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Machines 2

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Submitted  
To

## Q3 Nos 18

Write Introduction, Advantages, disadvantages and Construction of three phase Induction Motor:

**Ans**

An Induction motor is an AC electric motor in which the electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of stator windings.

Induction motor are also known as asynchronous motor because its rotor rotates at a speed less than the synchronous speed.

They run at essentially constant speed from no load



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to full-load.

However, the speed is frequency dependent and consequently these motors are not easily adapted to speed control.

⇒ 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.

⇒ Advantages:

⇒ The working of an induction motor is very simple. It can operate in any environmental condition. The construction of an induction motor is robust and sturdy.

⇒ Induction motors are cheaper in cost due to the absence of brushes,

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Commutators, and slip rings.

⇒ It is highly efficient motor. The efficiency of induction motor is varying from 85 to 95%.

⇒ The brushes are not used in an induction motor so, there are no sparks in the motor and it can be used in polluted and hazardous environment.

⇒ 3 phase induction motor is the self-starting motor so any special starting arrangement is not required:

⇒ The speed variation from no-load to rated load is very less:

⇒ Disadvantages:

⇒ The power factor of the motor is very low during the light load condition.



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→ It is essentially a constant speed motor and its speed cannot be changed easily.

→ The motor cannot be used in such applications where high starting torque is necessary like traction and lifting weight.

### Construction:

Like any other electrical motor induction motor also here two main parts namely:

① Stator ② rotor. The rotor is separated from the stator by a small air-gap which ranges from 0.4mm to 1mm, depending upon the power of motor.

The main body of the induction motor comprises of:

→ Shaft for transmitting the torque to the load.

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This shaft is made up of steel:

- ⇒ Terminal box for receiving external electrical connection.
- ⇒ Fan is needed for cooling.
- ⇒ Bearings for supporting the rotating shaft.

### Stator:

Stator is a stationary part of induction motor.

A stator winding is placed in the stator of induction motor and three

phase supply is given. Stator is made up of

number of stampings in which different stator

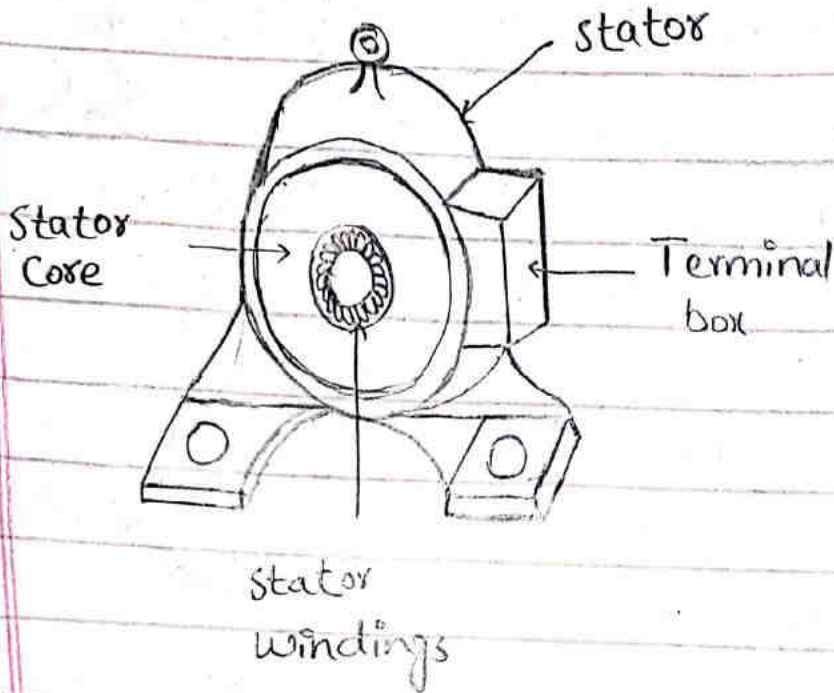
are cut of receive 3 phase winding circuit

which are connected to 3 phase AC supply.

Stator is wound with three-phase windings which are overlapped with

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One another at 120 degree phase shift into slotted laminations;



The windings are wound for a definite number of poles depending upon the speed requirement, as speed is inversely proportional to the number of poles:

$$N_s = \frac{120}{P} f$$

where  $N_s$  = Synchronous Speed

$f$  = Frequency

$P$  = no. of poles

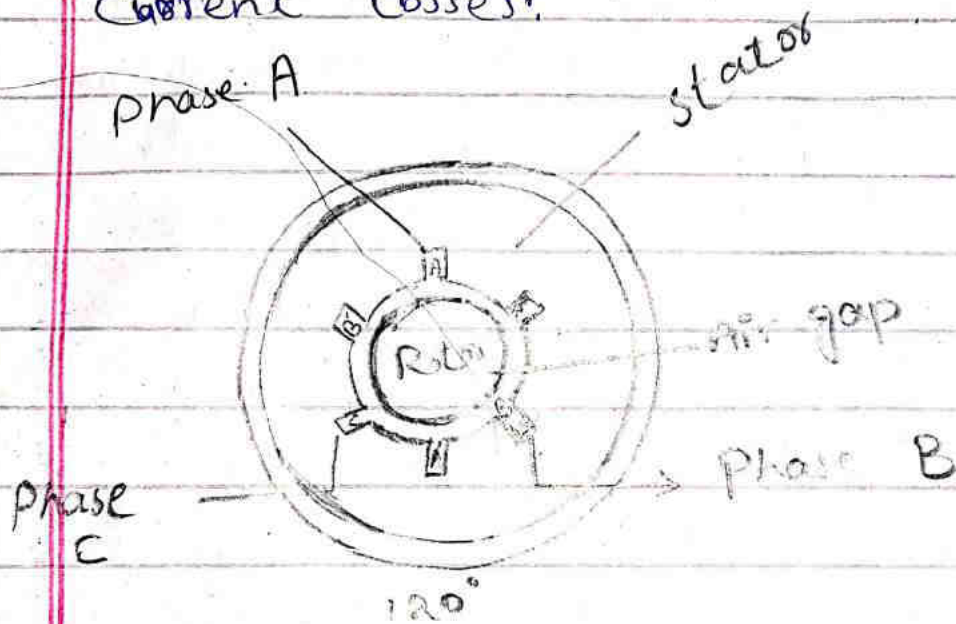
Greater the no. of poles, lesser in the speed of



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the motor and vice versa.

It consists of a steel frame which encloses a hollow, cylindrical core made up of thin laminations of silicon steel to reduce hysteresis and eddy current losses.



### Rotor:

The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft. Rotor consists of cylindrical laminated core with



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parallel slots that carry conductors bars. An induction motor's rotor can be either Squirrel-cage type or wound type.

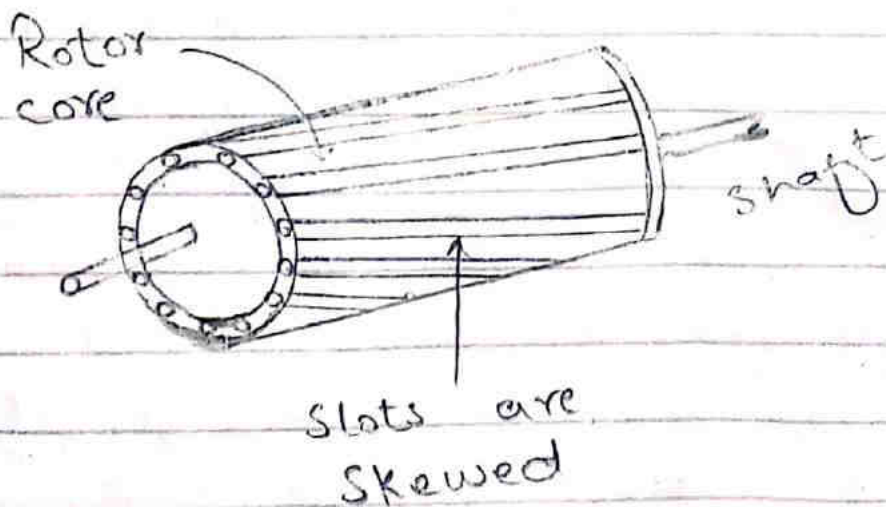
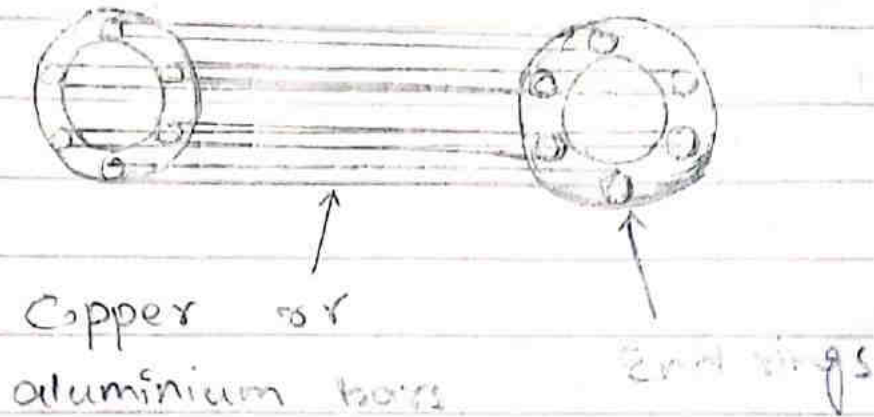
**Squirrel Cage rotor:**

Squirrel cage rotor is cylindrical in shape and has slots on its periphery. The slots are not made parallel to each other but are bit skewed as the skewing prevents magnetic locking of stator and rotor teeth and makes the working of motor more smooth and quieter.

The squirrel cage rotor consists of aluminium, brass or copper bars conductors. The rotor conductors are permanently shorted by copper or aluminium

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rings are called the end rings:



Advantages:

Its construction is very simple and rugged.  
⇒ As there are no brushes and slip rings these motors requires less



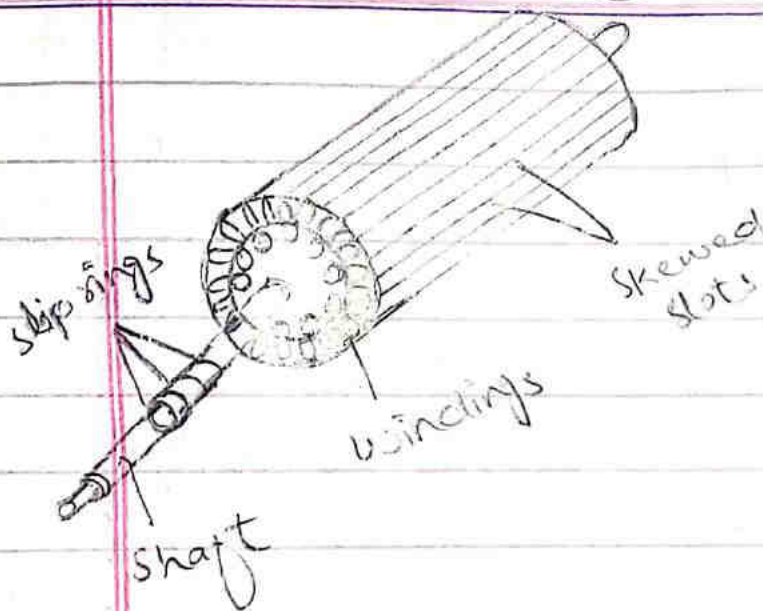
maintenance:

Application:

Squirrel cage induction motor is used in lathes, drilling machines, fans, blower, painting machines etc.

Wound Rotor

In this type of three phase induction motor the rotor is wound for the same no. of poles as that of stator but it has less number of slots and has less turns per phase of a heavier conductor. The rotor windings are placed in slots and three end terminals are connected together to form star connection. Slip rings are connected on same shaft as that of rotor. The three end phase winding is:



### Advantages:

- ⇒ It has high starting torque and low starting current:
- ⇒ Possibility of adding additional resistance to control speed:

### Application:

Slip ring induction motors are used where high starting torque is required. i.e. in hoist, cranes, elevators:

### Q: No: 2:

Write operation principle (working) of three phase Induction Motor:



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**Ans:**

The working principal of a three phase induction motor is "Faraday's Law of electromagnetic induction".

The stator of the motor consists of overlapping windings offset by an electrical angle of  $120^\circ$ . When we connected the primary windings or the stators to a  $3\phi$  AC source, it establishes rotating magnetic field which rotates at the synchronous speed.

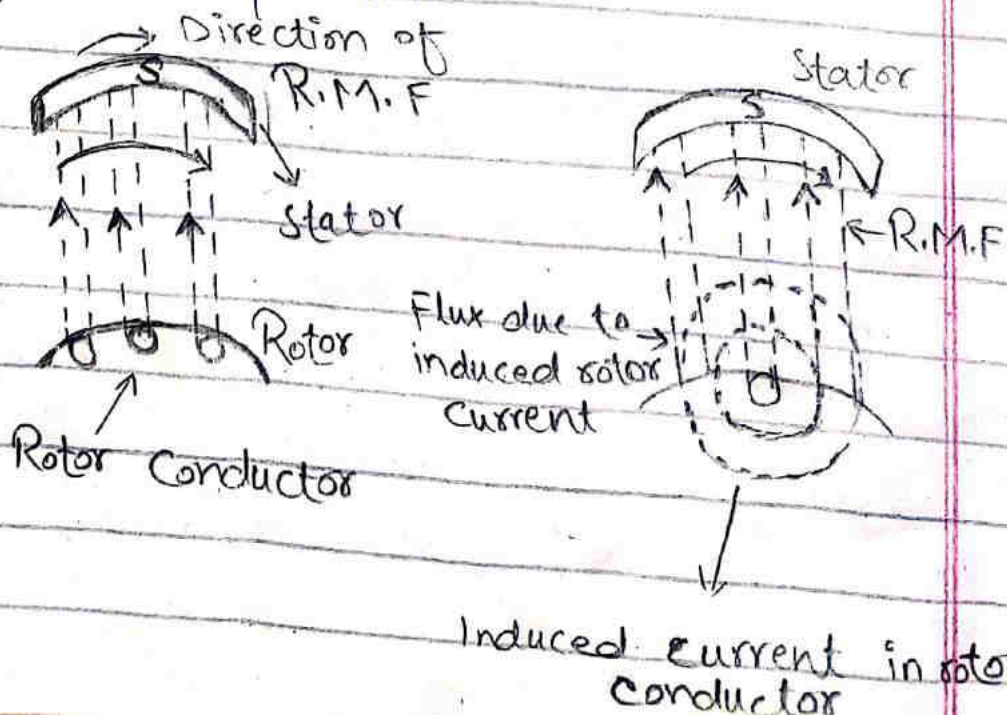
This changing magnetic field cuts the rotor conductors and induce the current in them according to the principle of electromagnetic induction. As this rotor conductors are shorted, the current starts to flow through these conductors.

The rotor conductors rotation can be explained by Lenz's Law, which tells that the induced currents in the rotor oppose the cause for its

production, here this opposition is rotating magnetic field. This result the rotor starts rotating in the same direction of the stator rotating magnetic field:

If the rotor speed is more than stator speed, then no current will induce in AC rotor because the reason for rotor rotation is the relative speed of the rotor and stator magnetic fields.

Hence for producing rotations the rotor speed must always be less than the stator field speed.





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Q: No: 3:

Discuss different types of starter for three phase induction motor:

⇒ Ans:

⇒ Direct on-line starter (DOL)

A DOL starter or across the line starter is a method of starting of a 3 phase induction motor.

In DOL starter an induction motor is connected directly across its 3-phase supply, and the DOL applies the full line voltage to the motor terminal.

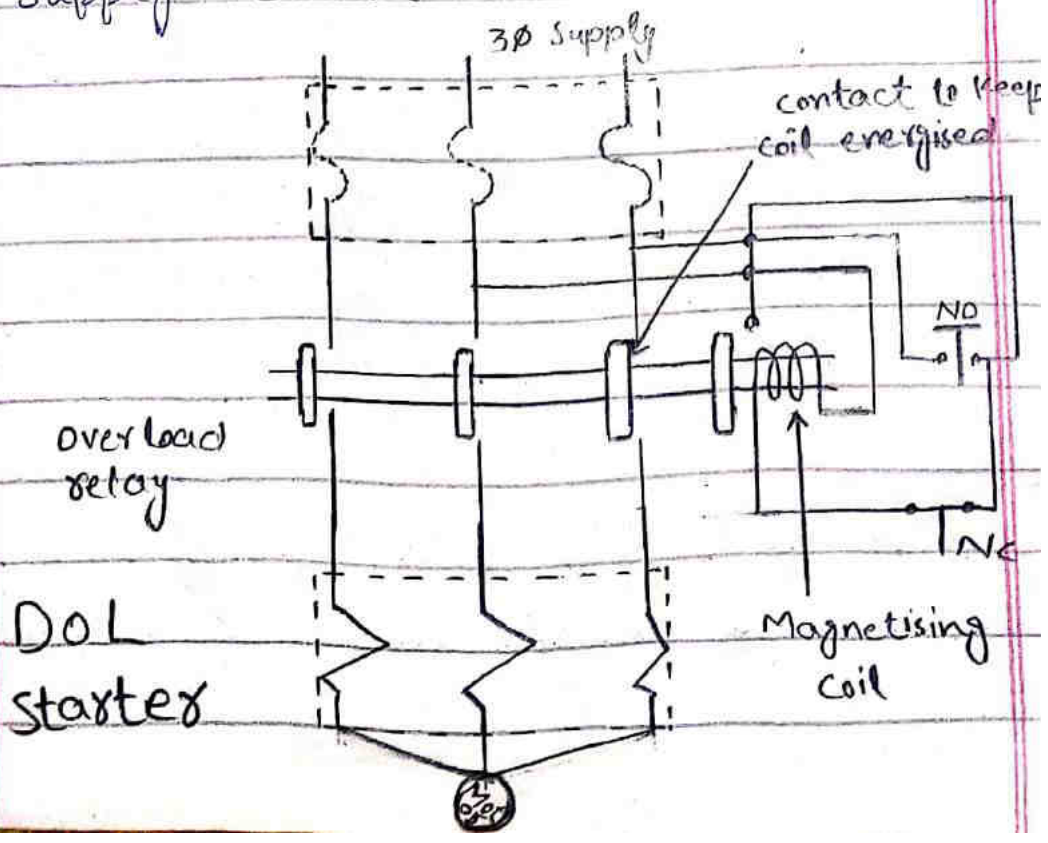
A DOL motor starter contains protection devices such as circuit breaker, overload relay and contactor for protecting motor.

Although, this starter doesn't reduce the starting voltage it provide protection to the motor against overloading single

phasing and Low Voltage

During start conditions, normally open contact is pushed for fraction of a second and this makes the magnetizing coil become energised. This magnetic flux produced by the coil attracts the contactor so that the motor is now connected to the supply.

When a normally closed switch is pressed the coil becomes de-energised and the conductor get separated by spring arranged there by the supply to the motor is removed.

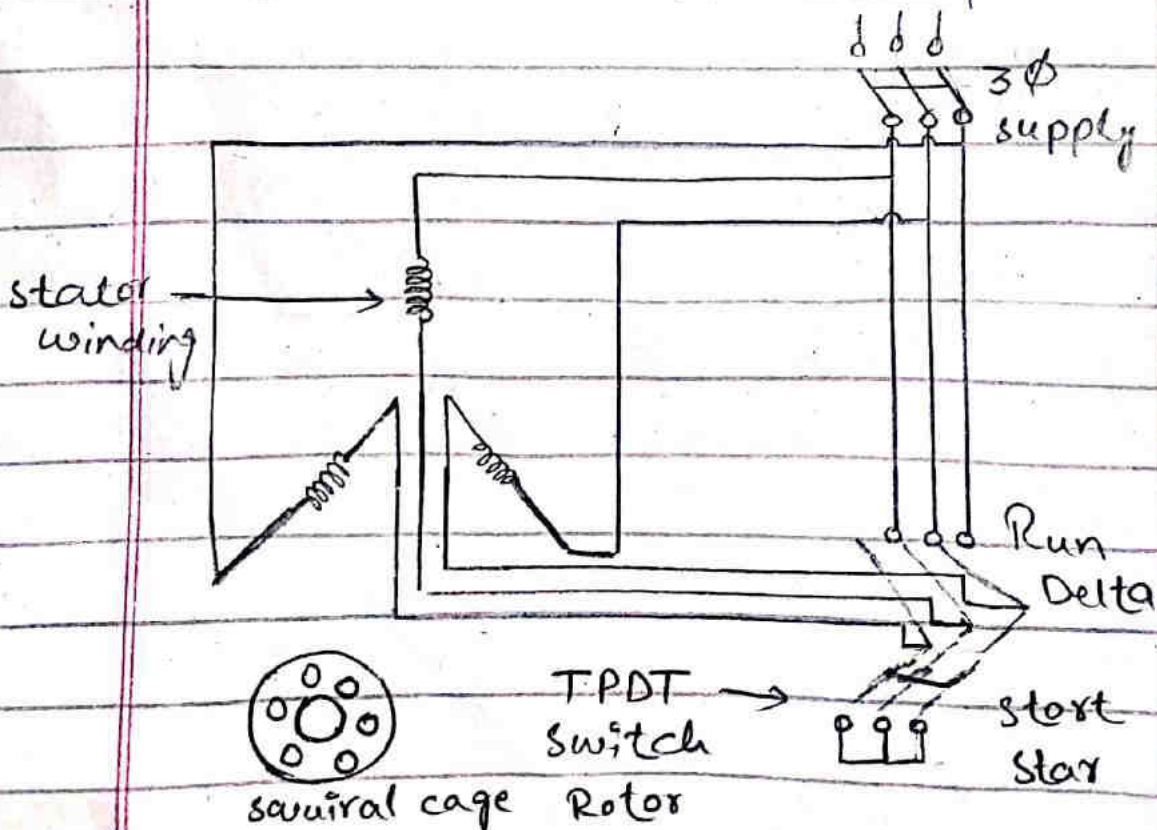




## ⇒ Star-Delta Starters:

A star delta starter is the most commonly used method for the starting of a 3-phase induction motor. When the motor picks up the speed, the TPST switch is thrown automatically on the other side by using relay such that the winding is now connected in delta across the supply.

So the normal voltage is applied to the motor and motor runs at normal speed:

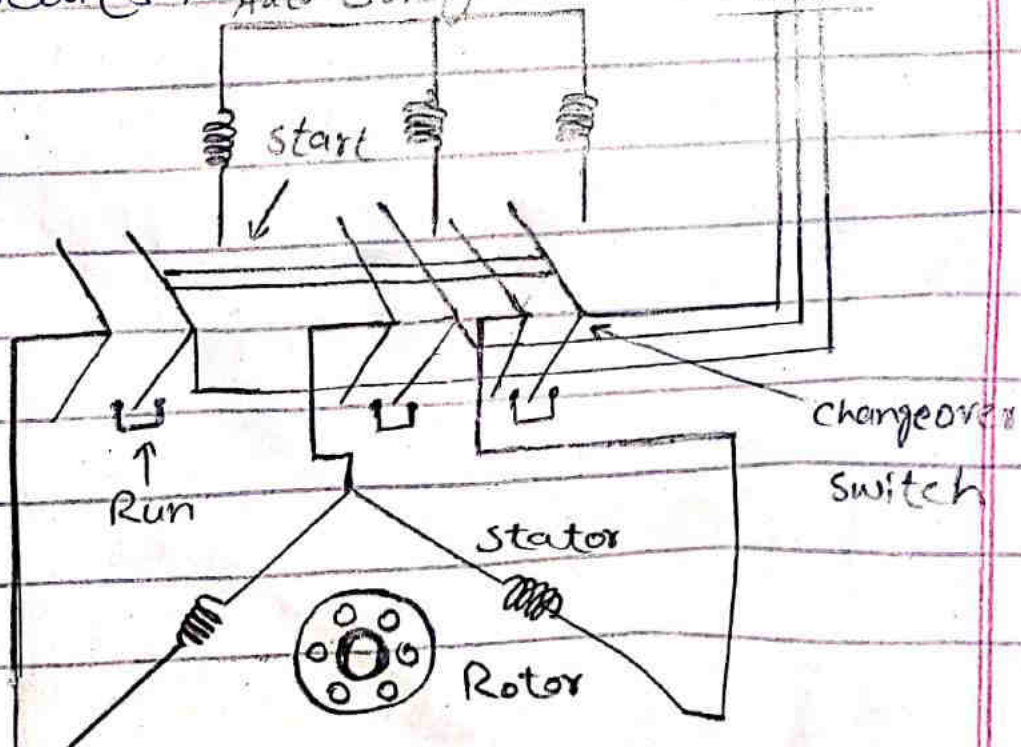


# ⇒ Auto transformer Starters

In this method, a 3φ auto transformer is connected in series with the motor. This transformer reduces the voltage applied to the motor and hence the current.

When the motor attains 80% of its rated speed the changeover switch is connected to run position automatically using relays. Due to this a rated voltage is then supplied to motor. These transformers are also provided with overload, no-load and time delay

Circuit of auto transformer





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## ⇒ Rotor Impedance starters:

The easiest method of starting wound rotor induction motor is to connect some extra resistance in the rotor circuit.

Connection of extra resistance in the rotor circuit decrease and at the same time increase the starting torque. As the motor starts rotating, the extra resistance is gradually cut.

When the motor attains rated speed the resistance is fully cut out and the slip ring terminals are short circuited.

