

Date: / / 20

DAY  
@ 10:00 AM

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Semester:

4th

Department:

Electrical  
Technology

Assignment:

AC Machines II

Submitted to:

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## Question No 1

Write Introduction, Advantages, disadvantages & Construction of three phase induction Motor.

### INTRODUCTION

The popularity of 3 phase induction motors on board ships is because of their simple, robust construction and high reliability factor in the sea environment. A 3 phase induction motor can be used for different application with various speed & load requirements.

### ADVANTAGES

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



- It has self-starting torque.

## DISADVANTAGES

- It is essentially a constant speed motor & its speed cannot be change easily.
- Its starting torque is inferior to d.c. Shunt motor.

## DO CONSTRUCTION

Like any other electrical motor induction motor has two main parts namely.

↳ Stator

↳ Rotor

The rotor is separated from the stator by a small air gap which ranges from **0.4mm** to **4mm** depending upon the power of motor.

The main body of the induction motor comprises of

Shaft for transmitting the torque to the load. This shaft made

up of steel.

Bearing for supporting the rotating shaft.

Terminal box for receiving external electrical connection.

Fan is needed for cooling.

## STATOR

Stator is a stationary part of induction motor. A stator winding is placed in the stator of induction motor & the three phase supply is given to it.

Stator is made up of jumping number of stamping in which different stators are cut to receive three phase winding circuit which are connected to 3 phase AC supply.

Stator is wound with three-phase windings which are overlapped with one another at 120 degree phase shift into slotted lamination.



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

$$N_s = 120f/p$$

Where  $N_s$  = Synchronous speed

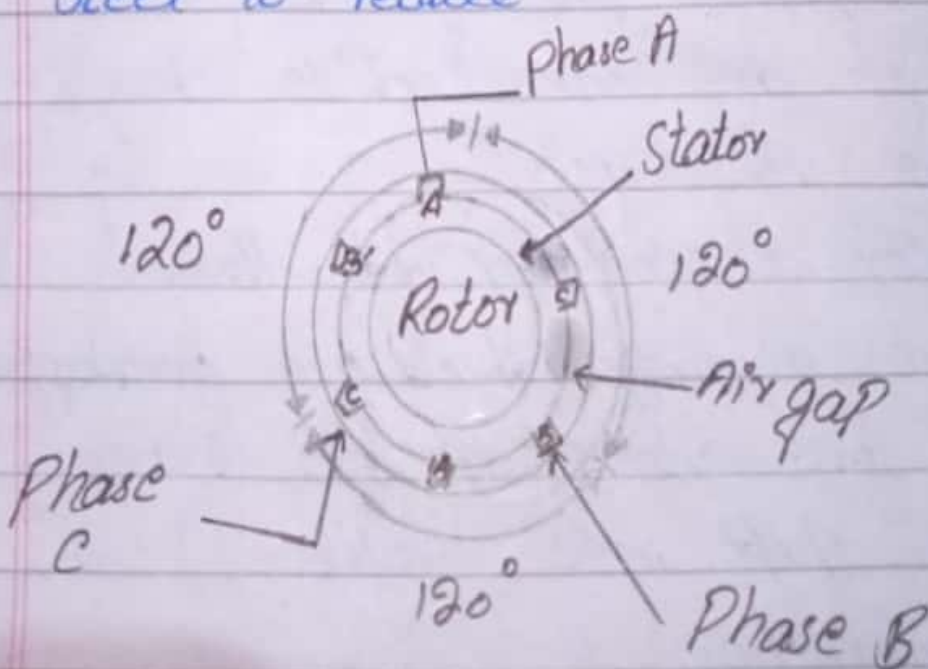
$f$  = frequency

$p$  = no. of poles

Greater the no. of poles, lesser is the speed of the motor

Ex vice versa.

It consists of a steel frame which encloses a hollow, cylindrical core made up of thin laminations of silicon steel to reduce



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## ROTOR

The Rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft. Rotor consist of cylindrical laminated core with parallel slots that carry conductor 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 & have slots on its periphery. The slots are not made parallel to each other but are bite skewed as the skewing prevents magnetic locking of stator & rotor teeth and makes the working of motor more smooth & quieter.

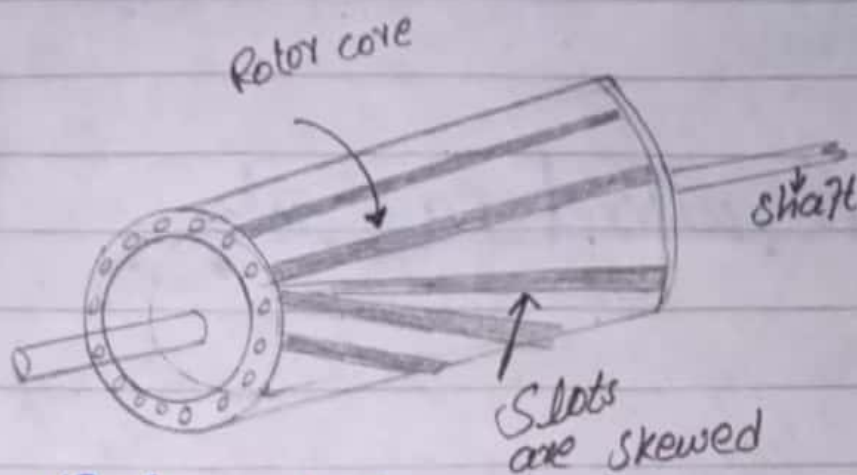
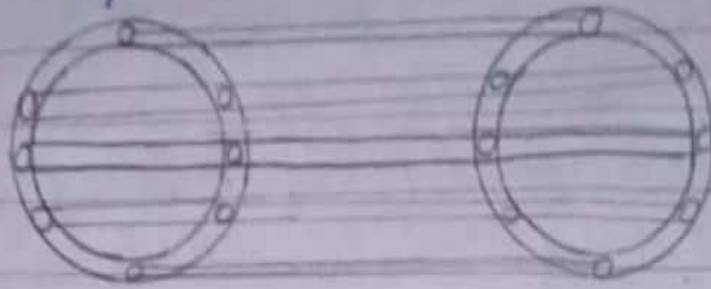
The squirrel cage rotor



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Consist of aluminium, brass or copper bars conductor.

The rotor conductors are permanently shorted by copper or aluminium rings called the end rings.



## Advantages:

- ⇒ Its construction is very simple & rugged.
- ⇒ As there are no brushes & slip rings these motor require less maintenance.

## Application

- ⇒ Squirrel cage induction motor is used in

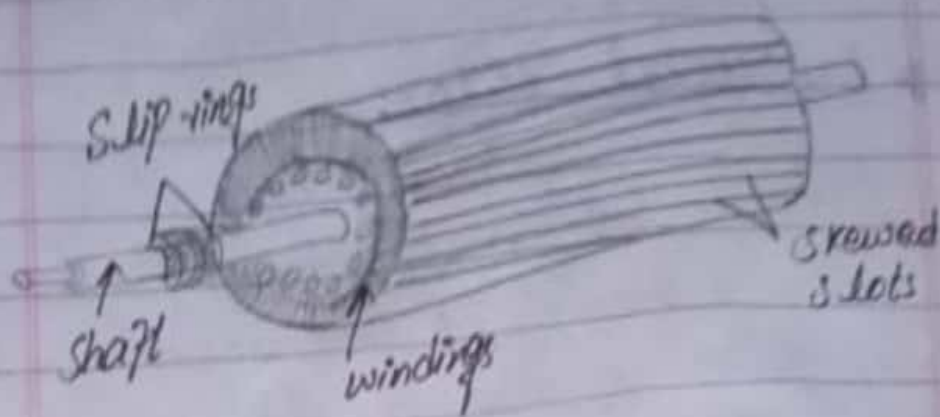
lather, drilling machine, fan blower, printing machine etc.

### ↳ Wound rotor:-

In this type of 3-phase induction motor the rotor is wound for the same no. of poles as that of stator but it has less number of slots & has less turns per phase of a heavier conductor. The rotor windings are placed in slots & three end terminals are connected together to form star connection. Slip rings are connected on same shaft as that of rotor. The three ends of phase windings are permanently connected to these slip rings.

For developing a high-starting torque these windings are connected to rheostat with the help of carbon-brushes. These brushes are used to carry current to and from the rotor windings.





### Advantages:-

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

### Application:-

- ⇒ Slip ring induction motor are used where high starting torque is required (i.e) in hoists, cranes, elevator etc.

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## Question No 2

Write operation principal (working) of three phase induction motor.

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

The stator of the motor consist of overlapping windings offset by an electrical angle of  $120^\circ$ . When we connected the primary windings or the stator 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 induces a current in them according to the principle of electromagnetic induction. As these rotor conductor are the current starts to flow through these conductors.



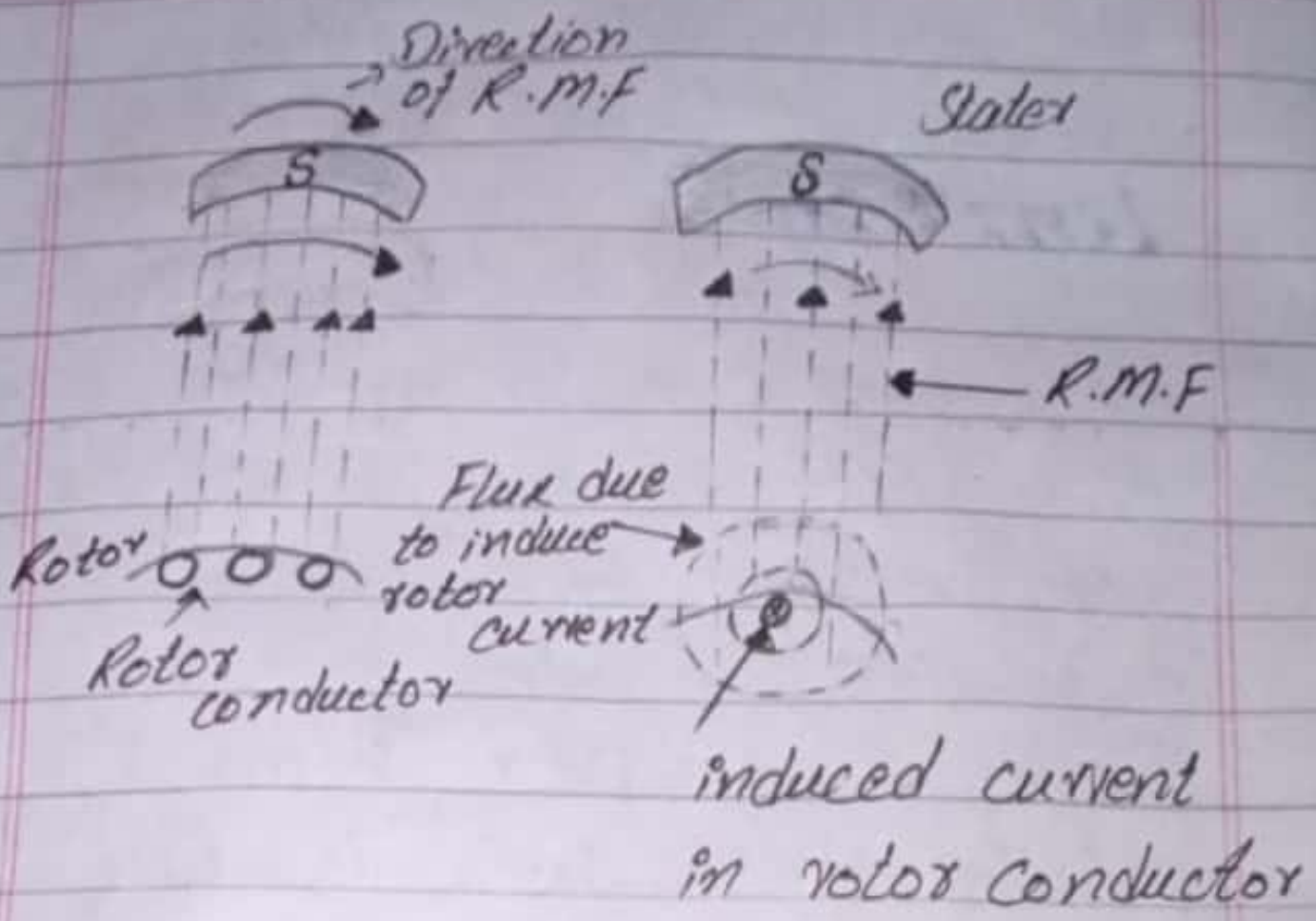
The rotor conductors rotation can be explained by **Lenz's law**

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 the rotor because the reason for rotor rotation is the relative speed of the rotor & stator magnetic field.

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

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## Question No 3

Discuss different types of starter for three phase induction motor.

### 1 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 & the DOL applies the full line voltage to the motor terminal.

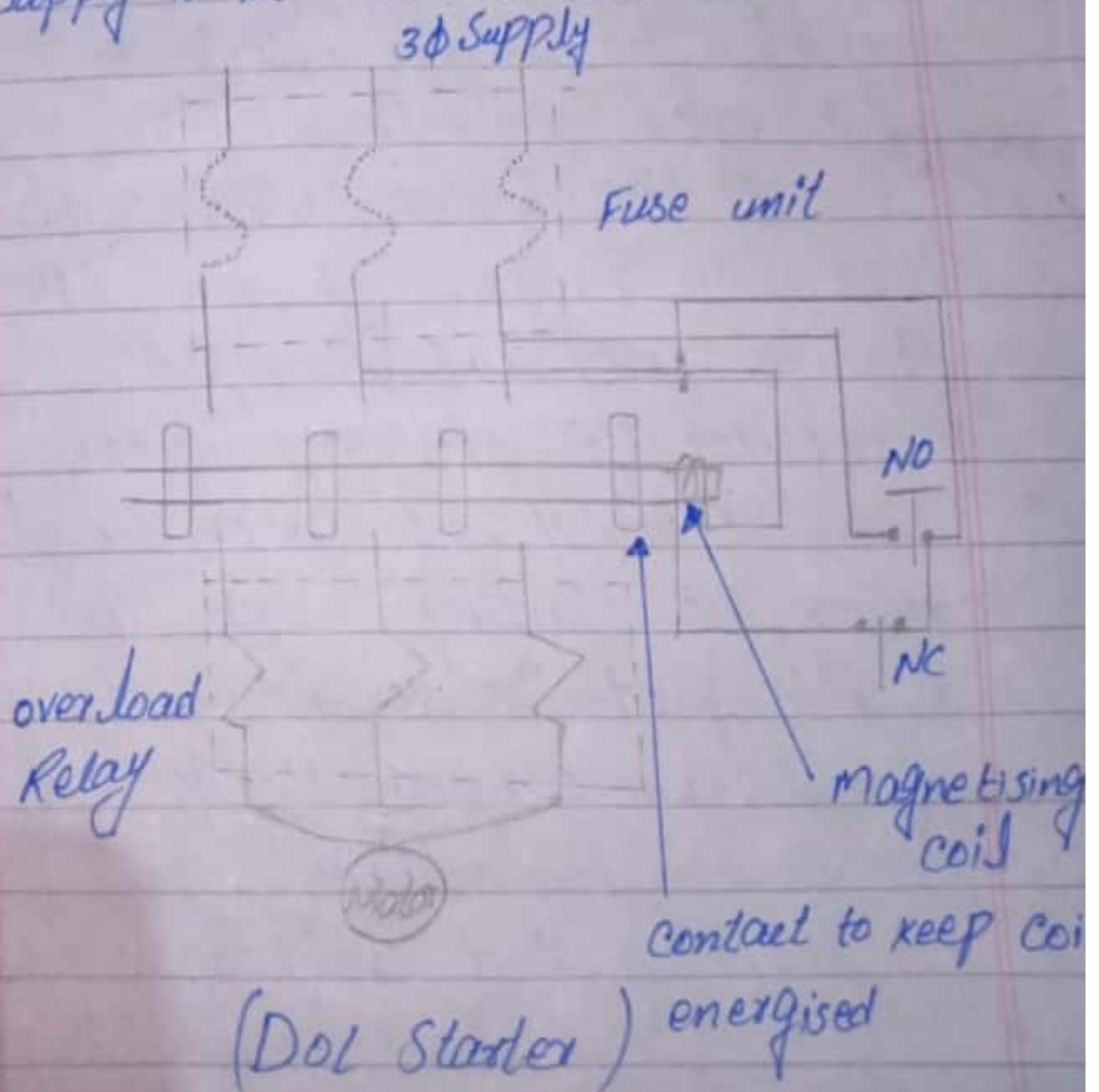
A DOL motor starter contains protection devices such as circuit breaker, over load relay & contactor for protecting motor.

Although, this starter doesn't reduce the starting voltage it provide protection to the motor against over loading single phasing & low voltage.

During start conditions,

Normally open contact is pushed for fraction of a second & this makes the magnetising 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 become de-energised & the contactor get separated by spring arrangement then by the supply to the motor is removed.





## 2 Star-Delta Starter:-

A Star delta Starter is the most commonly used method for the starting of a 3-phase induction motor.

In Star delta starting an induction motor is connected in through a star connection throughout the starting period. Then once the motor reaches the required speed, the motor is connected in through a delta connection.

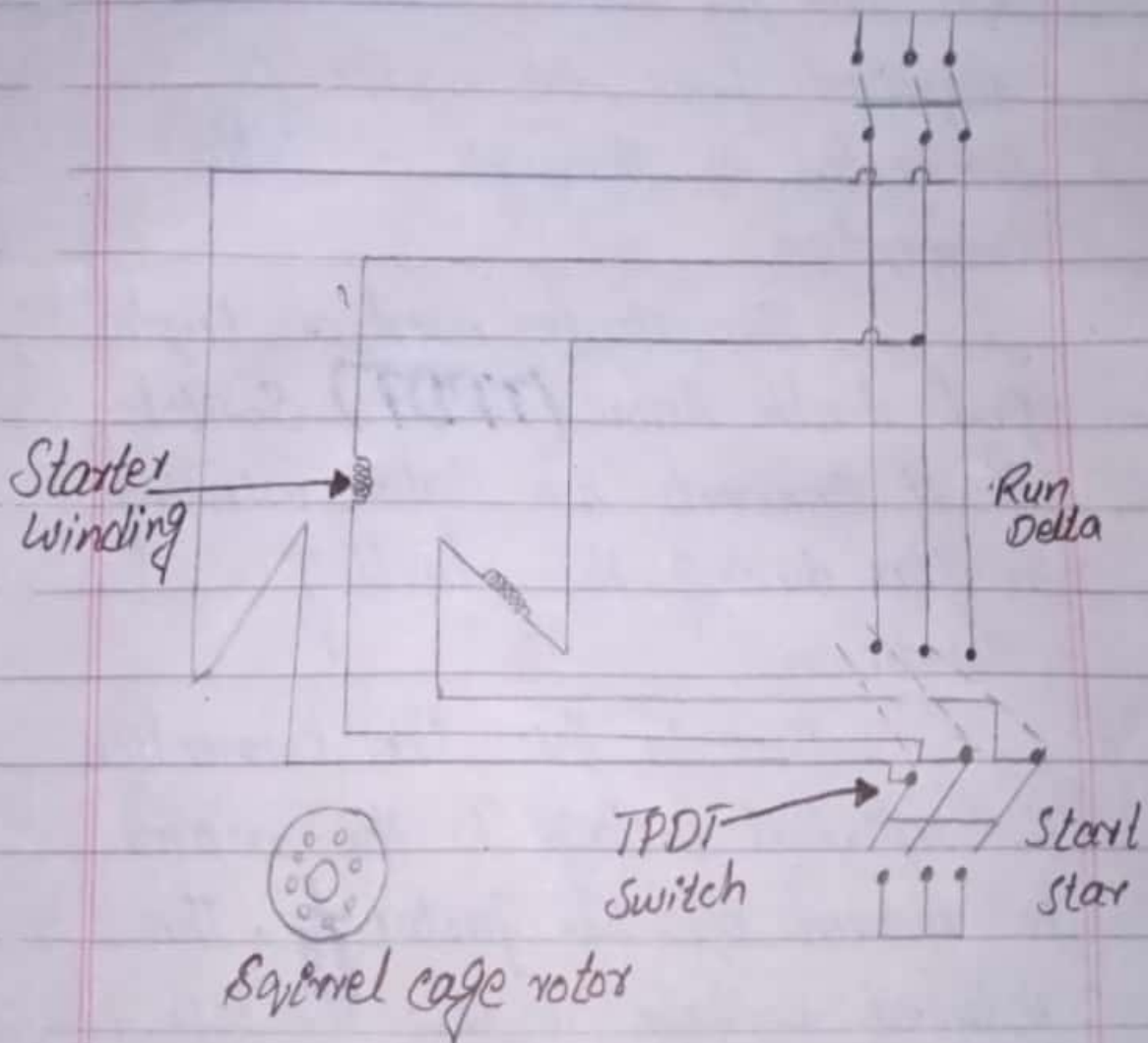
This starter used a triple pole double throw (TPDT) Switch & it connects the stator winding in star during the starting condition.

Due to this star connection the applied voltage to the motor is reduced by the factor  $\frac{1}{\sqrt{3}}$ . This reduced voltage results the less current through the motor.

When the motor pick 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 & motor runs at normal speed.





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## Auto transformer Starter

In this method, a 3 $\phi$  auto transformer is connected in series with the motor. This transformer reduces the voltage applied to the motor & hence the current.

The starter consist of changover switch that switches the motor between reduced voltage & full voltage condition when this switch is in the starter position, voltage is reduced. This voltage depends on the fractional percentage of tapping & is controlled by changing position of autotransformer slides.

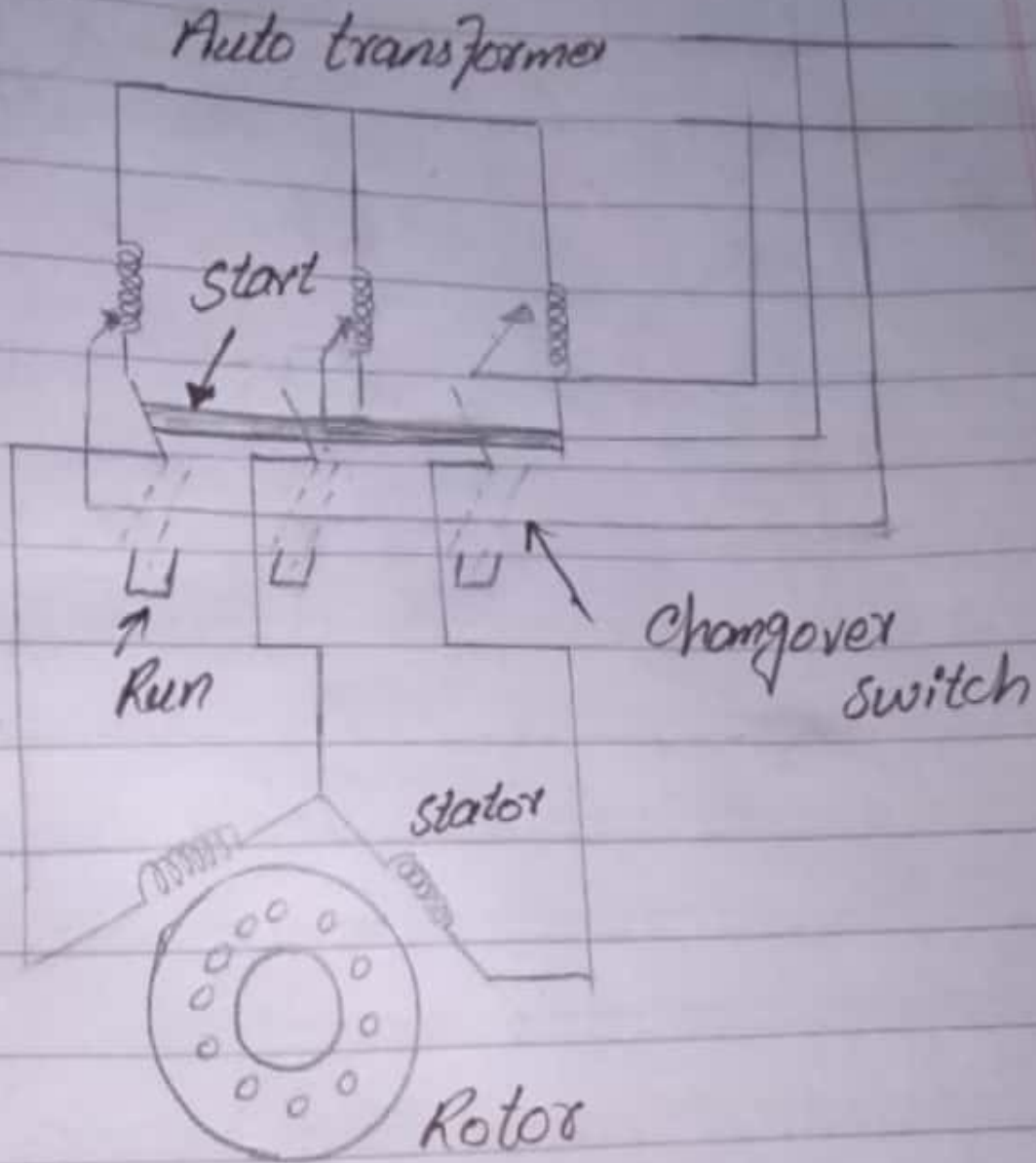
When the motor attains 80% of its rated speed, the changover switch is connected to run position automatically using relays.

Due to this, a rated voltage is then applied to motor.

The transformer are also provided with overload, non-load & time delay circuits.

# Auto-transformer Starter

3 $\phi$  supply





## 4 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  $s_r$  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 & the slip ring terminals are short circuited.

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# Rotor Impedance Starter:

