Q 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 3phase induction motor can be used fordifferent applications with various speed and load requirements. Electric motors canbe found in almost every production process today. Getting the most out of your application is becoming more and more important in order to ensure cost-effective operations. The three-phase induction motors are the most widely used electric motors in industry. They run 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 requirements. Like any electric motor, a 3-phase induction motor has a stator and a rotor. The stator carries a 3-phase winding (called stator winding) while the rotor carries a short-circuited winding (called rotor winding). Only the stator winding is fed from 3-phase supply. The rotor winding derives its voltage and power from the extremely energized stator winding through electromagnetic induction and hence the name. The induction motor may be considered to be a transformer with a rotating secondary and its can, therefore, be considered as a "transformer type" a.c

DATE MONTH YEAR

machine in which electrical energy is converted into mechanical energy.

Advantages:-

i) It has simple and rugged construction

ii) It is relatively cheap

iii) It requires little maintenance

iv) It has high efficiency and reasonably good power factor

v) It has self-starting torque.

Disadvantages:-

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

ii) Its starting torque is inferior to d.c. shunt motor.

Construction.

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 because of its simple and rugged construction, low cost, good operating characteristics, absence of commutator and good speed regulation. In three phase induction motor the power is transferred from stator to rotor winding through induction. The induction motor is also called asychronous motor as it runs at a speed other than the sychronous speed. Like any other electrical motor induction motor also have two main parts namely rotor and stator. 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 0.4mm to 4mm, depending on the power of the motor.

DATE MONTH YEAR

The motor main body of the induction Motor comprises of two major parts as shows in Figure 1:

i) Shaft for transmitting the torque to the load. This shaft is made up of steel.

ii) Bearings for supporting the rotating shaft.

iii) One of the problems with electrical motor is the production of heat during its rotating. In order to overcome this problem we need fan for cooling.

iv) For receving external electrical connection Terminal box is needed.

v) There is a small distance between rotor and stator which usually varies from 0.4mm to 4mm Such a distance is called air gap.

Q No 2.

Write operation principal (working) of the Three phase Induction Motor.

Unlike toys

Operation principle:-

Unlike toys and flashlights, most home, offices, factories, and other buildings are not powered by little batteries: they are supplied with DC current, but with alternating current (AC) which reverses its direction about 50 times per second (with a 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.

DATE MONTH YEAR

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 magnetic field. Inside the stator, there's a solid metal axle, a loop of wire, a coil, a squirrel cage made of metal bars and interconnections (like the rotating cages people sometimes get to amuse pet mice), or some other freely rotating metal part that can conduct electricity. Unlike in a DC motor, where you send power to the inner rotor, in an AC motor you send power to the outer coils that makes 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 (because it's rotating) So, according to the laws of electromagnetism (Faraday's own term) 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 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. (You can think of the rotor frantically trying to "catch up" with the rotating magnetic field in an effort to eliminate the different in motion between them) Electromagnetic induction is the key to why a motor like this spins and that's why it's called an induction motor. An electrical converts electrical energy into mechanical energy which is then the supplied to different types of loads.

DATE MONTH YEAR

A.C motors operates on A.C supply. and they are classified into synchronous, single phase induction motors are most widely used for industrial applications mainly because they do not require a starting device. three phase induction motor derives its name from the fact that the rotor current is induced by the magnetic field, instead of electrical connection. The operation principle of a three phase induction motors is based on the production of rotating magnetic field.

Q No 3

Discuss different types of starter for three phase induction Motor

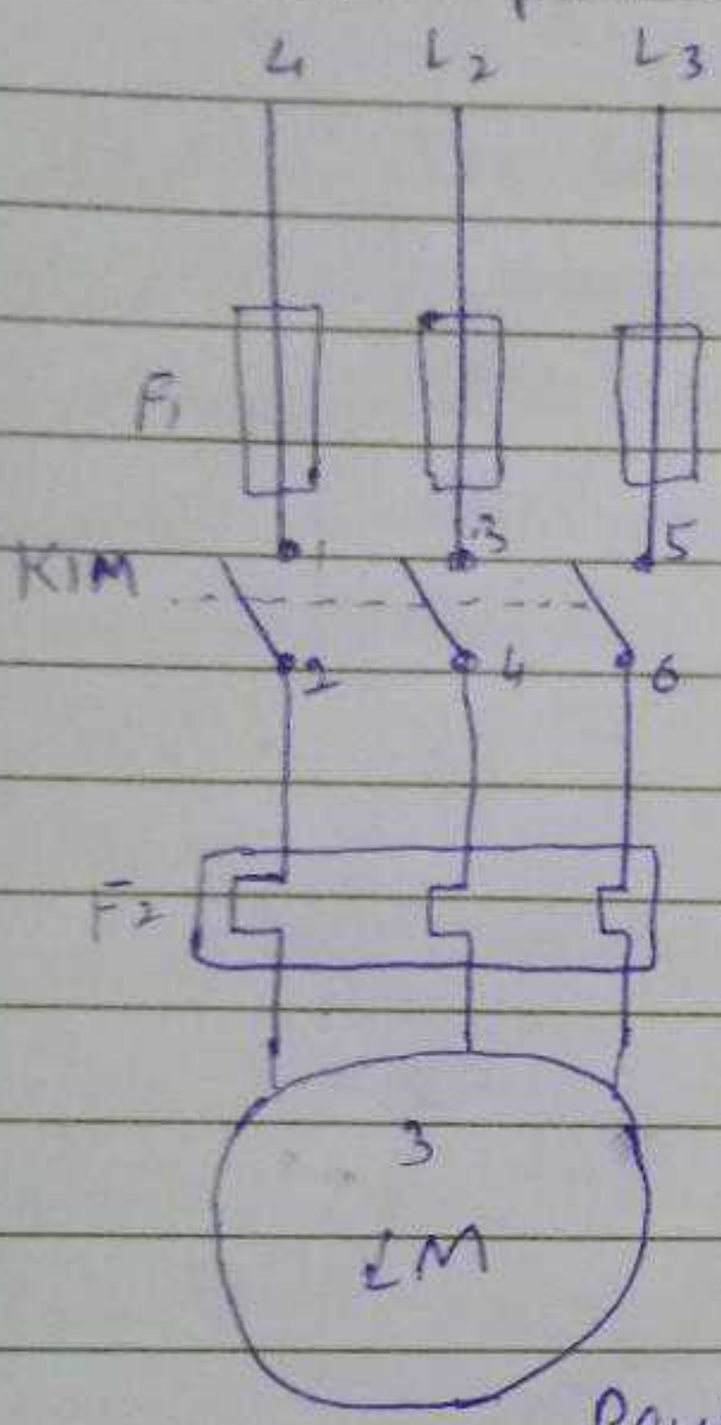
i) Direct On-Line starter (DOL)
ii) Star-Delta starter
iii) Auto Transformer starter
iv) Rotor Impedance starter.

(i) Direct On-line Starter (DOL)

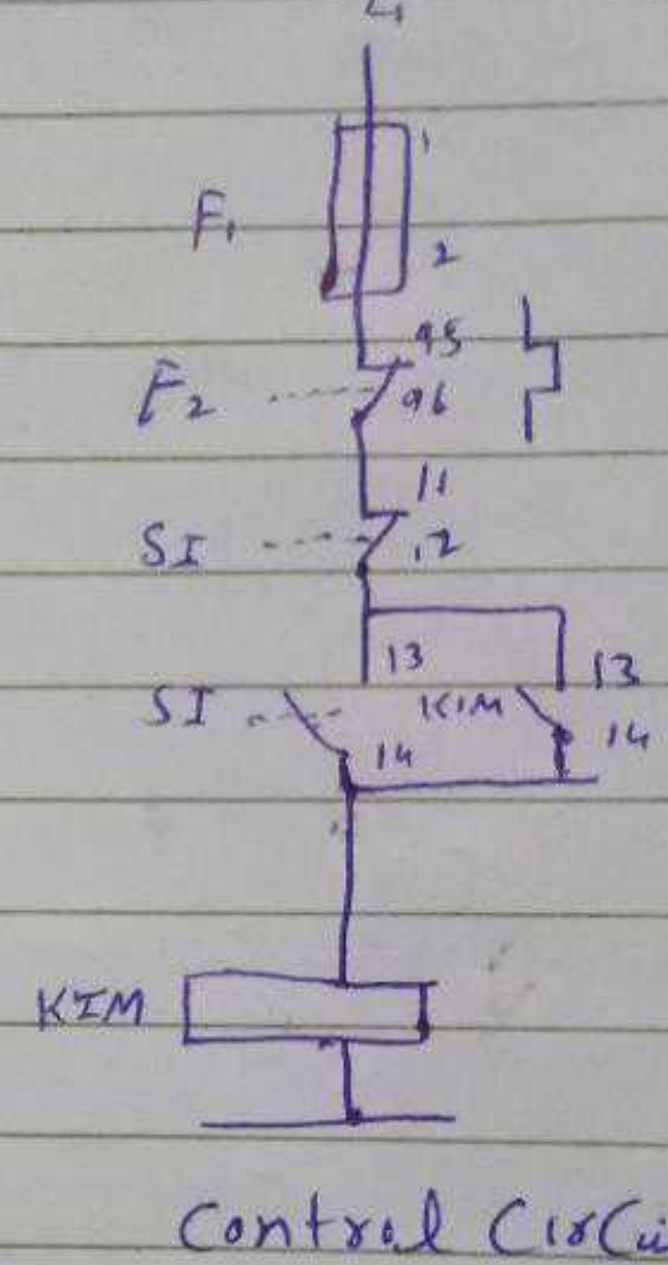
The Direct On-Line (DOL) starter is the simplest and the most inexpensive of all starting methods and is usually used for squirrel cage induction motors. It directly connects the contacts of the motor to the full supply voltage. The starting torque is likely to be 0.75 to 2 times the full load torque. In order to avoid excessive voltage droops 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 machanisms inside the DOL stater which provides protection to the motor as well as the operator of the motor. The power and control circuits of induction motor with DOL starter

DATE MONTH YEAR

and the real picture of contactor.



Power Circuit.



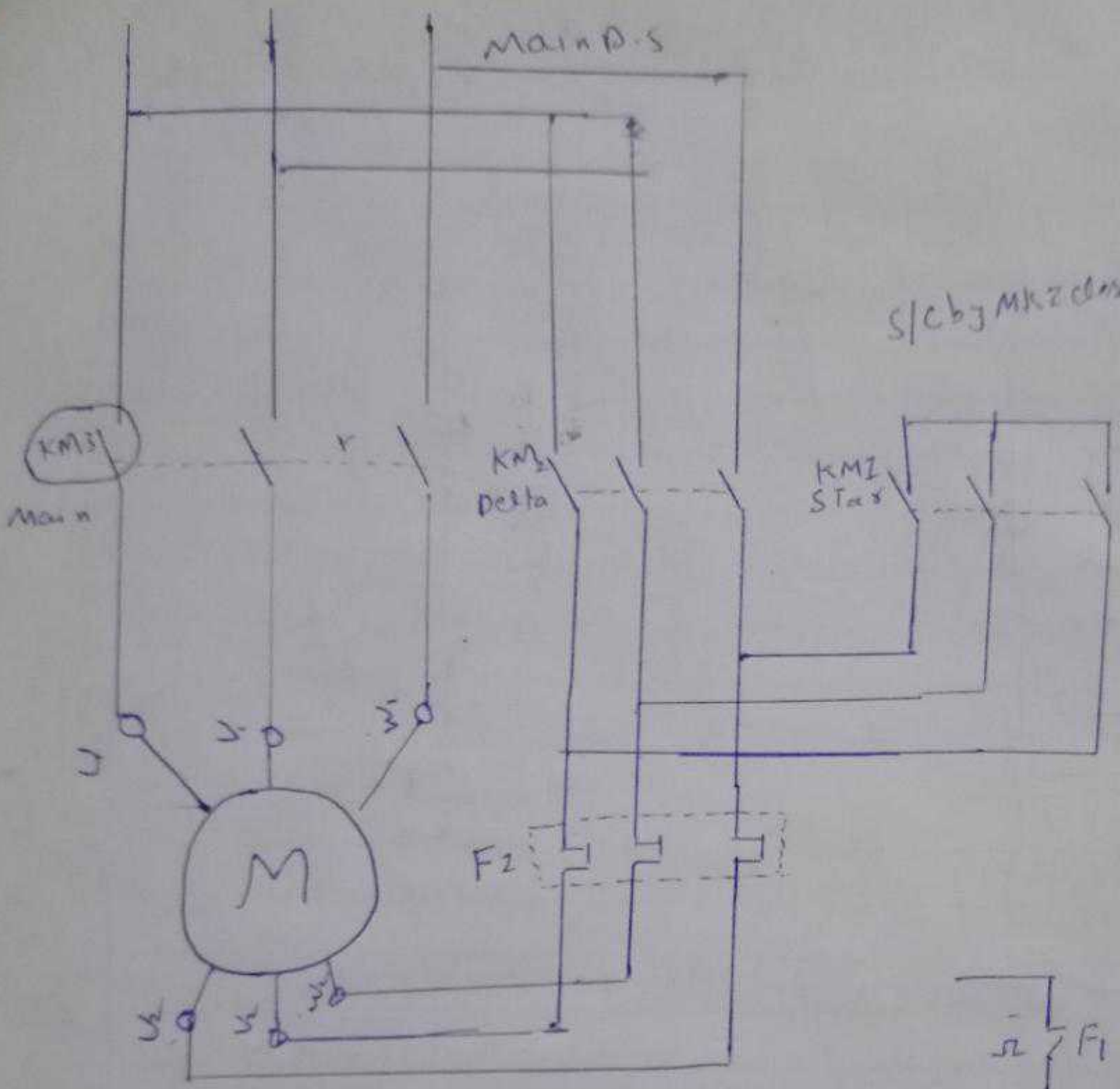
Control Circuit

The DOL starter consists of a coil operated contactor KIM controlled by start and stop push buttons. On pressing the start push button S1, the contactor coil KIM is energized from line L1. The three mains 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 ~~operated~~ opened. The supply to motor is disconnected and the motor stops.

DATE MONTH YEAR

Star-Delta starter:-

The star delta starting is a very common type of starter and extensively used compared to the other types of the starts. This method used reduced supply voltage in starting the connection of a 3 phase induction 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 configration. By switch changes connecting the stator windinge, first in star and then in delta, 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 voltages $V_L/\sqrt{3}$ 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.



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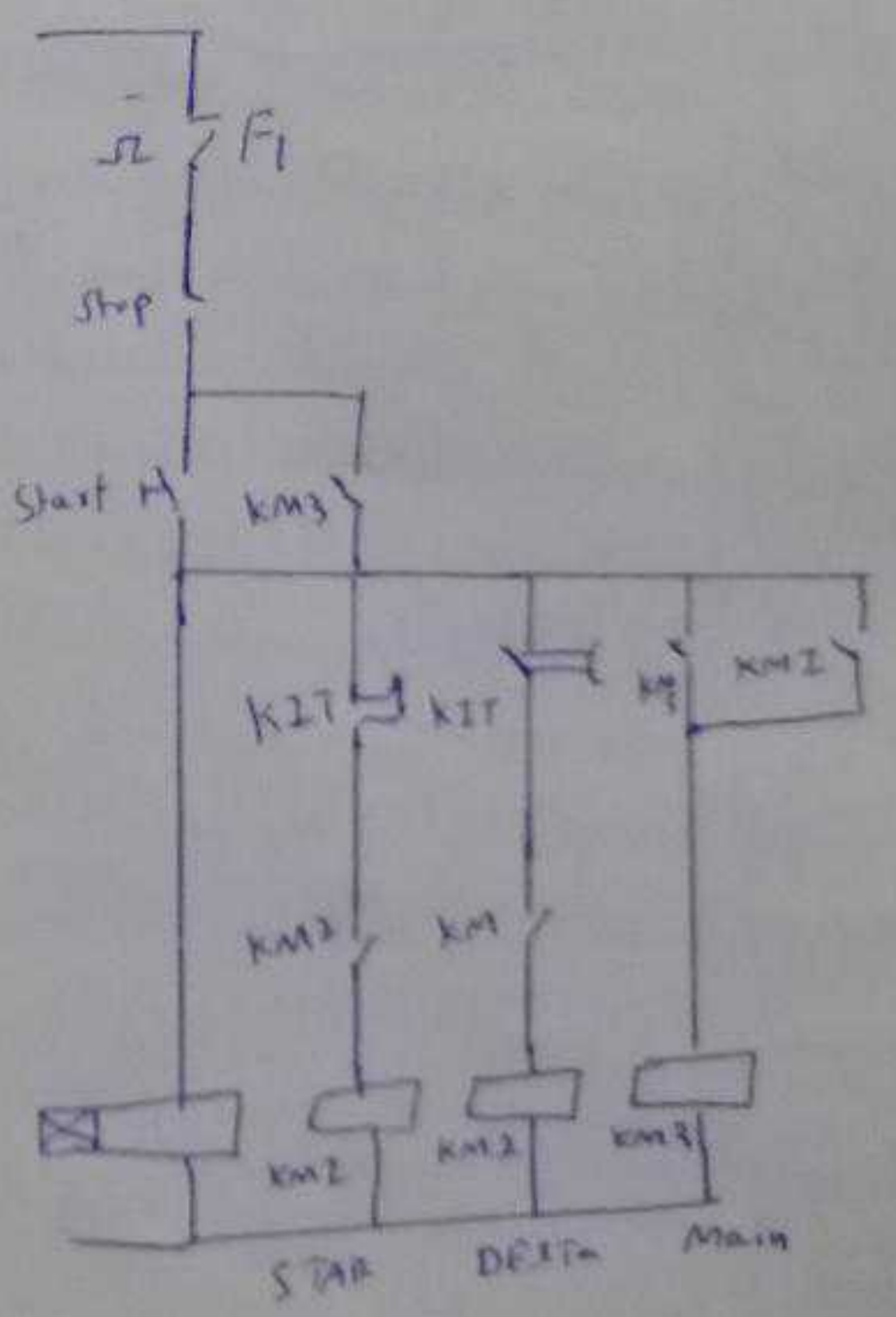
Power and Circuit of three phase induction motor with star delta starter



DATE MONTH YEAR

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 $1/\sqrt{3}$

the connection of a 3phase induction motor with auto transformer starter. It can brief operation of auto transformer as:-

1:- Operated by a two position switch i.e 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 auto transformer which reduces applied voltage to 50, 60 and 70% of normal value depending on tapping used.

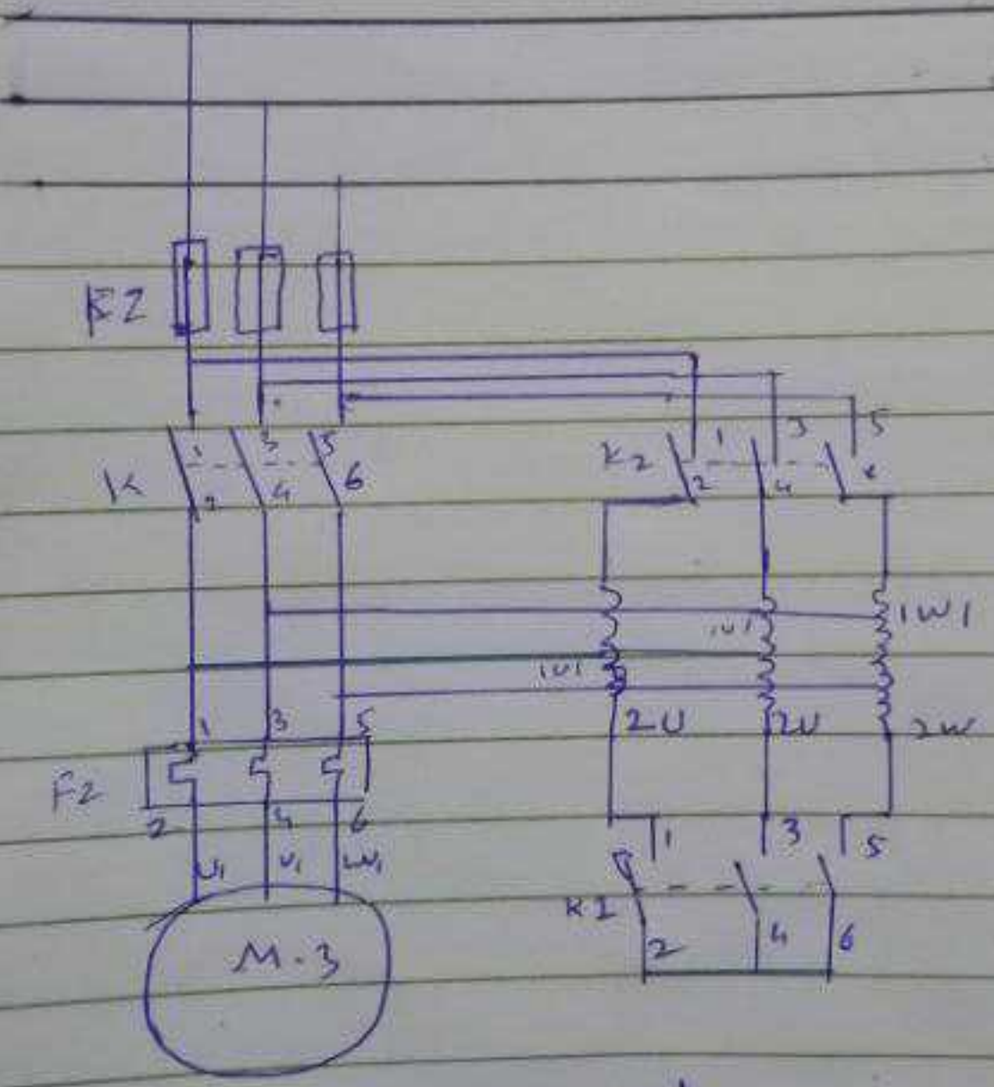
3. Reduced voltage reduces current in motor windings with 50% tapping used motor current is halved and supply current will be half of the motor current. Thus starting current taken from supply will only be 25% of the taken by DOL starter.

4. For an induction motor, torque T is developed by V^2, thus on 50% tapping, torque at starting is only $(0.5V)^2$ of the obtained by DOL starting. Hence 25% torque is produced.

DATE MONTH YEAR

5. Stastess used in larger industries, it is larger in size and expensive

6:- Switching from start to run positions causing transient current which can be greater in value than those obtained by DOL starting.



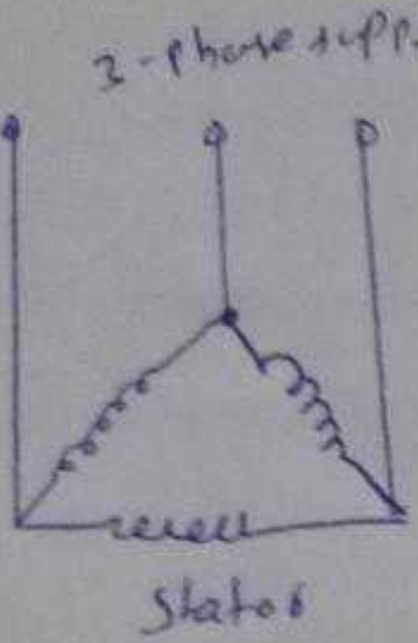
Main Circuit.

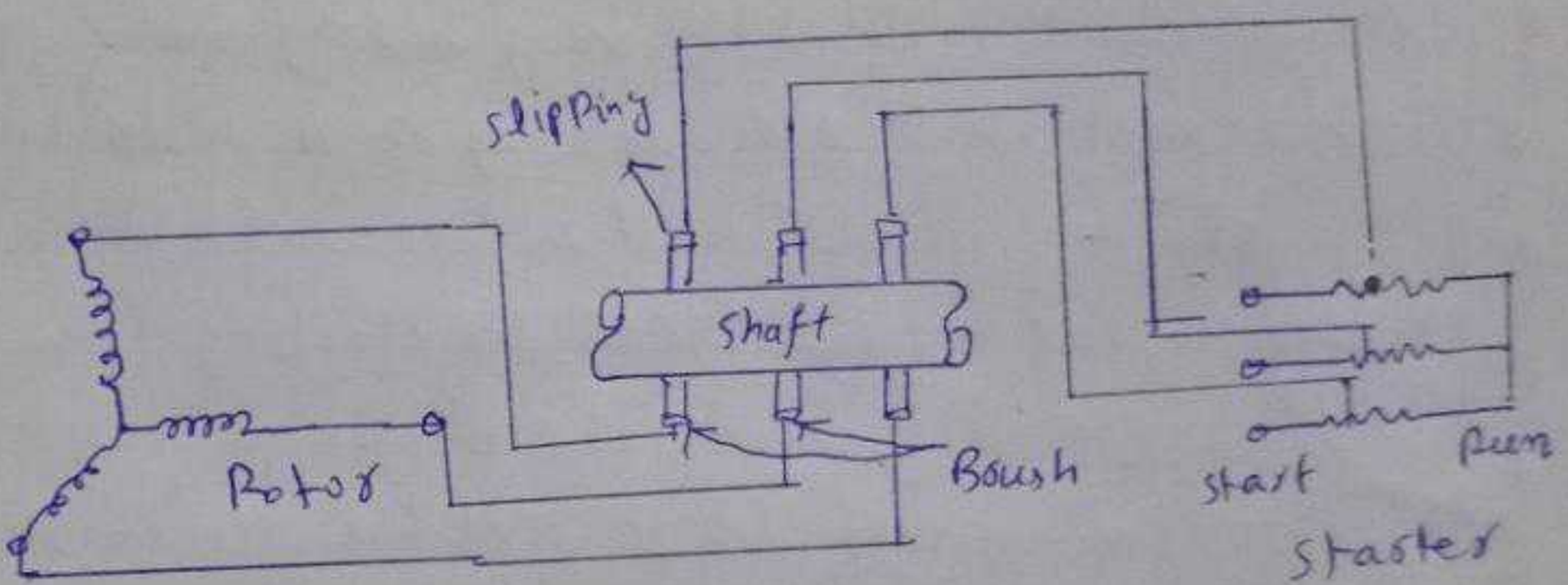
DATE MONTH YEAR

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 decrease 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 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. The connection of a 3phase induction motor with rotor resistance starter.

This will decrease the starting current, increase the starting torque and also improves the power factor. The circuit diagram is shown below. In the circuit digram, 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 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.





Induction motor with rotor resistance staster