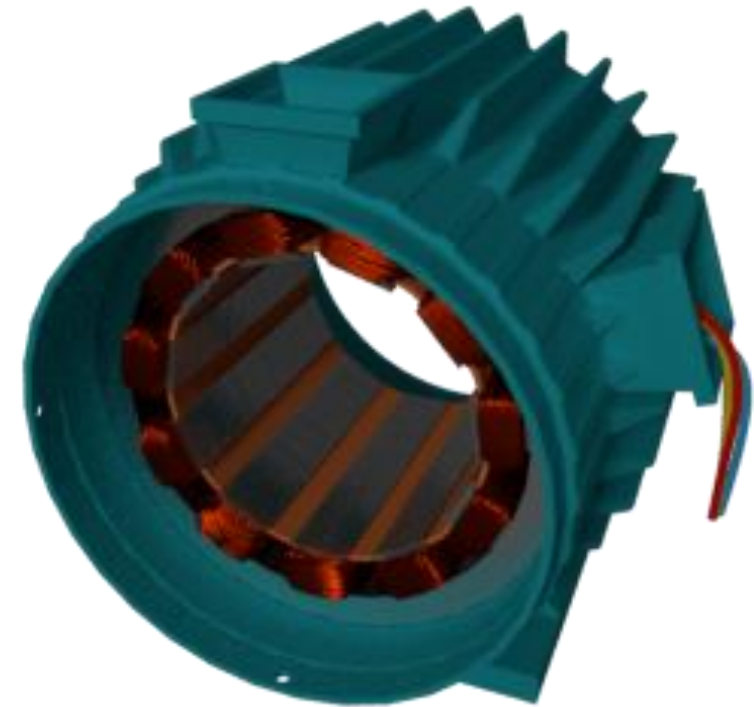
Stator Core

- The main function of the stator core is to carry the alternating flux.
- In order to reduce the eddy current loss, the stator core is laminated. These laminated types of structure are made up of stamping which is about 0.4 to 0.5 mm thick.
- All the stamping are stamped together to form stator core, which is then housed in stator frame. The stamping is made up of silicon steel, which helps to reduce the hysteresis loss occurring in the motor.



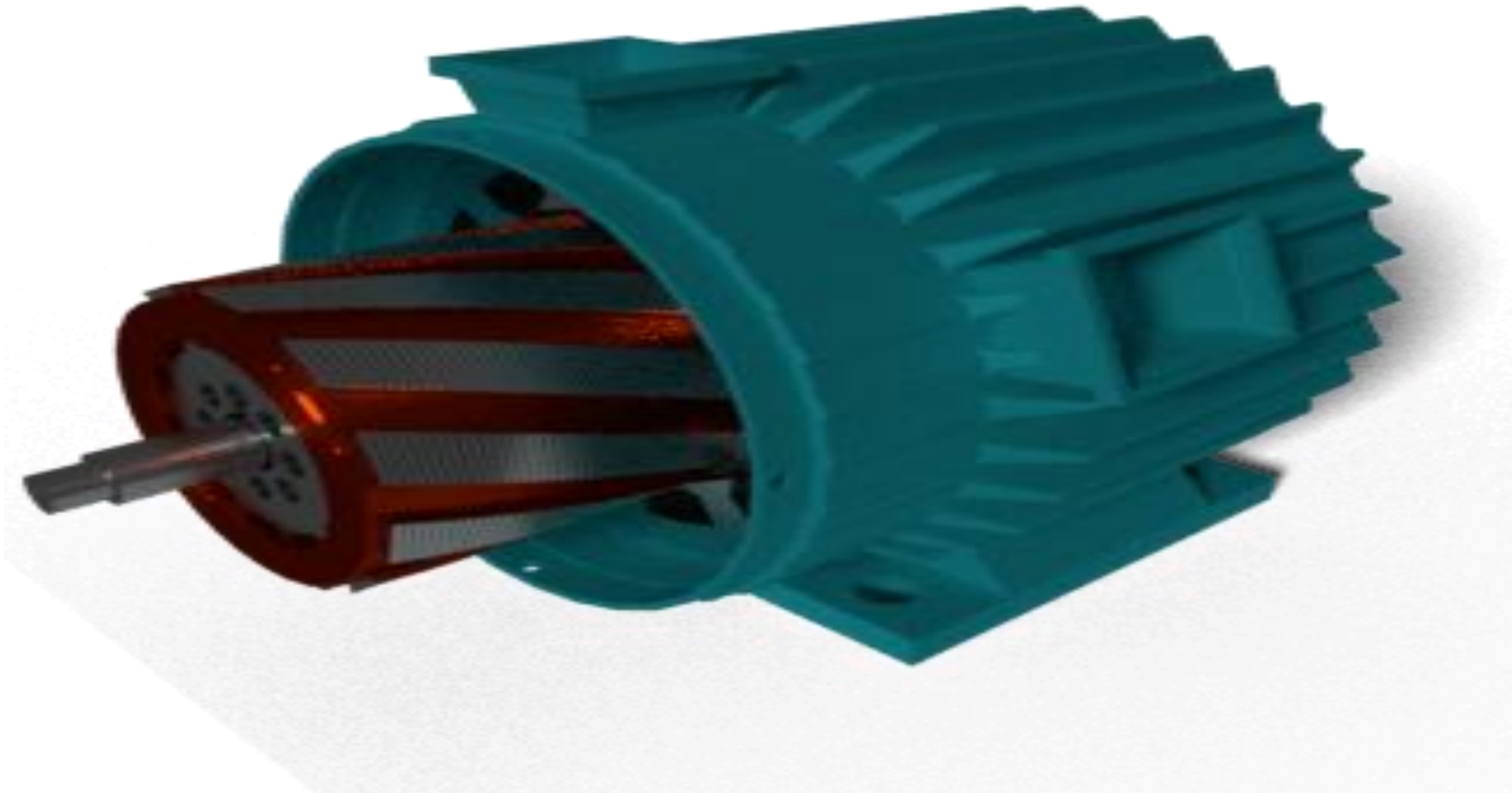
Stator Winding or Field Winding

- The slots on the periphery of the stator core of the three-phase induction motor carry three phase windings.
- We apply three phase ac supply to this three-phase winding. The three phases of the winding are connected either in star or delta depending upon which type of starting method we use.
- The winding wound on the stator of three phase induction motor is also called field winding, and when this winding is excited by three phase ac supply, it produces a rotating magnetic field.



Types of Three Phase Induction Motor

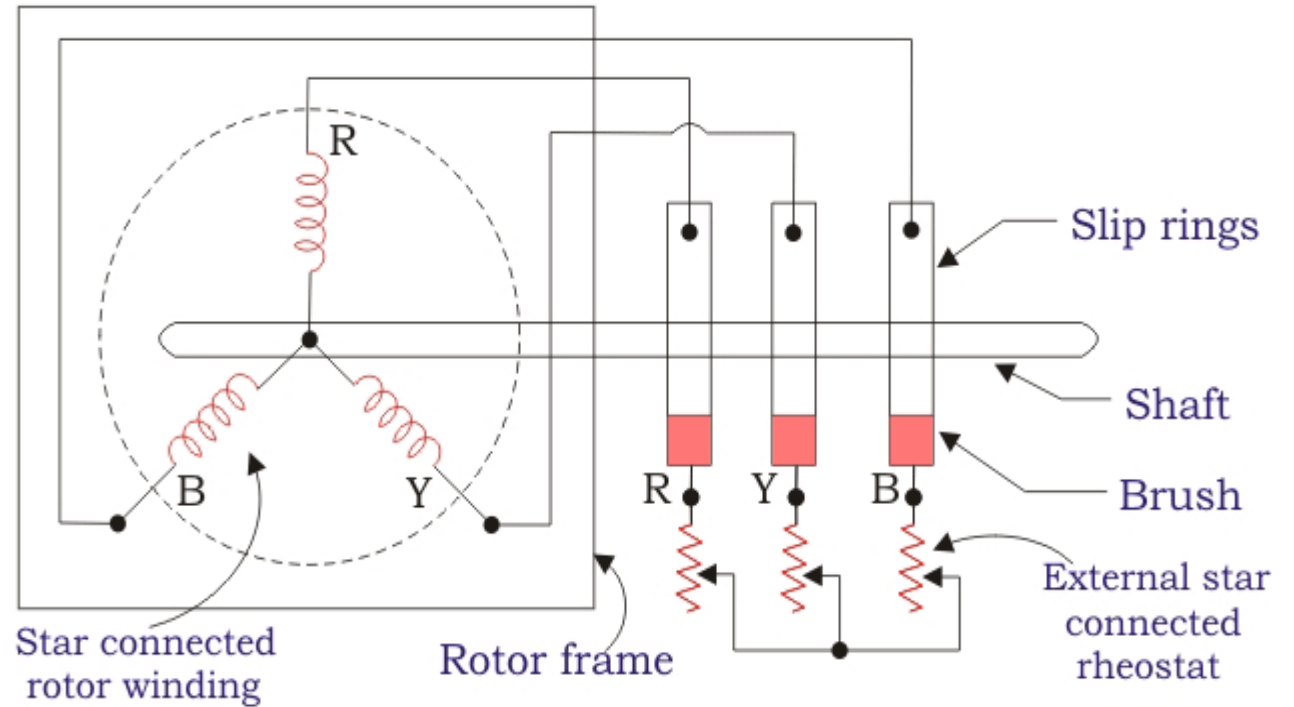
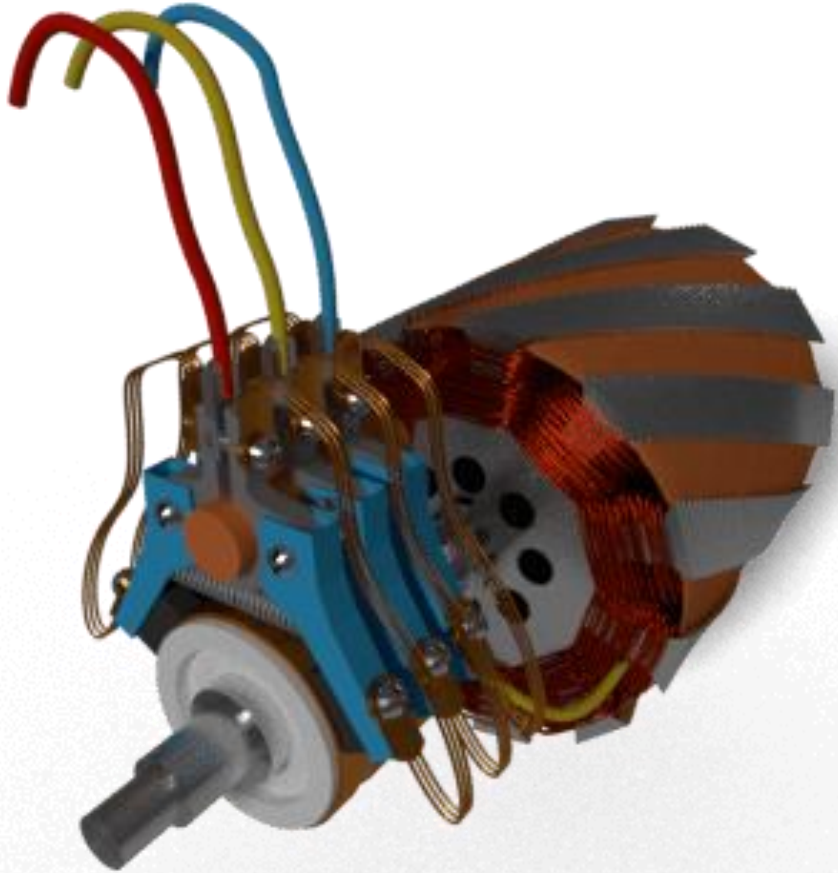
Squirrel Cage Rotor



- The rotor of the squirrel cage three phase induction motor is cylindrical and have slots on its periphery. The slots are not made parallel to each other but are bit skewed (skewing is not shown in the figure of squirrel cage rotor besides) as the skewing prevents magnetic locking of stator and rotor teeth and makes the working of the motor more smooth and quieter.
- The squirrel cage rotor consists of aluminium, brass or copper bars (copper bras rotor is shown in the figure beside). These aluminium, brass or copper bars are called rotor conductors and are placed in the slots on the periphery of the rotor.
- The rotor conductors are permanently shorted by the copper, or aluminium rings called the end rings. To provide mechanical strength, these rotor conductors are braced to the end ring and hence form a complete closed circuit resembling like a cage and hence got its name as squirrel cage induction motor.

- The squirrel cage rotor winding is made symmetrical. As end rings permanently short the bars, the rotor resistance is quite small, and it is not possible to add external resistance as the bars get permanently shorted.
- The absence of slip ring and brushes make the construction of Squirrel cage three-phase induction motor very simple and robust and hence widely used three phase induction motor. These motors have the advantage of adopting any number of pole pairs. The below diagram shows a squirrel cage induction rotor having aluminium bars short circuit by aluminium end rings

Slip Ring or Wound Rotor Three Phase Induction Motor



Slip Ring Three Phase Induction Motor

- At starting, the resistance is connected to the rotor circuit and is gradually cut out as the rotor pick up its speed.
- When the motor is running the slip ring are shorted by connecting a metal collar, which connects all slip ring together, and the brushes are also removed. This reduces the wear and tear of the brushes.
- Due to the presence of slip rings and brushes the rotor construction becomes somewhat complicated therefore it is less used as compare to squirrel cage induction motor.

Working of an Induction Motor

- Alternating flux is produced around the stator winding due to AC supply. This alternating flux revolves with synchronous speed. The revolving flux is called as "Rotating Magnetic Field" (RMF).
- The relative speed between stator RMF and rotor conductors causes an induced emf in the rotor conductors, according to the Faraday's law of electromagnetic induction. The rotor conductors are short circuited, and hence rotor current is produced due to induced emf. That is why such motors are called as induction motors. (This action is same as that occurs in transformers, hence induction motors can be called as rotating transformers.)

- Now, induced current in rotor will also produce alternating flux around it. This rotor flux lags behind the stator flux. The direction of induced rotor current, according to Lenz's law, is such that it will tend to oppose the cause of its production.
- As the cause of production of rotor current is the relative velocity between rotating stator flux and the rotor, the rotor will try to catch up with the stator RMF. Thus the rotor rotates in the same direction as that of stator flux to minimize the relative velocity. However, the rotor never succeeds in catching up the synchronous speed. This is the basic working principle of induction motor of either type, single phase or 3 phase.