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Q No 1:- Write introduction, Advantages and disadvantages of 3- $\phi$  induction motor?

Ans:-

Introduction:

The popularity of 3-phase induction motor on board ships is because of their simple robust construction and high reliability factor in the sea environment - A 3- $\phi$  induction motor can be used for various application depending on the speed and load requirements.

Advantages:

- (i) It has simple and rugged construction.
- (ii) It is relatively cheap.
- (iii) It has self starting torque.
- (iv) It has high efficiency and reasonable good power factor.
- (v) It requires less maintenance.



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### Disadvantages:

(i) It is a constant speed motor and its speed cannot be changed easily.

(ii) Its starting torque is inferior to DC shunt motor.

### Construction:

The three phase induction motor is a widely used electrical motor. Almost 80% of mechanical power is used by the 3- $\phi$  induction motor.

The 3- $\phi$  induction motor has two main parts-

(i) Stator

(ii) Rotor

rotor is separated from the stator by a small gap which ranges from 0.4mm to 4mm, depending on the power of the motor.

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## Stator:

Stator is a stationary part of an induction motor. A stator winding is placed in the stator of the motor and the three phase supply is given to it. Stator is made up of number of stampings in which slots are cut to receive 3 phase winding circuit which is connected to 3 phase AC supply.

$$N_s = 120 f/p$$

$$N_s = \text{synchronous speed}$$

$$f = \text{frequency}$$

$$P = \text{no. of Poles}$$

## Stator frame and core:

It is the outer most part of a three phase induction motor. Its main function is to support the stator core and the field winding. While the stator core



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carrying order alternating flux - In order to reduce the eddy current losses - The stator core is laminated -

Field windings :

Three phase windings is supplied by three phase A.C supply - The squirrel cage motor is mostly started by star delta starter -

Rotor :

The rotating part of a induction motor and is connected to the mechanical load through the shaft -

Squirrel cage rotor -

The rotor of squirrel cage three phase induction motor is cylindrical in shape and having slots on its periphery. The slots are not made parallel to each other but a bit skewed -

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## Advantages of Squirrel cage induction:

- (i) As there are no brushes and slip rings, these motors requires less maintenance.
- (ii) Its construction is very simple and smooth.



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Q No 2:- Write operation,  
principle, and working  
of an induction motor.

Principle:-

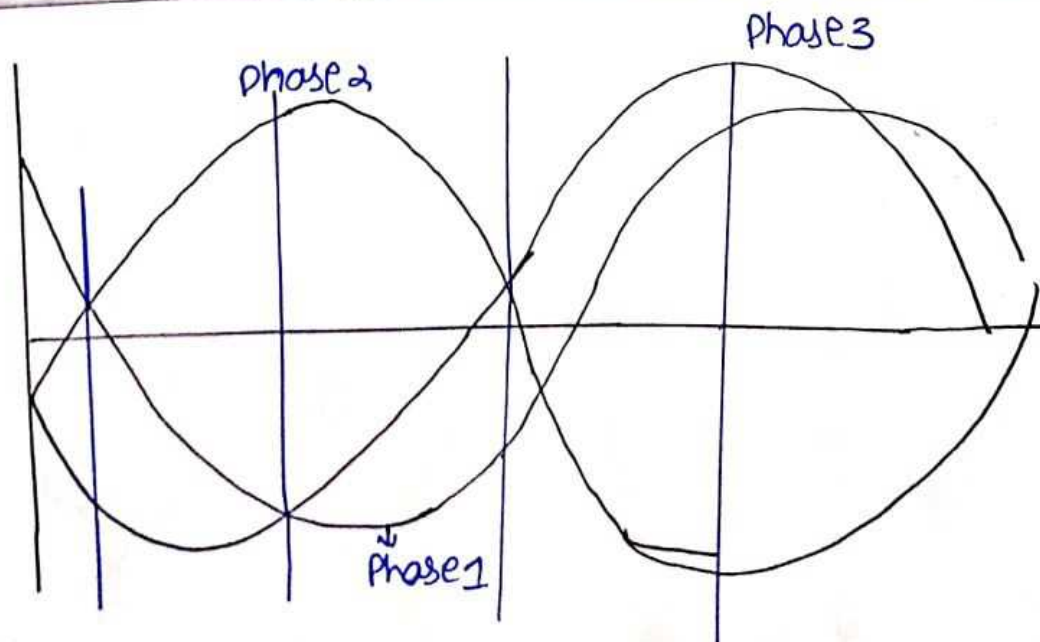
In an A.C motor, there is a ring of electromagnets arranged around the outside which designed a rotatory magnetic field. Inside a stator there is a solid metal axle a loop of wire a coil a squirrel cage made of metal bars and interconnections or some other freely rotating cages metal part that can conduct electricity unlike dc motor where you send power to the inner rotor in an A.C motor you send power to the outer coils are energized in pair of sequence, produces a magnetic field that rotates around the outside of the motor. The rotor is suspended inside the magnetic field.

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in an electrical conductor  
Electromagnetism is that an  
electric current inside the  
rotor if the conductor is  
a ring or a wire the  
current flows around it in  
a loop.

3- $\phi$  rotating fields.

Three phase induction motor  
also operates on the  
principle of a rotating  
magnetic field - The following  
discussion shows the stator  
windings can be connected  
through a three phase  
input and have a resultant  
magnetic field that rotates.





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The result of this analysis are shown for voltage point 1 through 7. At point 2 the magnetic field in coil 1 - 1A is maximum with polarities as shown above. At the same time negative voltages are being felt in the 2A and 3A windings -

This creates a strong magnetic field which in turn is aided by the weaker fields in 1 - 1A and 2 - 2A - As each point on the voltage graph is analyzed -



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Q No 3:- Discuss different types of starter for three phase induction motor?

Ans:-

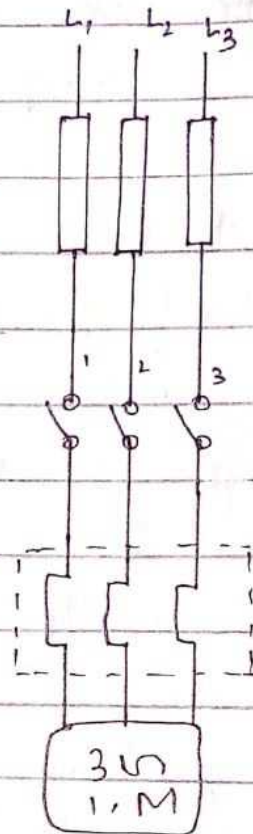
DOL (Direct online starter)

The direct online starter is the simplest and most inexpensive of all starting methods and is usually used for squirrel cage induction motor. It directly connects the contact of the motor to the full supply voltage. The starting current is very large about 6 to 8 times the rated current.

The starting torque is likely to be 0.75 to 2 ~~times~~ times the full load torque. In order to avoid excessive voltage drop in the supply line due to high starting current the DOL starter is used only with motors for a rotating of less than 5 KW. There are safety mechanism inside the motor to provide protection to the motor as well as the protection of the motor. The power and control circuits of induction motor with DOL starter and

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conductor size is shown below.



### Star-Delta starters:

It is a very common type of starter and extensively used compared to other starters. This method achieved low starting current by first connecting the stator winding in star configuration then after the motor reaches a certain speed through a switch changes the winding arrangements from star to

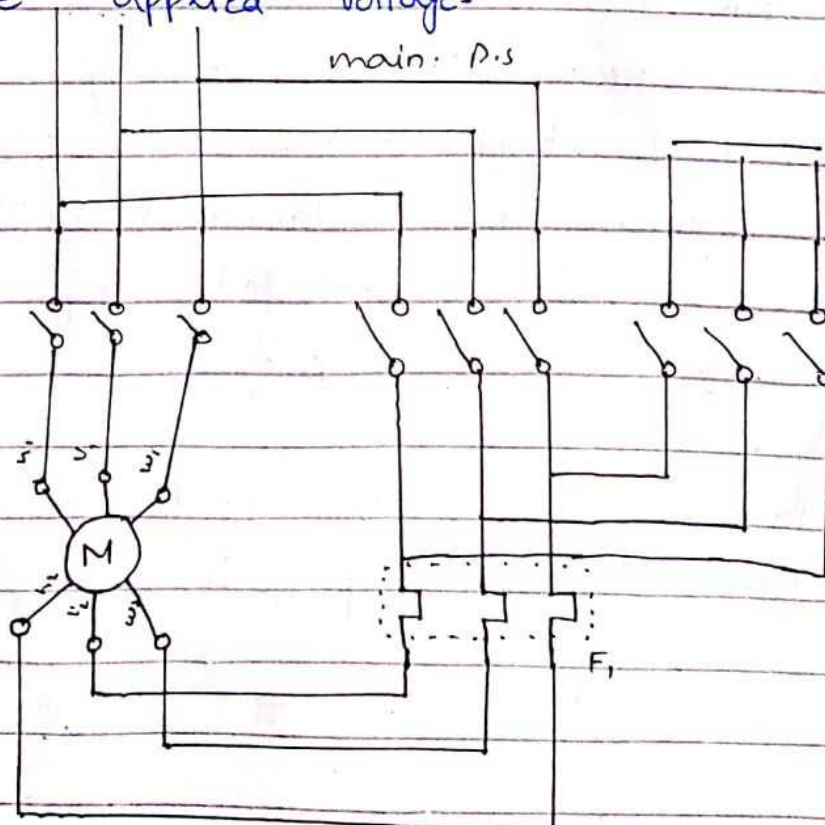


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delta configuration.

By connecting the stator winding first with star than delta, so, the starting current reduces to  $\frac{1}{3}$  as compared to connecting firstly stator winding to delta configuration.

All the time when stator windings are star connected each stator phase gets voltage  $\frac{V_L}{\sqrt{3}}$  where  $V_L$  is the line voltage. Since the torque developed by an induction motor is proportional to the square of the applied voltage.



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## Auto transformer Starter:

The operational principle of auto transformer method is similar to the star - Delta starter method.

The starting current is limited with 3- $\phi$  auto transformer, reduce the initial stator applied voltage.

The auto transformer starter method is most expensive and more complicated in its construction, when compared with the star - Delta connector method - But an auto transformer is suitable for both star and delta connectors - and the starting current and torque can be adjusted to the desired value, by taking the current tapping from auto transformer while the star - delta starter's voltage can be adjusted only by a factor of  $1/\sqrt{3}$ .

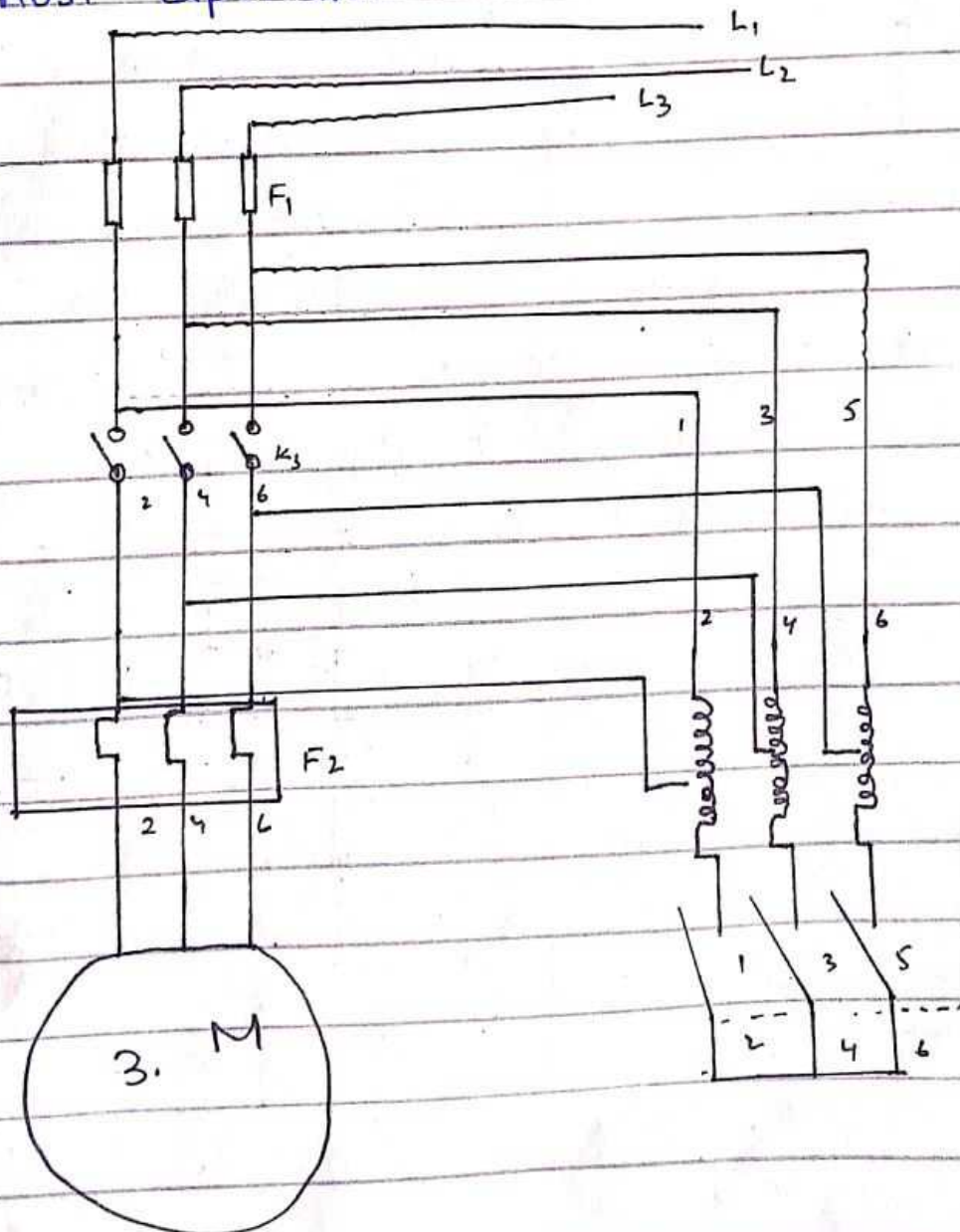
- 1- Operation by a two position switch manually or automatically by using timer to change.



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2- The starting position supply is connected to stator winding through an auto transformer which reduce applied voltage to 50 - 60% of normal value depending on tapping used.

3- Starters used in large industries because it is larger in size and most expensive.



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## Rotor Impedance starter:-

This method allows external resistance to be connected to the rotor through slip rings and brushes. Initially, the rotor resistance is set to be maximum and then gradually decrease as the motor speed increases it becomes zero.

The rotor impedance starting mechanism is bulky and expensive when compared with other methods.

It also have very high maintenance cost. Also a considerable amount of heat is generated through the resistors. When current runs through them, the starting is also limited in this method.

