

# Basic Electrical Engineering (TEE 101)

## ***Lecture 53: Introduction to Three Phase Induction Motor***



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# Content

**This lecture  
covers:**

**Introduction to Three  
Phase Induction Motor**

**Types of Induction  
Motor**

**Construction of  
Induction Motors**

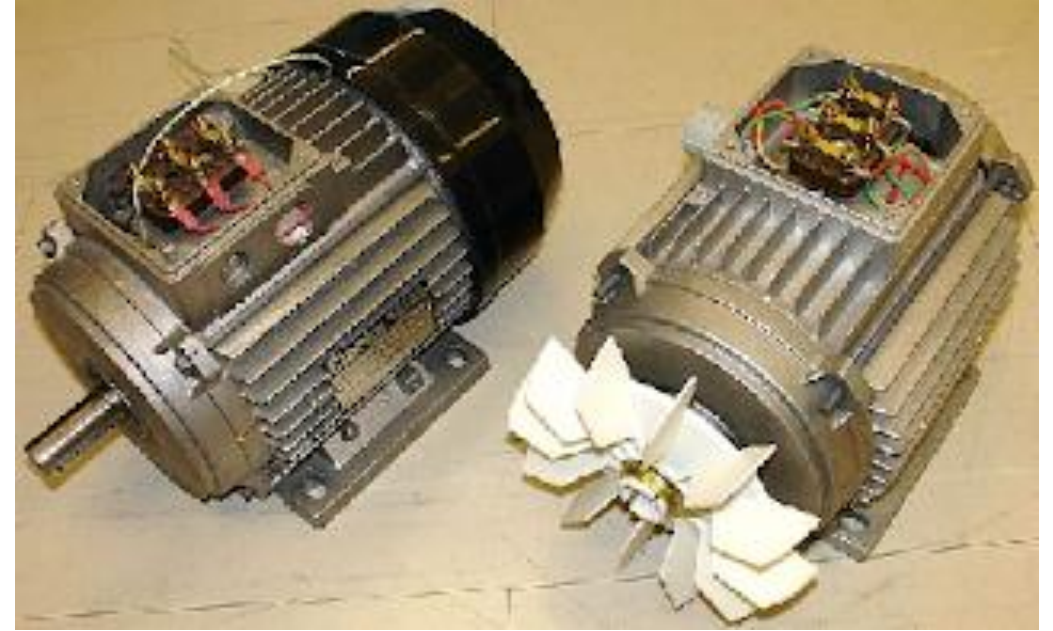
**Advantages,  
Disadvantages and  
Applications of  
Induction Motors**

## Three Phase Induction Motor

- Induction motors are the **ac motors** which are employed as the prime movers in most of the industries.
- There are two types of Induction Motors
  - **Single Phase Induction Motors, and**
  - **3-Phase Induction Motors**
- The **3 – phase induction motors** are the most widely used electric motors in the industry.
- They run at essentially constant speed from no-load to full-load.
- However, the speed is frequency dependent and consequently, these motors are not easily adapted to speed control.
- **3-phase induction motors** are simple, rugged, low-priced, easy to maintain and can be manufactured with characteristics to suit most industrial requirements.

## Constructional Details:

- Similar to DC machines an induction motor consists of a stationary member called stator and a rotating member called rotor.
- However the induction motor differs from a dc machine in the following aspects.
  - **Laminated stator**
  - **Absence of commutator**
  - **Uniform and small air gap**
  - **Practically almost constant speed**



The AC induction motor comprises two electromagnetic parts:

- Stationary part called the stator
- Rotating part called the rotor

## The stator

The stator is the outer stationary part of the motor, which consists of

- **The outer cylindrical frame** of the motor or yoke, which is made either of welded sheet steel, cast iron or cast aluminum alloy.
- **The magnetic path**, which comprises a set of slotted steel laminations called stator core pressed into the cylindrical space inside the outer frame. The magnetic path is laminated to reduce eddy currents, reducing losses and heating.

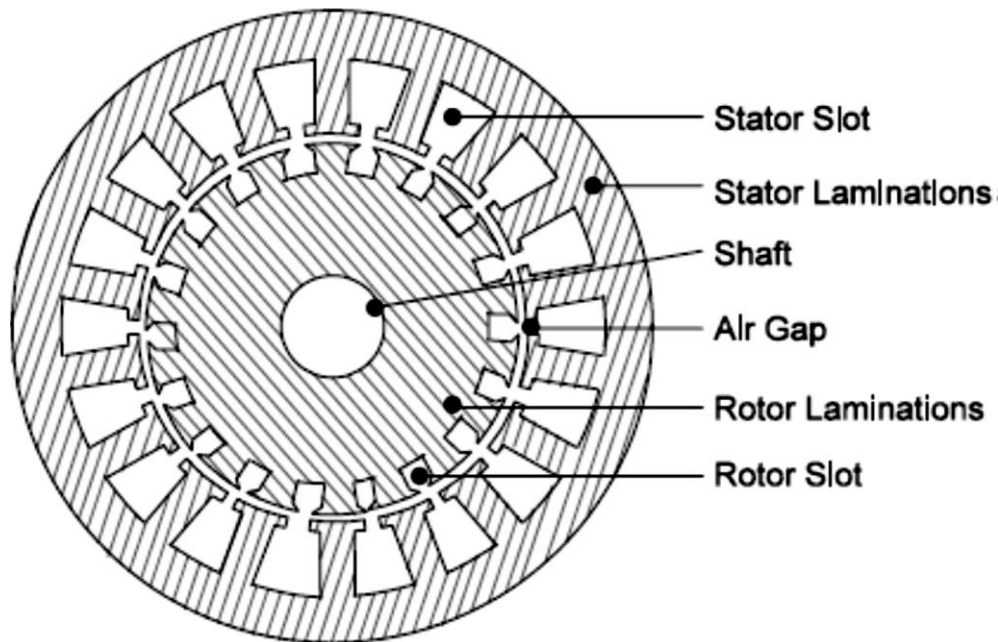
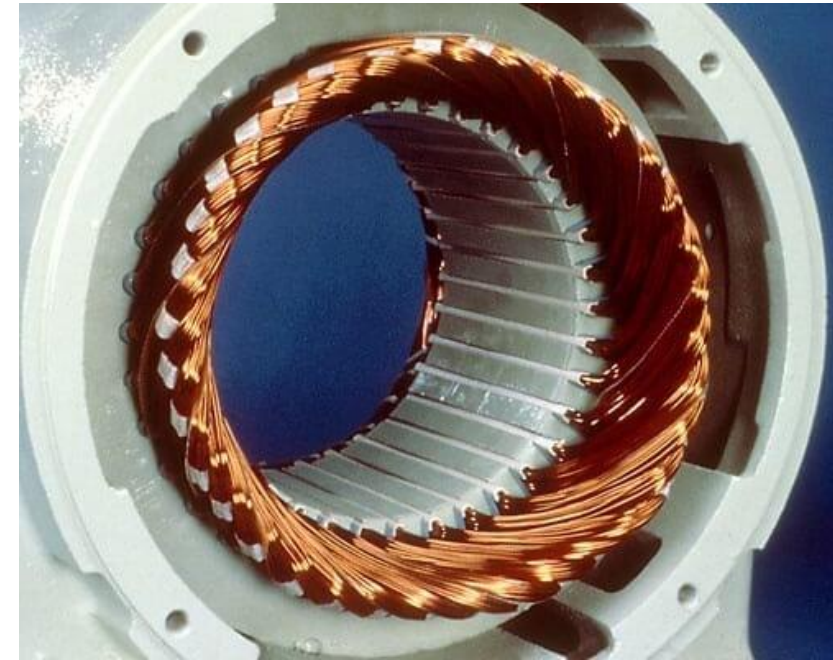


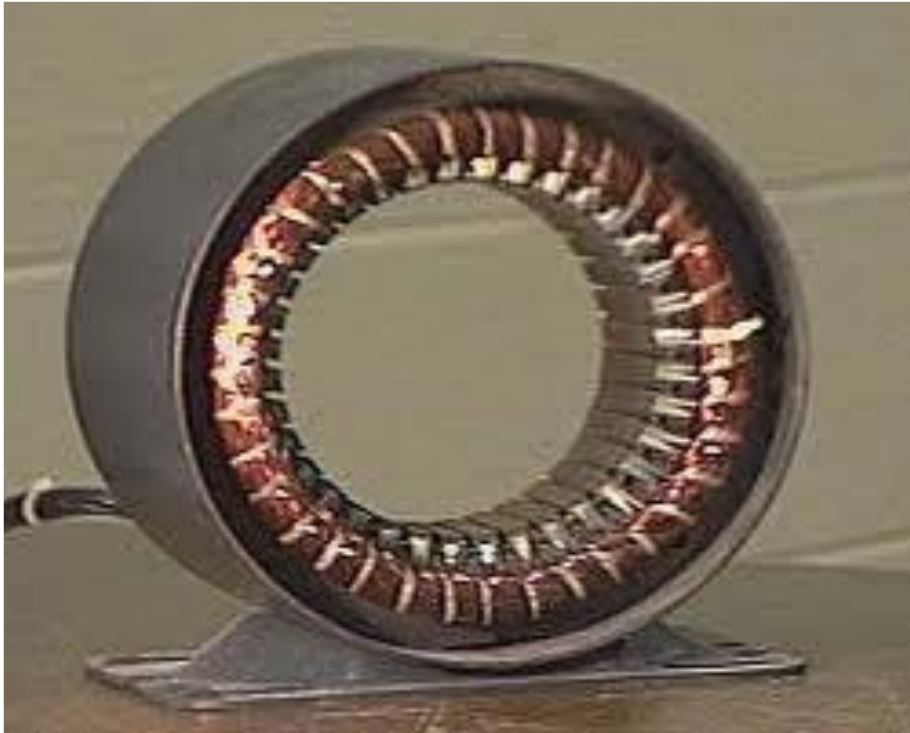
Fig 1: Stator and rotor laminations



Fig. 2 Stator laminations



- A set of insulated electrical windings, which are placed inside the slots of the laminated stator.
- The cross-sectional area of these windings must be large enough for the power rating of the motor.
- For a 3-phase motor, 3 sets of windings are required, one for each phase connected in either star or delta.
- Fig below shows the cross sectional view of an induction motor. Details of construction of stator are shown in Figs



**Fig. 3 stator core with smooth yoke**



**Fig.4 Stator with ribbed yoke**

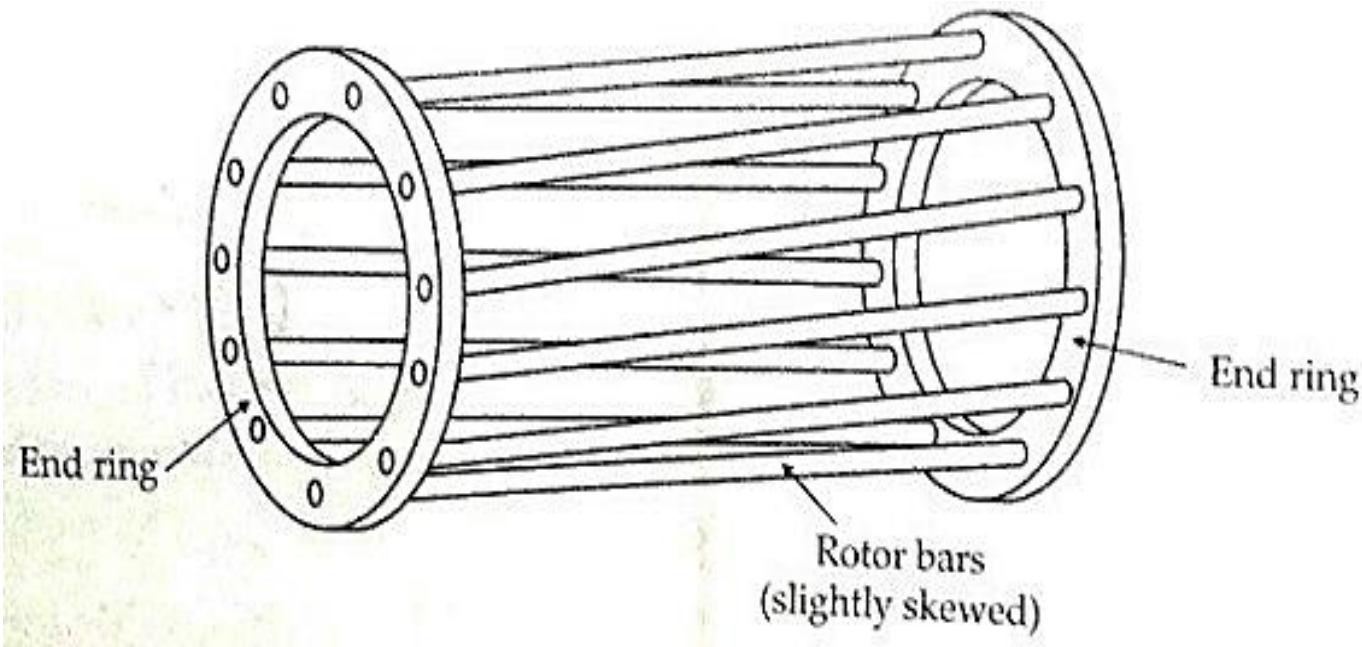
## The rotor

- Rotor is the rotating part of the induction motor.
- The rotor also consists of a set of slotted silicon steel laminations pressed together to form of a cylindrical magnetic circuit and the electrical circuit.

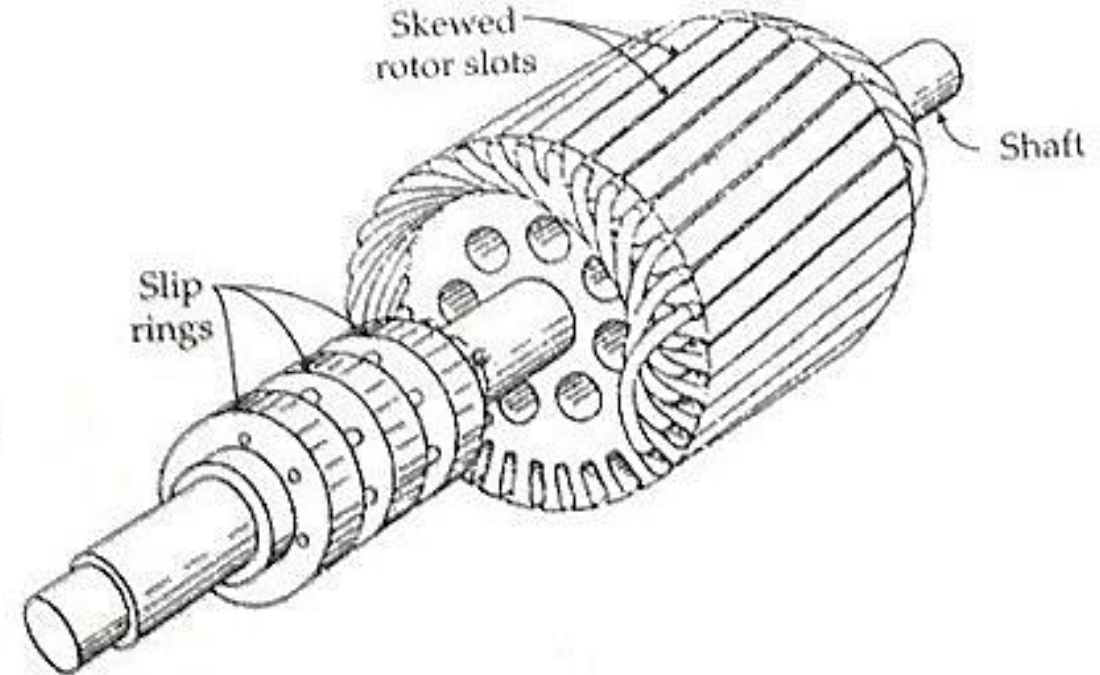
### Types of three phase induction motor:

**1: Squirrel Cage Induction Motor (SCIM) (figure 5)**

**2: Wound Rotor Induction Motor (or also known as Slip Ring Induction Motor (SRIM) (figure 6)**



**Fig. 5 Squirrel Cage Induction Motor (SCIM)**



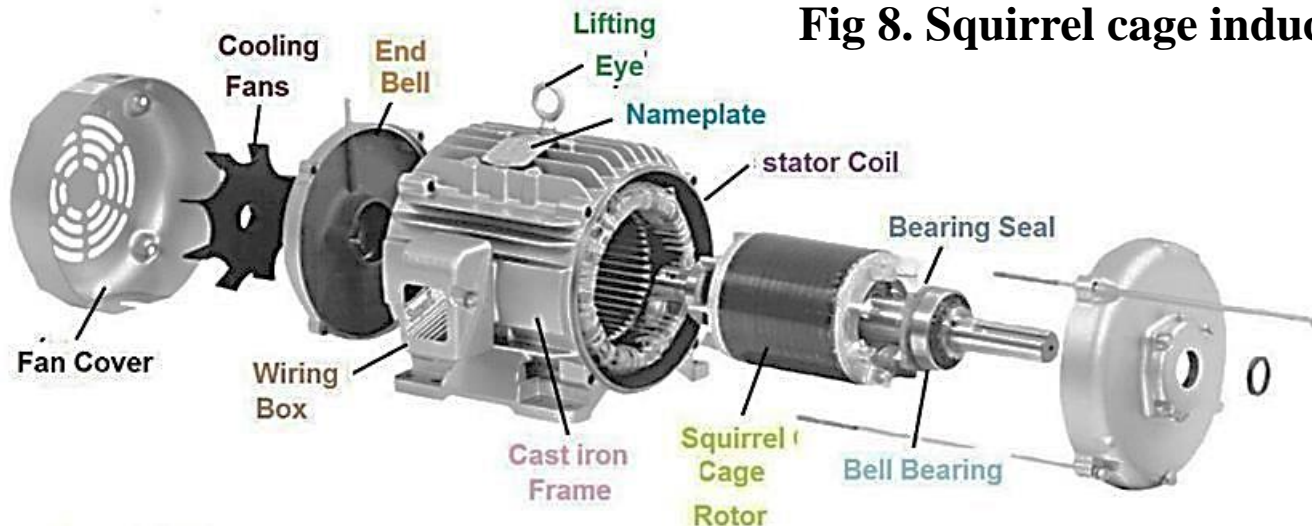
**Fig. 6 Slip Ring Induction Motor (SRIM)**

## Squirrel Cage Induction Motor (SCIM)

- **Squirrel cage rotor (figure 7)** consists of a set of copper or aluminum bars installed into the slots, which are connected to an end-ring at each end of the rotor.
- The construction of this type of rotor along with windings resembles a ‘**squirrel cage**’.
- **Aluminum rotor bars** are usually die-cast into the rotor slots, which results in a very rugged construction.
- Even though the aluminum rotor bars are in direct contact with the steel laminations, practically all the rotor current flows through the aluminum bars and not in the lamination

**The skewing of cage rotor conductors offers the following advantages.**

1. More uniform torque is produced and noise is reduced during operation.
2. The locking tendency of the rotor is reduced. During the locking, the rotor and stator teeth attract each other due to magnetic action.



**Fig 8. Squirrel cage induction motor**



**Fig 7. Squirrel cage rotor**

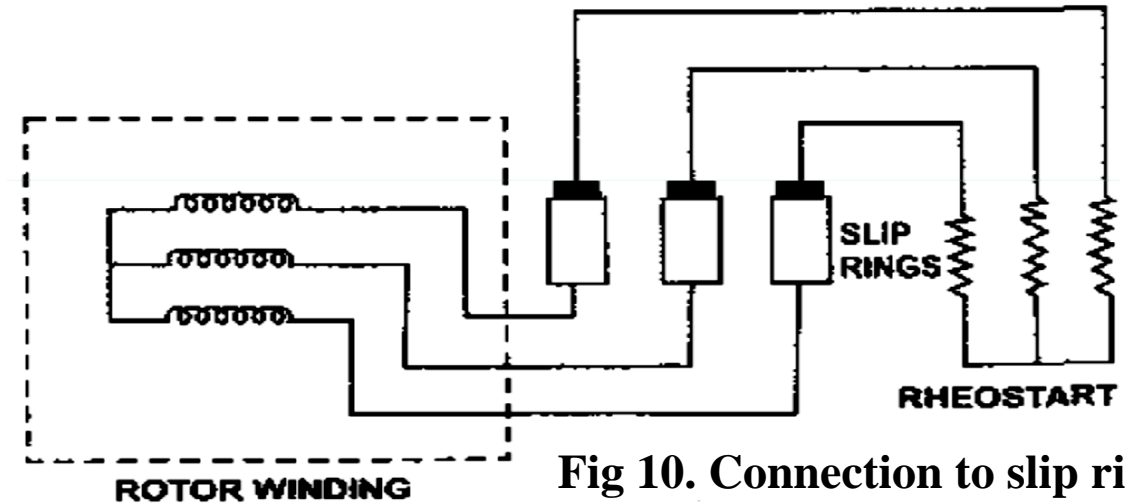


## Wound Rotor Induction Motor

- **Wound rotor (figure 9)** consists of three sets of insulated windings with connections brought out to three slip rings mounted on one end of the shaft.
- The external connections to the rotor are made through brushes onto the slip rings as shown in fig 10.
- Due to the presence of slip rings such type of motors are called slip ring motors.



**Fig. 9. Slip ring rotor**



**Fig 10. Connection to slip rings**

The resistor enables the variation of each rotor phase resistance to serve the following purposes given below:

- To increase the starting torque and decrease the starting current from the supply
- To control the speed of the motor.

- Some more parts, which are required to complete the constructional details of an induction motor, are:
- **Two end-flanges to support the two bearings, one at the driving-end and the other at the non driving-end, where the driving end will have the shaft extension.**
- **Two sets of bearings to support the rotating shaft.**
- **Steel shaft for transmitting the mechanical power to the load**
- **Cooling fan located at the non driving end to provide forced cooling for the stator and rotor**
- **Terminal box on top of the yoke or on side to receive the external electrical connections**
- Sectional view of the full induction motor is shown in Figure 11

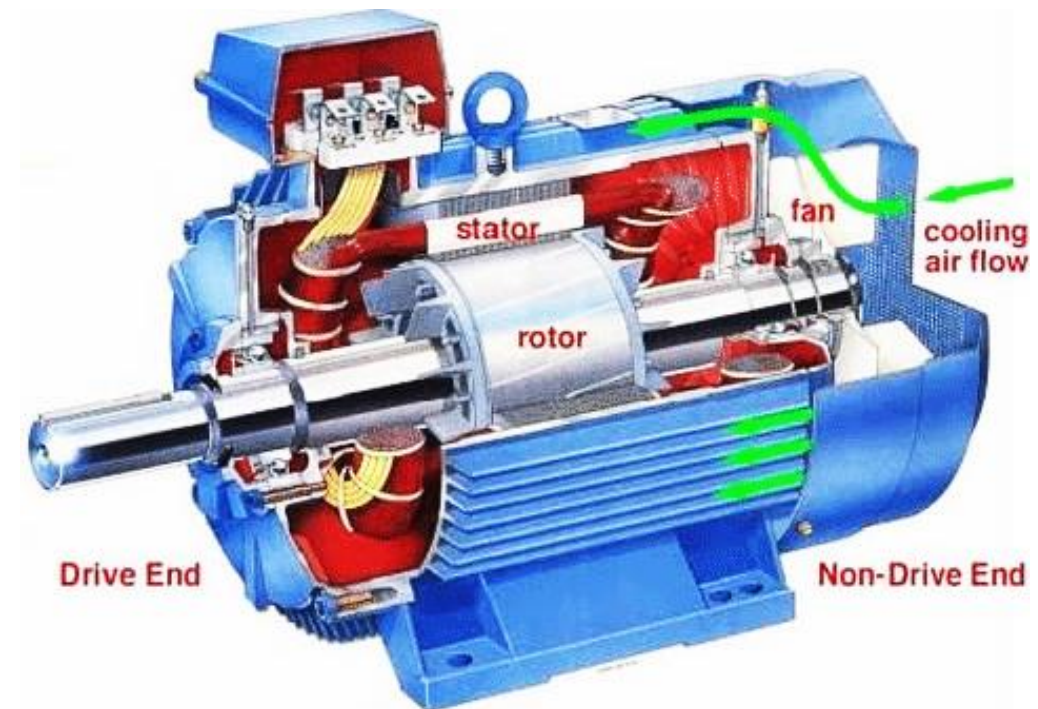


Figure 11: Sectional view of the full induction motor

# Advantages of Cage Rotor Induction Motor and Wound Rotor Induction Motor

**The following advantages of the cage rotor are given below:**

- The cage rotor is cheaper, and the construction is robust.
- The absence of the brushes reduces the risk of sparking.
- Its Maintenance is less.
- The power factor is higher
- The efficiency of the cage rotor is higher.

**The wound rotors have the following merits**

1. High starting torque and low starting current.
2. Additional resistance can be connected in the rotor circuit to control the speed.

### **Three Phase Induction Motor Advantages:**

- It has simple and rugged construction.
- It is relatively cheap.
- It requires little maintenance.
- It has high efficiency and reasonably good power factor.
- It has self starting torque.

### **Three Phase Induction Motor Disadvantages:**

- It is essentially a constant speed motor and its speed cannot be changed easily.
- Its starting torque is inferior to dc shunt motor.

### **Applications:**

- Induction motors are widely used in industrial applications from small workshops to large industries.
- These motors are employed in applications such as
  - **centrifugal pumps**
  - **Conveyers**
  - **Compressors**
  - **crushers, and**
  - **drilling machines etc.**



**Thank You**