Name: M. Zohaib Afzal

Roll: 12548

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Submitted To:
Sir Farhan Khalid

Assignment:
EET-402
Electrical Machines-II

GCUF.

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Question # 01: Write introduction, advantages, disadvantages and construction of Three phase Induction motor.

An electric motor is an electro-mechanical device which converts electrical energy into mechanical energy. In Case of three phase AC operation, The most wisedly used motor is a 3-Phase induction motor.

Introduction:

The Popularity of 3-ϕ induction motor on board Ships is because of their Simple, robust Construction and reliability factor in the few environment. A 3-ϕ induction motor can be used for different applications with various speed and load requirements. The 3-ϕ induction motor are the most widely use electric motor in industry. They run at essentialy Constant speed from no-load to full -load. However, The speed is frequency dependent and consequently these motor are not easily adopted To speed Control 3-ϕ Induction motor are simple rugged, Low priced, easy To maintain and can be manufactured with characteristics

To Suit most industrial required. Like any electric motor a 3-ϕ induction motor has a Stator and a Rotor.
The Stator Carries a 3-ϕ winding while the rotor Carries a Short Circuited winding. Only The Stator winding is fed from 3-ϕ Supply. The rotor winding drives in voltages and Power from the externally energized Stator winding through electromagnetic induction because the owes the name.

⇒ Advantages:

(i) It has Simple and rugged construction.
(ii) It is relatively cheap.
(iii) It requires little maintenance.
(iv) It has high efficiency and reasonbly good Power factor.
(v) It has Self starting Torque
(vi) The operation of 3-ϕ Induction motor is quite reliable.

Disadvantages:

(i) Speed Control of an induction motor not possible without Sacrifiancy its efficiency level.
(ii) Also the speed of the motor

decreases increasing mechanical load.

(iii) Its Starts Torque is a Little bit Lower Than that of a Dc Shunt motor.

Construction:

3-ϕ induction motor is the most widely used electrical motor Almost 80% of the mechanical Power used by industries is Provided by 3ϕ induction motor because of its simple and rugged construction absence of Commuter and good speed regulation. In 3-ϕ induction motor the Power is Transfarsed form stator To rotor winding through induction. The induction motor is also called asynchronous motor as it run at a Speed othes than the Synchronus speed like any electrical motor induction motor also have Two main points normally rotor & stator. A Three Phase induction motor has two main parts.

(i) Stator

(ii) Rotor

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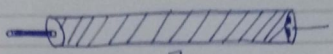
The rotor is separated from the stator by a small air-gap which ranges from 0.4mm to 4mm, depending on the power of the motor.



* Shaft for transmitting the torque to the load. This shaft mad up of Steal.
* Bearing for Supporting the rotating Shaft.
* One of the Problem with electrical motors is the production of heat during its rotation. In order to overcome this problem we need for fan Cooling.
* for reciving external electrical Connection terminal box in needed.
* These are a small distance between rotor and stator which usually varies from 0.4mm To 4mm. Such a distance

is called air-gap.

=> **Rotor:**

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

Rotor is consists of cylindrical laminated core with parallel slots that carry conductor bars. Conductors are heavy copper or aluminium bars which fit in each slots.

These conductors are brazed to the short circuiting end rings. The slots are not exactly made parallel to the axis of the shaft but are slotted a little skewed for the following reason.

There are two main types of a rotors:

(i) **Squirrel rotor:**

(ii) **Wound rotor:**

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(i) Squired Cage rotor:

The rotor of the Squiral Cage 3-p induction motor is Cylinchical in Shape & have 3 Lots on its Resphary. The Slots are not made Parallel to lach other but one bit Skewed as the Showing Prevents. Magnette locking of stator anel rotor teeth and make the wooking of motor more smooth and soft. The Squirel Cage rotor consists of a Luminum brass or Copper bass.

Adnulages:

* Its construction is very Simple anel rugged Jeel.

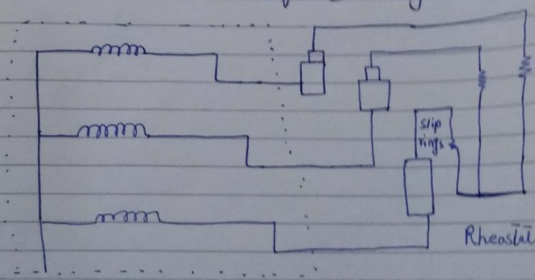
* As these are no brushes & slip rings These motor requires less maintenance.

Application:-

Squirel Cage induction motor is used in lathes, drilling machines, fan, blowers Printing machines etc.

Wound Rotor:-

Slip ring or wound three phase induction motor:
In this type of three phase induction motor the rotor is wound for the same number of poles as that of stator, but it has less no-of slots and has less turns per phase of a heavier conductor. The rotor also carries star or delta winding similar to that of stator winding. When the motor attains normal speed the three brushes are short circuited so that the wound rotor runs like a squirrel cage rotor.



Rotor winding

Advantages of Slip ring induction Motors:-

A:- It has high starting Torque and low starting current

B:- Possibility of adding additional resistance to control speed.

Application:

Slip ring induction motors are used where high starting Torque is required i.e in hoists, Cranes, elevators etc.

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Q No 2: Write operation Principle working of Three phase induction motor?

Operation Principle:

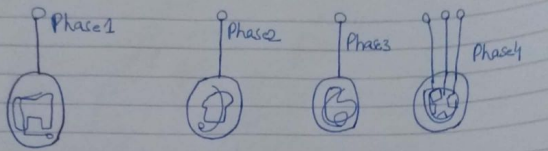
Unlike toys and flashlights most home offices, factories and other buildings are not powered by little batteries. They are not supplied with DC current but with alternating current (AC). which reverses its direction about 50 time per second (with frequency of 50Hz). If you want to run a motor from your household AC electricity supply instead of from a DC battery, you need a different design of motor.

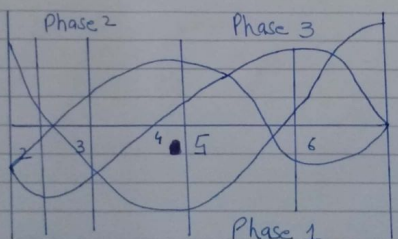
In an AC motor, there's a ring of electromagnets arranged around the outside which are designed to produce to rotating magnetic field. Inside the stator there is a solid metal axle a loop of wire a coil a squirrel cage made of metal bars and interconnections or some other fixely rotating cages.

metal part that can conduct electricity. Unlike in dc motors, where to you send power to the inner rotor, in an AC motor you send to power to outer coils that make-up the Stator. The coils are energized in pairs in sequence, producing a magnetic field that rotates around the outside of the motor the rotor suspended inside the magnetic field is an electrical conductor. The magnetic field is constantly changing. So, according to the law of electromagnetism an electric current inside the rotor. If the conductor is a ring or a wire, the current flows around it in a loop. If the conductor is simply a solid piece of metal eddy currents swirl around it instead. Either way the induced current produces its own magnetic field according to another law of electromagnetism (Lenz's law) tries to stop whatever it is that causes it - the rotating magnetic field by rotating as well.

Three-phase Rotating fields:

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





The result of this analysis are shown for voltage point 1 through 7 in figure 8.7. At point 1 the magnetic field in Coils 1.1A is maximum with polarities as shown. At the same time negative voltage are being felt in the 2A and 3A. windings. These create weaker magnetic fields which end to aid the 1-1A field. At Points, Maximum negative voltage is being felt in the 3-3A windings. These creates a strong magnetic field which is turn is aided by the weaker fields in 1-1A and 2-2A. As each point on the voltage graph is analyzed it can be seen that the resultant.

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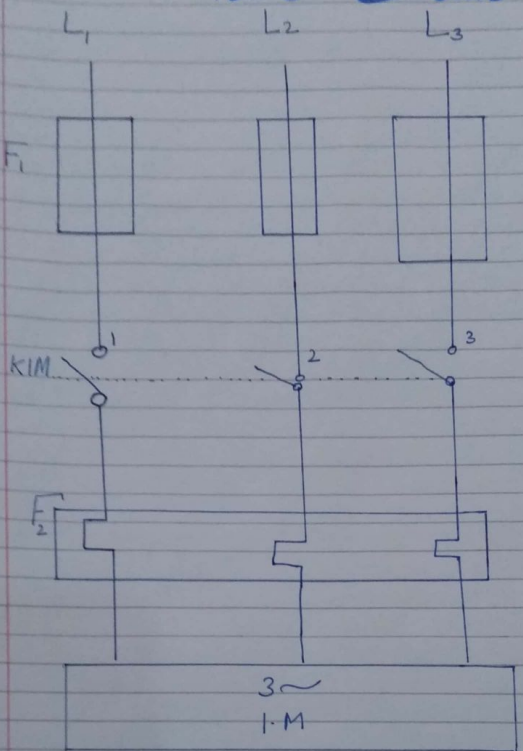
Q No. 3 Discuss different types of starter for three phase induction motor.

DOL (Direct on-line starter)

The Direct on line (DOL starter is the simplest and most inexpensive of all starting methods and is usually used for squirrel cage induction motors it directly connects the contacts of the motor to the full supply voltage. The starting current is very large, normally 6 to 8 times the rated current. The starting torque is likely to be 0.75 to 2 times the full load torque. In order to avoid excessive voltage drops in the supply line due to high starting currents, the DOL starter is used for motors with a rating of less than 5KW. There are safety mechanisms inside the DOL started which provides protection to the motor as well as the operator of the motor. The Power & control circuits of induction motor with DOL started and the picture of contactor are shown in fig.

(Fig 14) Power Circuit



Power Circuit

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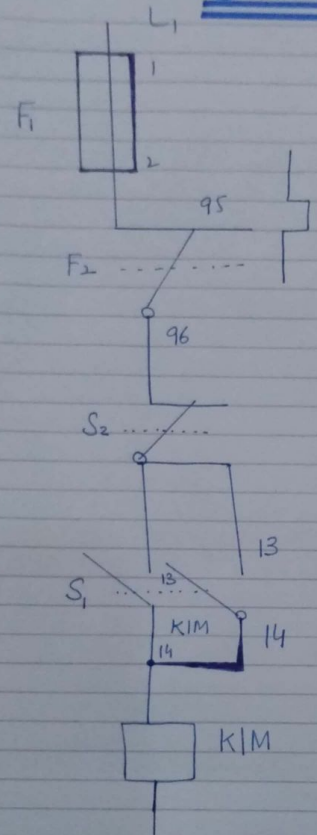
Control Circuit



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Star-Delta Starter:

The star delta starter is a very simple Common type of starter and extensively used compared To the other type of the starters. The method achived low starting current by first connecting the stator winding is star configuration and then after the motor reaches at certain speed, Throw Switch changes the winding arrangement from star to delta Configuration Connecting the starter windings. First on star and then in delta the line current drawn by the motor at starting in reduced to one third as compared to starting current will the winding connected in delta. AT the time of starting when the stator windings and star Connected each stator plane gets voltage $V_L/\sqrt{3}$ where V_L is the line voltage Since the torque developed by an inductive motor is Proportional to the square of the applied voltage Star-delta starting reduces the starting torque to one third that , obtained by direct delta starting.

Auto Transformer starter:

The operation principles of auto-transformer method is similar to the star delta starter method. The starting current is limited by (using a three phase auto transformer) reduce the initial stator applied voltage. The auto transformer starter is more expensive more complicated in operation and bulkier in construction when compared with star-delta starter method. But an auto transformer starter current is suitable for both star and delta connected motors. And the starting current & torque can be adjusted to a desired value by taking the current tapping from the auto transformer. When the star delta method is considered, voltage can be adjusted only by factor of $1/\sqrt{3}$.

1. Operation by a two position switch i.e manually/automatically using a time to change over from start to run position.

2:- In starting position supply is connected to stator windings through an auto transformer which reduced applied voltage to 50-60 and 70% of normal value depending on tapping used.

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3. Reduce voltage reduces current in motor. Winding with 50% Tapping used motor current is halved and supply current will be half of motor current.

4:- Starters used in larger industries it is larger in size and expensive.

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Rotor Impendance Starter

This method allows external resistance to be connected to the rotor through slip rings and brushes. Initially, the rotor resistance is set to maximum and is then gradually decreased as the motor speed increases until it becomes zero. The rotor impedance starting mechanism is usually very bulky and expensive when compared with other methods. It also have very high maintenance costs. Also a considerable amount of heat is generated through resistors. When current runs through them. The starting frequency is also limited in this method. However the rotor impedance method allows the motor to be started while on load. This will decrease the starting current, increase the starting torque and also improves the power factor. The circuit diagram, the three slip rings shown are connecting to the rotor terminals of the wound rotor motor. At the time, of starting of the motor, the entire external resistance is added in the rotor circuit.

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Than, the external rotor resistance is decreased in steps as the rotor speeds up. However the motor torque remain maximum during the acceleration period of the motor under normal condition when the motor develops load torque the external resistance is removed.