Assignment #1

Subject:

Electrical Machines 2 (Ac Machines)

Instructor:

Sir Farhan

Program:

BSc. Electrical Engineering Tech.

Semester:

4th

Submitted from:

Salman Arshad

Roll #

12541

Question # 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 and load requirments. Electric motors can be found in almost every Production Process today. The Three-Phase induction motors are the most widely used electric motor in 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. we usually Prefer d.c. motors when large speed variations are required. Nevertheless, the 3-Phase induction motors are simple, rugged, low-Priced, easy to maintain and can be manufactured with characteristics to suit most industrial requirement.

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.

Disadvantages

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

Construction

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.

In three phase induction motor the power is transferred from stator to rotor winding through induction, its also called asynchronous motor. A 3-phase induction motor has two main parts (i) stator and (ii) rotor. The rotor is separated from the stator by a small air-gap which ranges from .4mm to 4mm, depending on the power of the motor. induction motor has two main part.

Stator:

As its name indicates stator is a stationary Part of induction motor. A stator winding is Placed in the stator of induction motor and the three Phase supply is given to it. stator is made up of number of stampings in which different slots are cut to receive 3 Phase winding circuit which is connected to 3 Phase AC supply. The three Phase windings are arranged in such a manner in the slots that they Produce a rotating magnetic field after AC supply is given to them. The windings are wound for a definite number of Poles depending upon the speed requirment. it consists of a steel frame which encloses a hallow, cylindrical core made up of thin laminations of silicon steel to reduce hysteresis and eddy current loses. when 3-Phase supply is given to the stator winding, a rotating magnetic field of constant magnitude is Produced. This rotating field induces currents in the rotor by electromagnetic induction.

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 Parallel slots that carry conductor bar. Conductors are heavy copper or aluminium bars with fits in each slots. These conductor 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. They reduces magnetic hum or noise and They avoid stalling of motor. The rotor, mounted on a shaft, is a hallow laminated core having slots on its outer Periphery. The winding Place in these slots (called rotor winding) may be one of the following two types:

Squirrel cage type, wound type

Question No 2:

Write operation Principal (working) of three Phase induction Motor.

operation Principle

In an AC motor, there's a ring of electromagnets arranged around the outside making up the stator), which are designed to Produce a rotating mangnetic field. The coil 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, the magnetic field Produces an electric current inside the rotor. the induced current Produces its own magnetic field and 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.

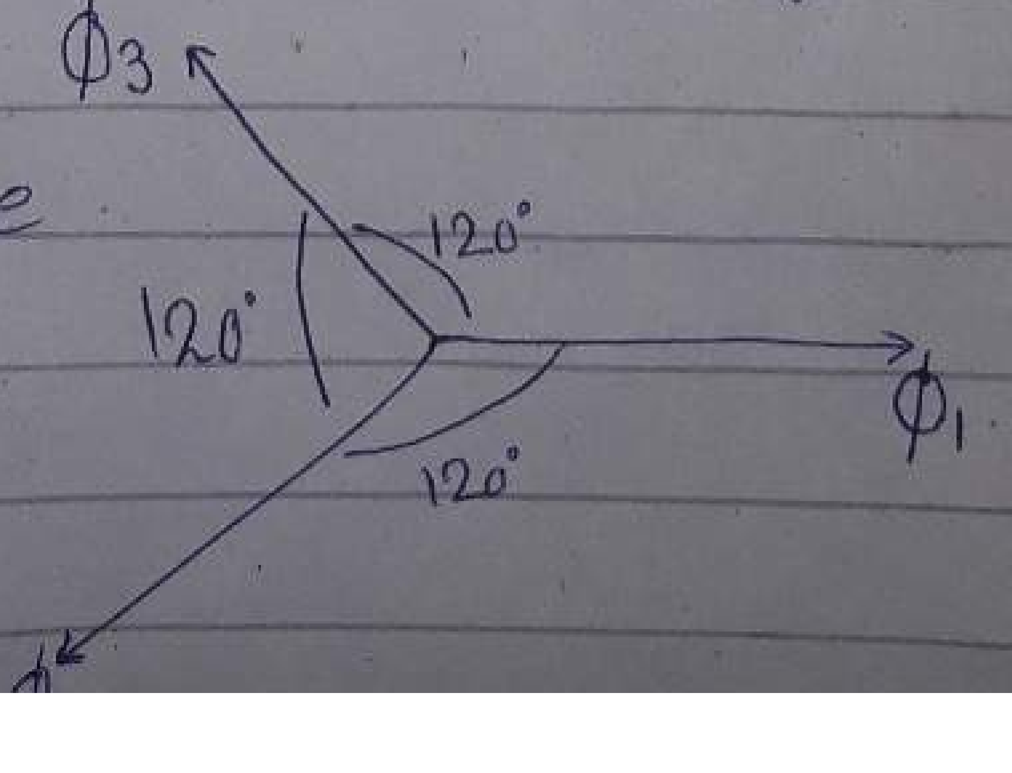
In A 3Phase motor field is such that its Poles do no remain in a fixed Position on the Stator but go on shifting their Positions around the stator for this reason, it is called a rotating field. it can be shown thet magnitude of this rotating field is constant and

and is equal to 1.5 ϕ_m where ϕ_m is the maximum flux due to any Phase. Consider a three Phase winding displaced in a space by 120°. Supplied by three Phase A.C supply. The three Phase current are also displaced from each other by 120°. The flux each Phase current is also sinusoidal in nature and all three flux are separated from each other by 120°. if the Phase sequence of winding is 1-2-3, then the mathematical equation for the instantaneous values of the fluxes ϕ_1, ϕ_2, ϕ_3 can be given as:

$$\phi_1 = \phi_m \sin(wt) = \phi_m \sin\phi$$
$$\phi_2 = \phi_m \sin(wt - 120°) = \phi_m \sin(\phi - 120°)$$
$$\phi_3 = \phi_m \sin(wt - 240°) = \phi_m \sin(\phi - 240°)$$

Assume Positive direction mean whenever the instantaneous value of the flux is Positive vector diagram is must be represented along its assumed Positive direction, and if flux has negative instantaneous value then must be represented in Positive to the assumed Positive direction, in vector diagram.

Assumed Positive direction



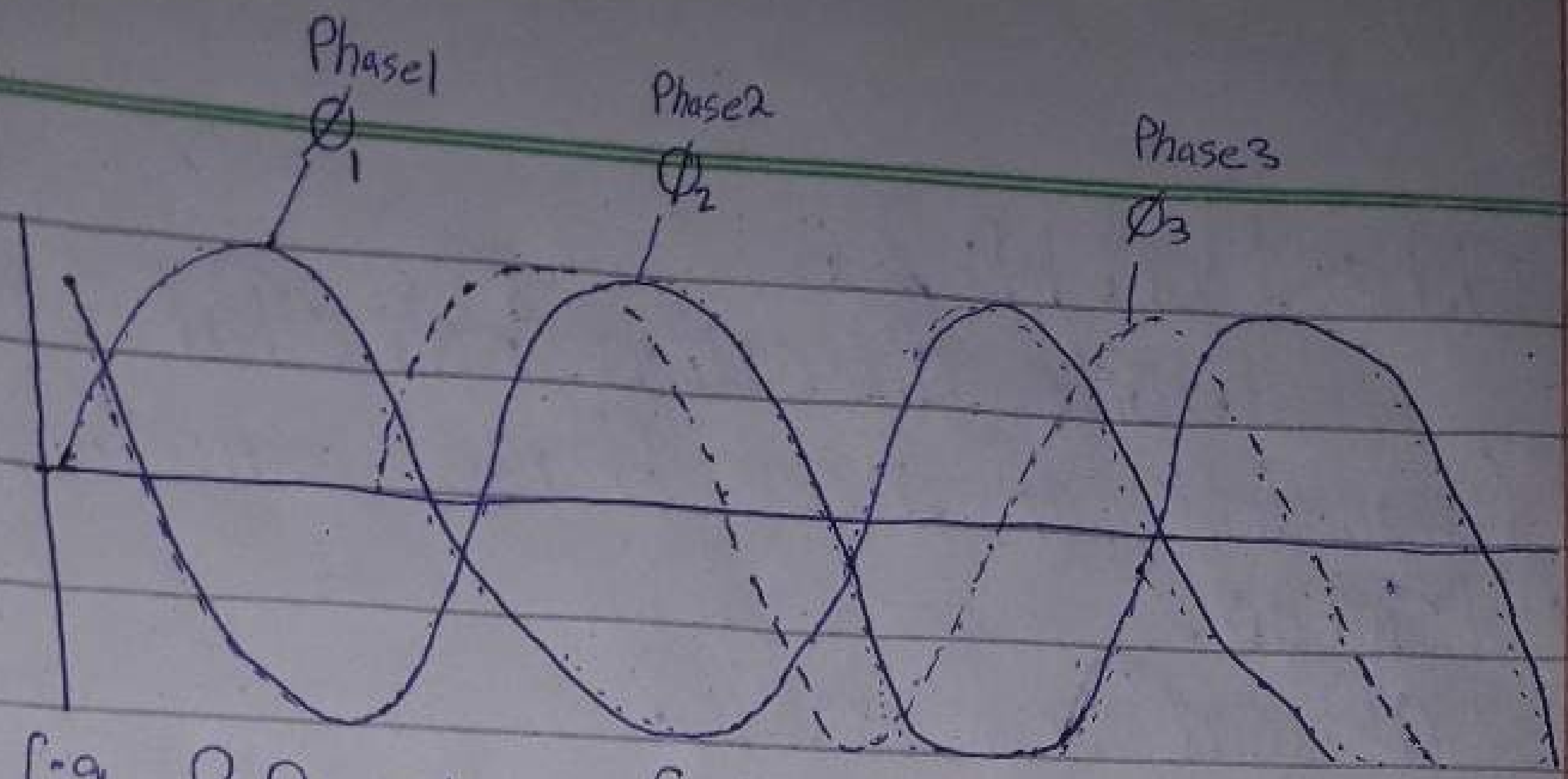


fig 8.9 Wave from three fluxes

Let ϕ_1, ϕ_2, ϕ_3 be the instantaneous value of the fluxes. The resultant flux ϕ_T, let us find out ϕ_T at four different instant 1,2,3 as shown in figure 8.9 respectively at $\theta = wt = 0°, 60°, 120°$ and $180°$.

Case 1 : when $\theta = 0°$

$$\phi_1 = \phi_m \sin(wt) = \phi_m \sin 0° = 0$$

$$\phi_2 = \phi_m \sin(wt - 120°) = \phi_m \sin(0° - 120°) = -0.866\,\phi_m$$

$$\phi_3 = \phi_m \sin(wt - 240°) = \phi_m \sin(0° - 240°) = .866\,\phi_m$$

$$\phi_T = \phi_1 + \phi_2 + \phi_3 = 1.5\,\phi_m$$

Case 2 : $\theta = 60°$

$$\phi_1 = \phi_m \sin(wt) = \phi_m \sin 60° = .866\,\phi_m$$

$$\phi_2 = \phi_m \sin(wt - 120°) = \phi_m \sin(60 - 120°) = -0.866\,\phi_m$$

$$\phi_3 = \phi_m \sin(wt - 240°) = \phi_m \sin(60° - 240°) = 0$$

$$\phi_T = \phi_1 + \phi_2 + \phi_3 = 1.5\,\phi_m$$

Case 3:

$\phi_1 = \phi_m \sin(wt) = \phi_m \sin 180^\circ = 0$

$\phi_2 = \phi_m \sin(wt - 120^\circ) = \phi_m \sin(180^\circ - 120^\circ) = .866\,\phi_m$

$\phi_3 = \phi_m \sin(wt - 240^\circ) = \phi \sin(180 - 240^\circ)$

$= -0.866\,\phi_m$

$\phi_T = \phi_1 + \phi_2 + \phi_3$

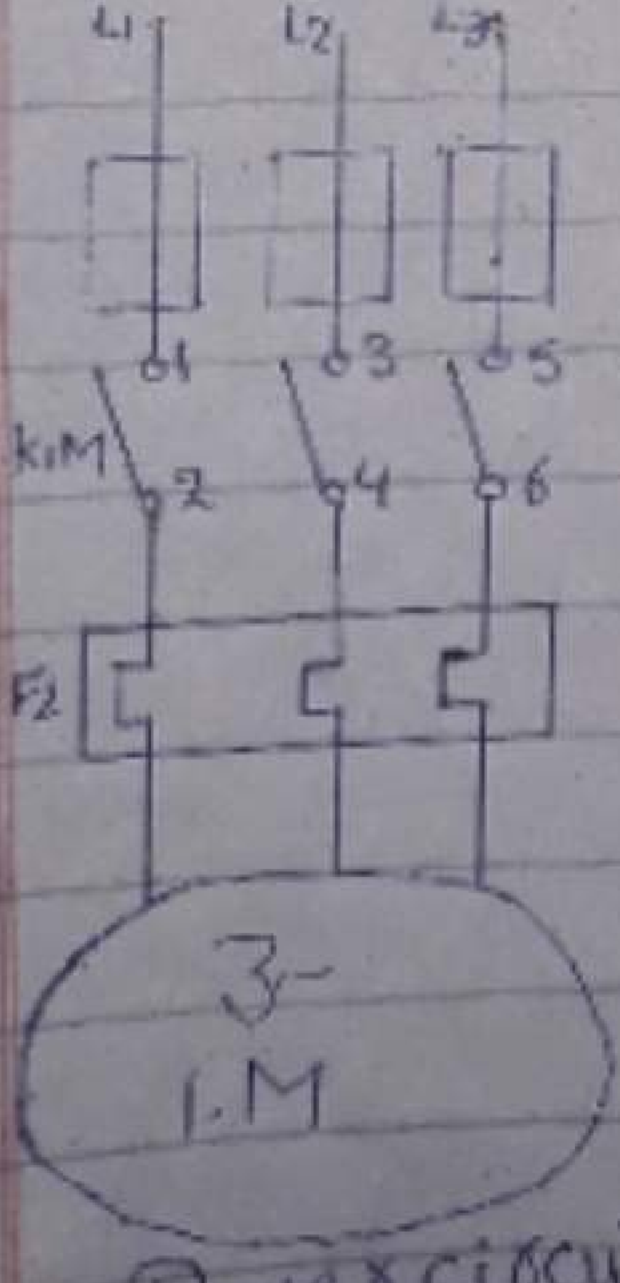
$\phi_T = 1.5\,\phi_m$

Question # 3

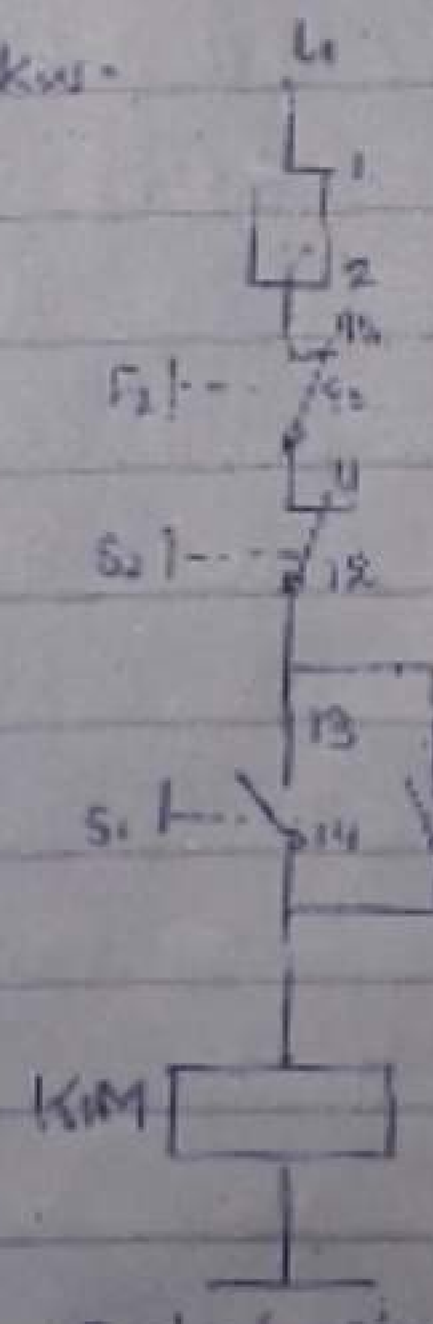
Discuss different types of Starter for three Phase induction motor.

Direct on-Line Starter.

The Direct on-Line starter is the simplest and the 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 .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 only for motors with a rating of less than 5kw.



Power circuit



Control circuit

The DOL starter consists of a coil operated contactor KIM controlled by starter and stop push buttons. On pressing the start push button S1, the contactor coil KIM is energized from line L1. The three main contacts (1-2), (3-4) and (5-6) are closed. The motor is thus connected to the supply. When the stop push button S2 is pressed, the supply through the contactor KIM is disconnected. Since the KIM is de-energized, the main contacts (1-2), (3-4) and (5-6) are opened. The supply to motor is disconnected and the motor stops.

Star-Delta Starter-

The star delta starting is a very common type of starter and extensively used compared to the other types of the starters. This method used reduced supply voltage in starting. Figure shows the connection of a 3 phase motor with a star-delta starter. The method achieved low starting current by first connecting the stator winding in star configuration, and then after the motor reaches a certain speed, throw switch changes the winding arrangements from star to delta configuration. The line current drawn by the motor at starting is reduced to one-third as compared to starting current with the windings connected in delta. At the time of starting when the stator windings are start connected, each stator phase gets voltage $V_L/\sqrt{3}$, where V_L is the line voltage. since the torque developed by an induction motor is proportional to the square of the applied voltage, star-delta starting reduced the starting torque to one-third that obtainable by direct delta starting.

Auto Transformer Starter.

The operation principle 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 the star-delta starter method. But an auto transformer starter is suitable for both star and delta connected motors, and the starting current and torque can be adjusted to a desired value by taking the correct tapping from the auto transformer. when the star delta method is considered, voltage can be adjusted only by factor of $1/\sqrt{3}$.

It can brief operation of auto transformer as:

1) operation by a two position switch ie. manually/ automatically using a timer to change over from start to run position.

2.) In starting position supply is connected to stator windings through an autotransformer which reduces applied voltage to 50, 60, and 70% of normal value depending on tapping used.

3) Reduced Voltage reduce current in motor winding with 50% tapping used motor current is halved and supply current will be half of the motor current.

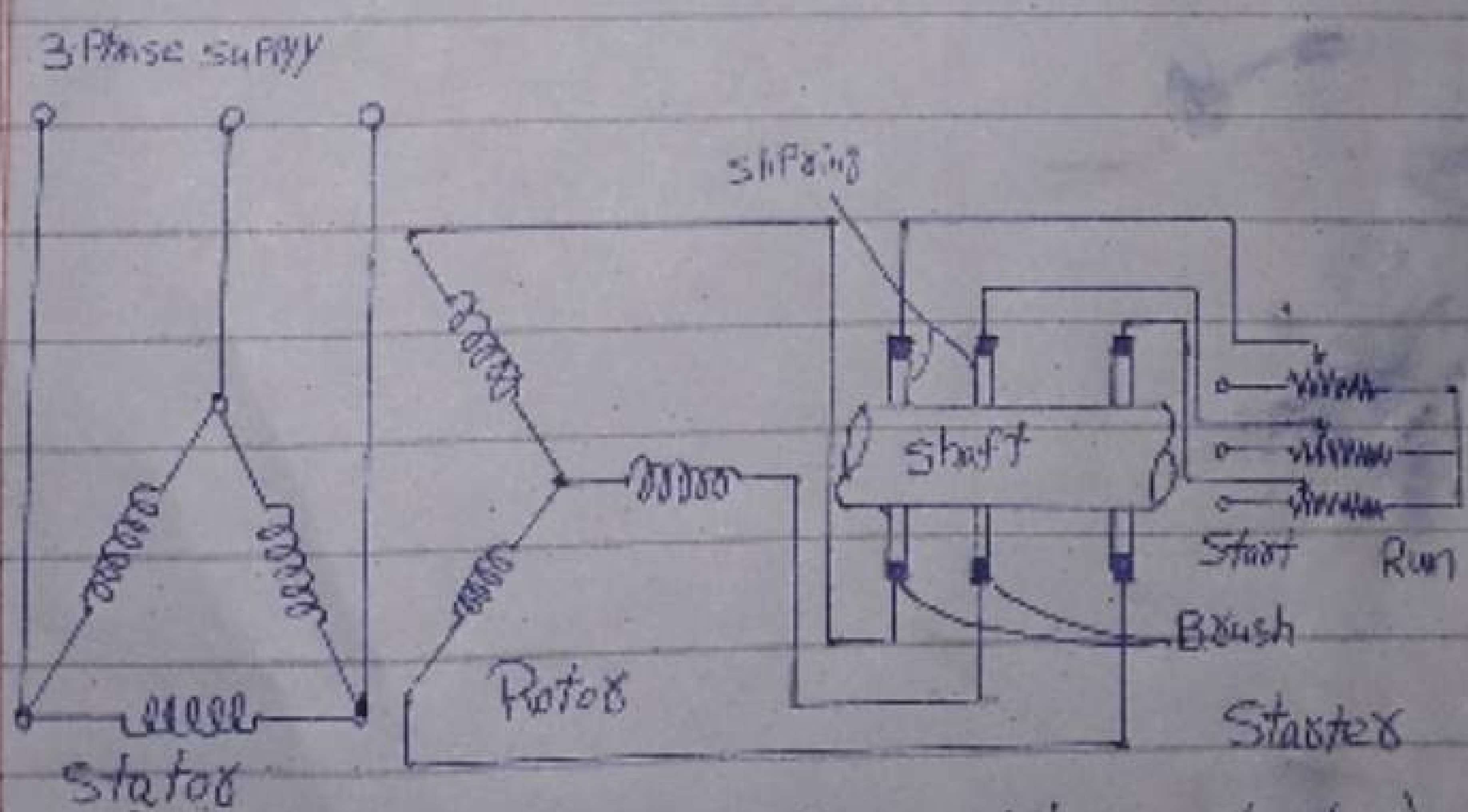
4) For an induction motor, torque T is developed by V2 thus on 50% tapping, torque at starting is only (.5V)^2 of the obtained by DoL starting. Hence 25% torque is produced.

5) Starters used in larger industries. it is larger in size and expensive.

6) switching from start to run position causing transient current, which can be greater in value than those obtained by DoL starting.

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 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 method. it also has very high maintenance costs. Also, a considerable amount of heat is generated through the 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.



(induction motor with rotor resistance starter)

This will decrease the starting current, increase the starting torque and also improves the power factor.

In the circuit diagram, the three slip rings shown are connected 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. Then the external rotor resistance is decreased in steps as the rotor speed 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.