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 applications with various speed and load requirements. Electric motors can be 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. The run at essentially constant speed from no-load to full-load. However, the speed is frequency depended 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 price, 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 carris a 3-phase winding (called rotor 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 externally energized stator winding through electromagnetic induction and hence the name. The induction motors may be considered to be a transformer with a rotating secondary. and it can, therfore, be described as a "transformer type" a.c. 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 It speed cannot be changed easily.

(II) It starting torque is inferior to d.c. shunt motor.

* Construction.

The three phase induction motor Is the most widely used electrical motor.

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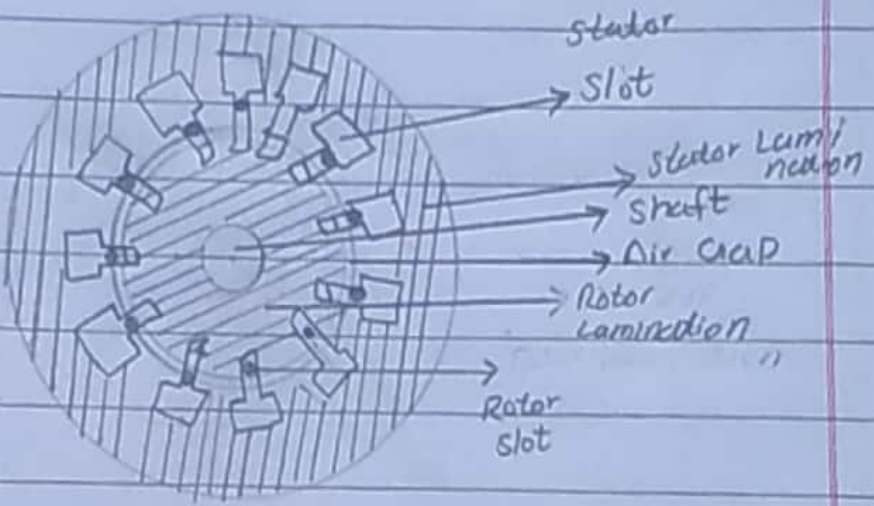
Almost 80% of the mechanical power used by industries is provided by three phase induction motors because of its simple and rugged construction, low cost, good operating charateristics, absece of commutator and good speed regulation. In three phase induction motor the power is transferred from stator to rotor winding through induction. The induction motor is also called asynchronous motor as it runs at a speed other than the synchoronous speed. Like any other electrical motor induction motor als 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. The main body of the Induction Motor comprises of two major parts as shows in Figure 1:

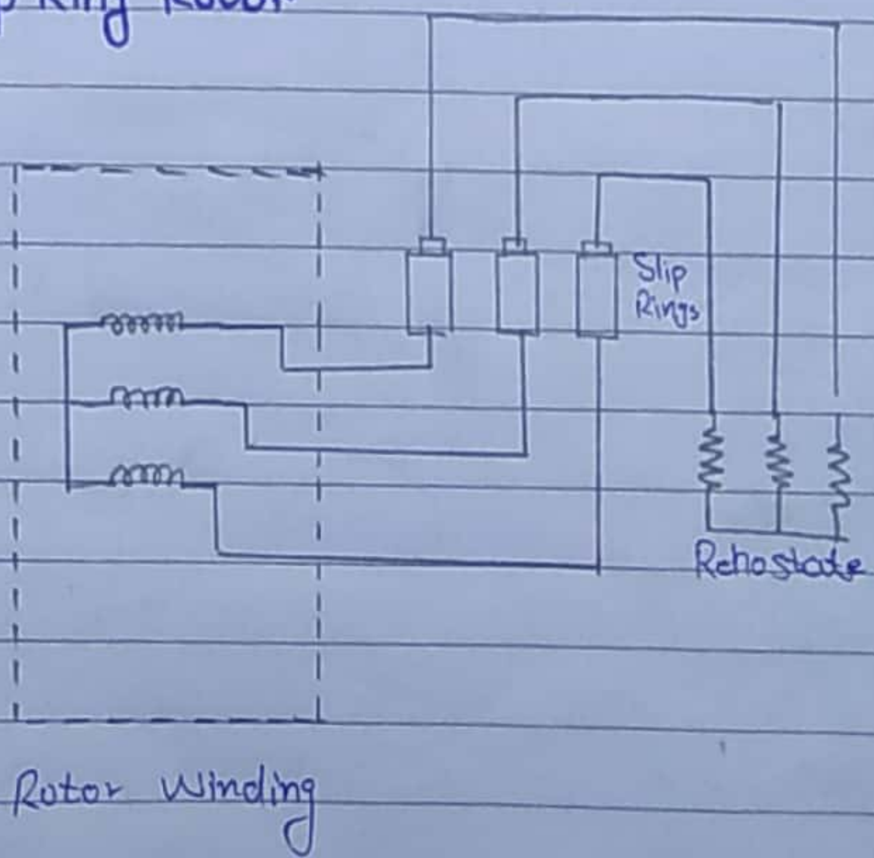
i. Shaft for transmitting the torque to the load. This Shaft is made up of steel.

ii. Bearnings for supporting the rotating shaft.

Diagrame
Lamination of stator and Rotor



Diagrame
Slip Ring Rotor



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

iv. For receiving 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.

Question # 2

Write ~~ope~~ operation principal (working) of Three phase induction Motor

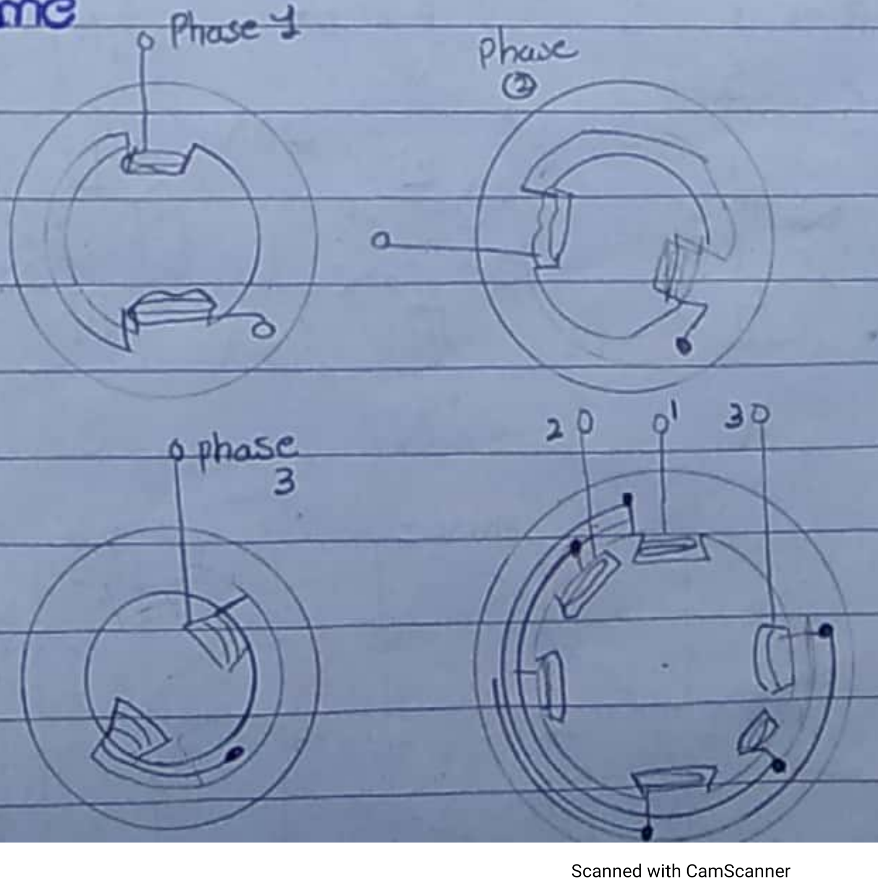
Ans:

in AC motor there a ring of electromagnets arranged by arround the outside (making up the stator) which are designed to Produce a rotating magnetic field. inside the stator ther's a Solid metal axle; a loop of wire a coil, a suawirl cage metal bars and interconnection (like rotating cages People Sometimes get to asume Pelmic. or Some other freely metal part that can conduct electricity. un like in a Dc motor where you send power inner rotor in a Ac motor you Send a power outer coils that make up stator. The coils are energized by pairs in Sequence, producing a magnatee field. that rotates arround side of the motor The field is on the rotor suspended inside the magnetic field is an electricaal conductor. The magnetic field is constanted change So, according to the lace of electromagnatism the magnetic field produce a electric current inside the rotor. if the conducter is ring or wire the current is flow around a loop. if the conductor is simply a Solid piece of metal eddy current swirl, around it insteal either way the induced current.

Three phase rotating field

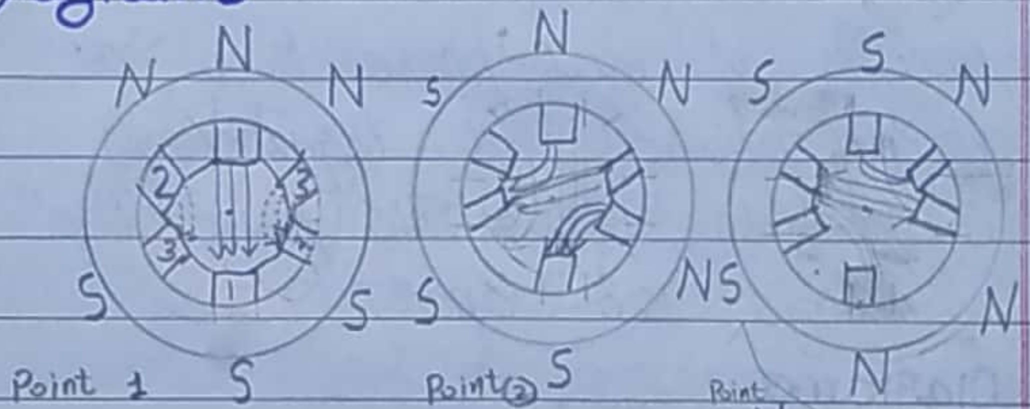
The three phase Induction Motor also operates on the principal of rotating magnetic field. the following discussion how Stator winding connected to a three phase input supply and have a resultant magnetic field that rotates. Show the individual winding of each phase how a three phase tied togather Y connected stator. This place the windings 120° apart.

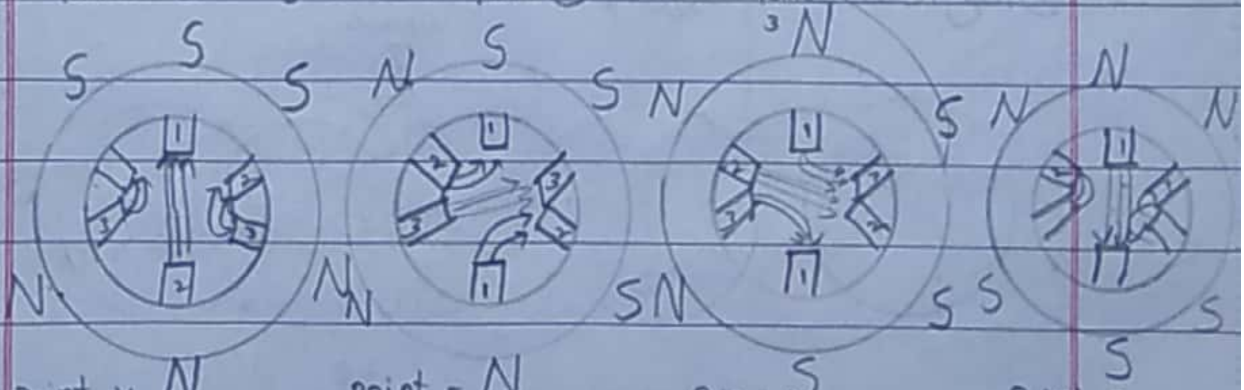
Diagrame

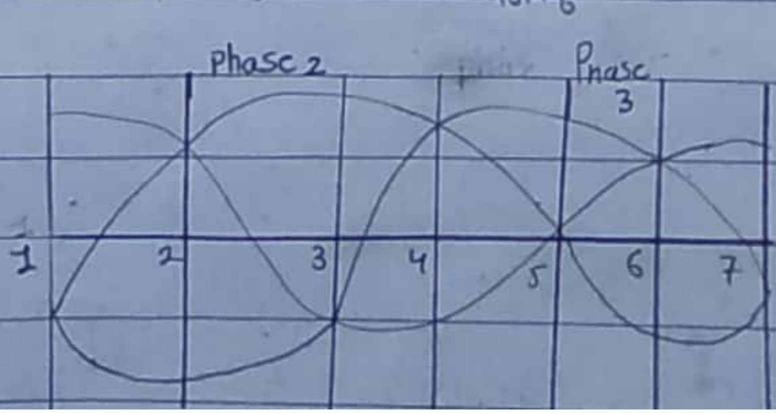


use the left hand rule to determine the electromagnetic polarity of the poles at any given instant. in applyin the rules in the coils consider that the current flows towards the terminal number for the positive Voltage and the away from the terminal number Voltage for the negative voltage.

Diagrame





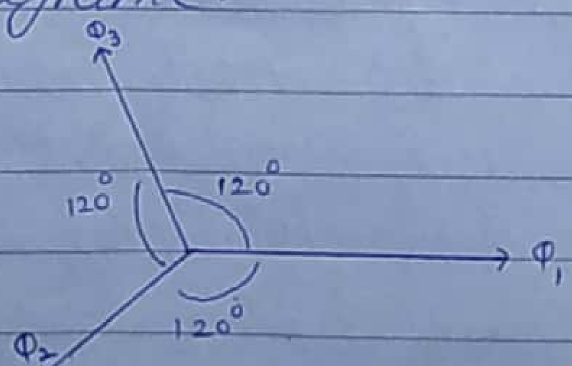


Genration of rotating magnetic field (RMF)

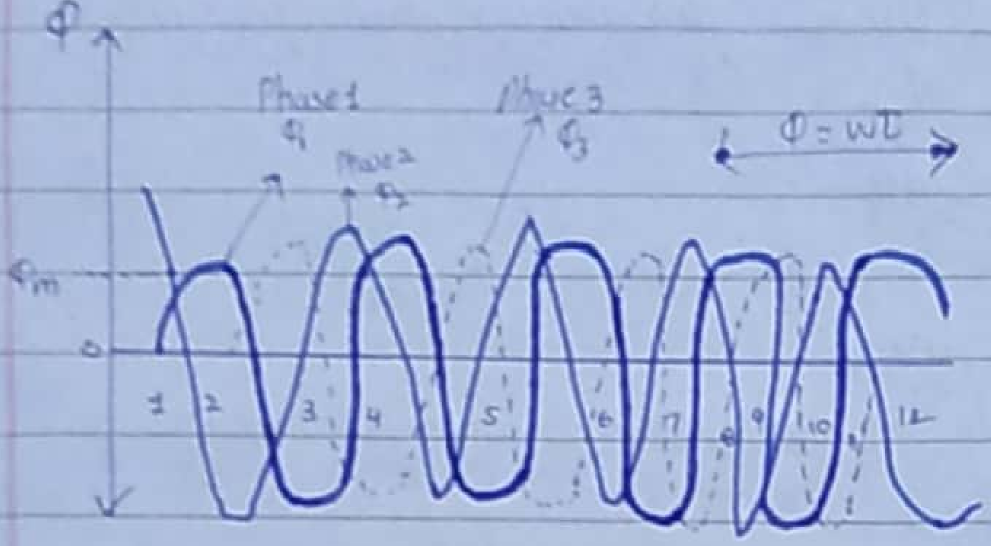
when a 3-phase winding is energized from a three phase supply a Rotating magnetic field is produce this field is such that is poles do no remain in a fixed position on the stator but go on shifting their position around the stator for this reason it is called a rotating field it can be shown that magnetic and the magnitude of this rotating field is constant and is eaxual 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 Ac supply The phase winding the each phase current also are also Sinusoidal in nature and all three flux are sprated from each other by 120° if the phase sequence winding is 1-2-3 than the mathmatical equation for the instantaneous values of the fluxes Φ_1, Φ_2 Φ_3 can be given as

$$\Phi_1 = \Phi_m \sin(wt) = \Phi_m \sin\Phi$$
$$\Phi_2 = \Phi_m \sin(wt) = \Phi_m \sin(\theta - 120^\circ)$$
$$\Phi_3 = \Phi_m \sin(wt - 240^\circ) = \Phi_m \sin(\theta - 240^\circ)$$

As windings are indicate and the supply is balanced the amplitude of each flux is same Φ_m. while assume positive direction of these fluxen in space are. Assume positive direction whenever the is instantaneous values of the flux is positive vector diagrame is must be represented along its assumed positive direction. in the vector diagrame.



Wave from three fluxes



Let Φ_1 Φ_2 and Φ_3 be the instantaneous values of the fluxes The resultant flux Φ_T at any intant is give by the phase combination of Φ_1 Φ_2 and Φ_3 at the instant. Let us find out Φ_T at four different instant 1, 2, 3, and 4 as

at $\Phi = w_t = 0°, 60°, 120°$ and $180°$

Case 1 when $\Phi = 0°$

$$\Phi_1 = \Phi_m \sin(wt) = \Phi_m \sin 0°$$

$$\Phi_2 = \Phi_m \sin(wt - 120°) = \Phi_m \sin(0° - 120°)$$

$$\Phi_3 = \Phi_m \sin(wt - 240°) = \Phi_m \sin(0 - 240°)$$

$$\Phi_T = \Phi_1 + \Phi_2 + \Phi_3$$

Hence vector diagrame

BD is perpendicular drawn from B on ϕ_T

Since

$OD = DA = \phi_T/2$

Since

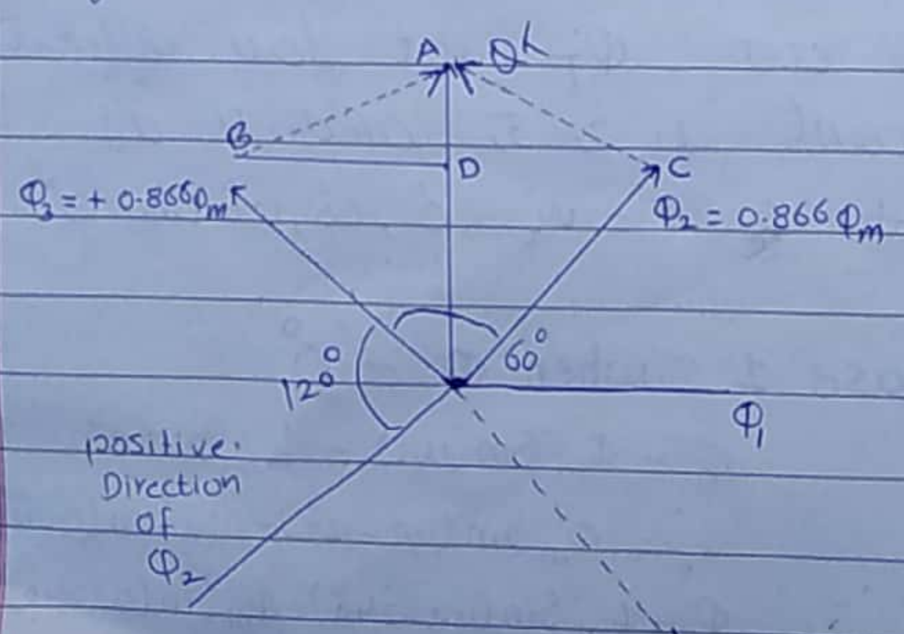
ΔOBD the angle of $BOD = 30^\circ$

So

$\cos 30^\circ = OB/OB = (\phi_T/2)(0.866\phi_m)$

$\phi_T = 2 * 0.866\phi_m * \cos 30^\circ = 1.5\phi_m$

So the magnitude of resultant flux is $1.5\phi_m$ time the maximum values of flux.



Case: 2 $\Phi = 60^\circ$

$\Phi_1 = \Phi_m \sin(wt) = \Phi_m \sin 60^\circ = 0.866\Phi_m$
$\Phi_2 = \Phi_m \sin(wt - 120^\circ) = \Phi_m \sin 120^\circ = 0.866\Phi_m$
$\Phi_3 = \Phi_m \sin(wt - 240^\circ) = \Phi_m \sin(60^\circ - 240^\circ) = 0.866$

$\Phi_T = \Phi_1 + \Phi_2 + \Phi_3$

Hence vector diagrame shown

Since

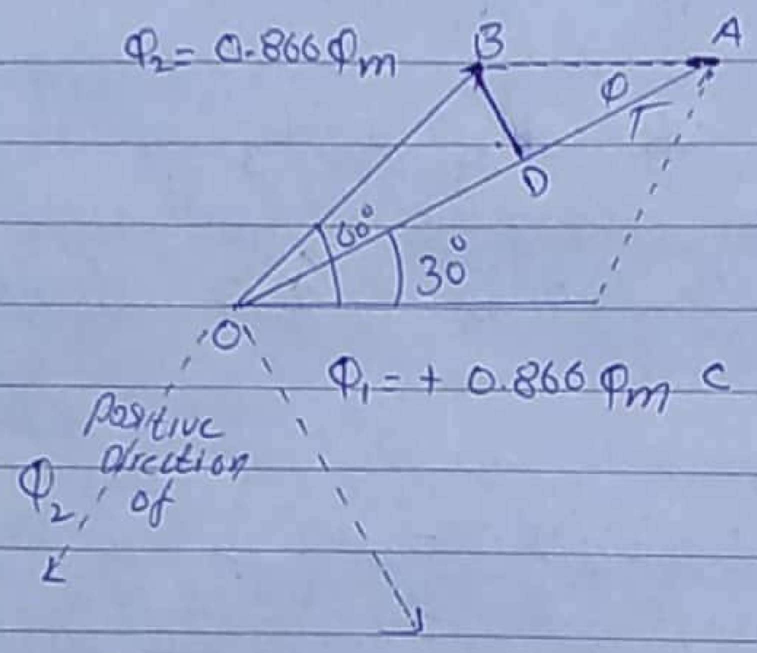
$OD = DA = \Phi_T / 2$

Since Δ OBD the angle of BOD = 30°

So, $\cos 30^\circ = OD/OB = (\Phi_T/2)/0.866\Phi_m$

So the magnitude of resulatnt flux $1.5\ \Phi_m$ tim the maximum values of the flux.

~~Jorit~~ Diagrame



cas.:3

$$\Phi_1 = \Phi_m \sin(\omega t) = \Phi_m \sin(120^\circ) = 0.866\Phi_m$$
$$\Phi_2 = \Phi_m \sin(\omega t - 120^\circ) = \Phi_m \sin(120^\circ - 120^\circ) = 0$$
$$\Phi_3 = \Phi_m \sin(\omega t - 240^\circ) = \Phi_m \sin(120^\circ - 240^\circ) = -0.866\Phi_m$$

$$\Phi_T = \Phi_1 + \Phi_2 + \Phi_3$$

Hence the vector diagrame

BD is perpendicular drawn from B on ϕ_T

Since

$$OD = BA = \phi_T/2$$

Since

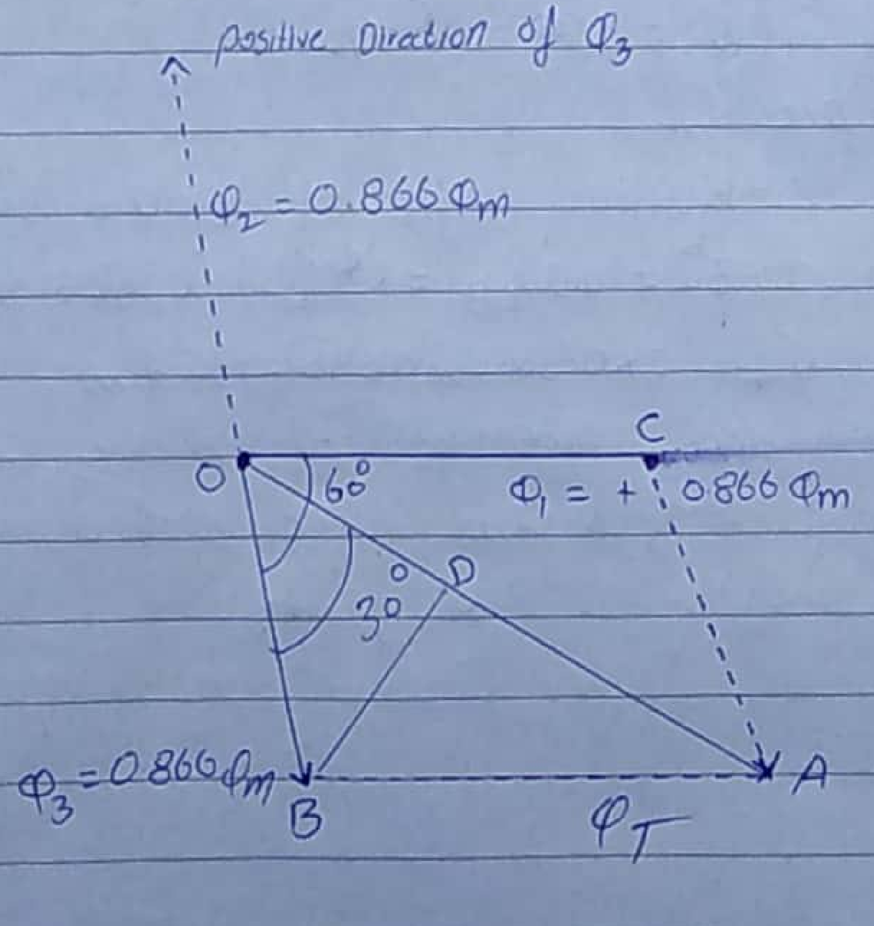
ΔOBD the angle of $BOD = 30^\circ$

So $\cos 30^\circ = OD/OB = (\phi_T/2)(\div 0.866\phi_m)$

$$\phi_T = 2 \times 0.866\phi_m \times \cos 30^\circ = 1.5\phi_m$$

So the magnitude of resultant flux $1.5\ \phi_m$ time the maximum values of flux.

Diagrame



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Case: 4 $\Phi = 180^\circ$

$\Phi_1 = \Phi_m \sin(\omega t) = \Phi_m \sin 180^\circ = 0$

$\Phi_2 = \Phi_m \sin(\omega t - 120^\circ) = \Phi_m \sin(180^\circ - 120^\circ) = 0.866$

$\Phi_3 = \Phi_m \sin(\omega t - 240^\circ) = \Phi_m \sin(180^\circ - 240^\circ) = 0.866$

$$\Phi_T = \Phi_1 + \Phi_2 + \Phi_3$$

Hence vector diagrame dike as BD is perpendicular drawn on B and Φ_T

Sin

$OD = DA = \Phi_T/2$

Since

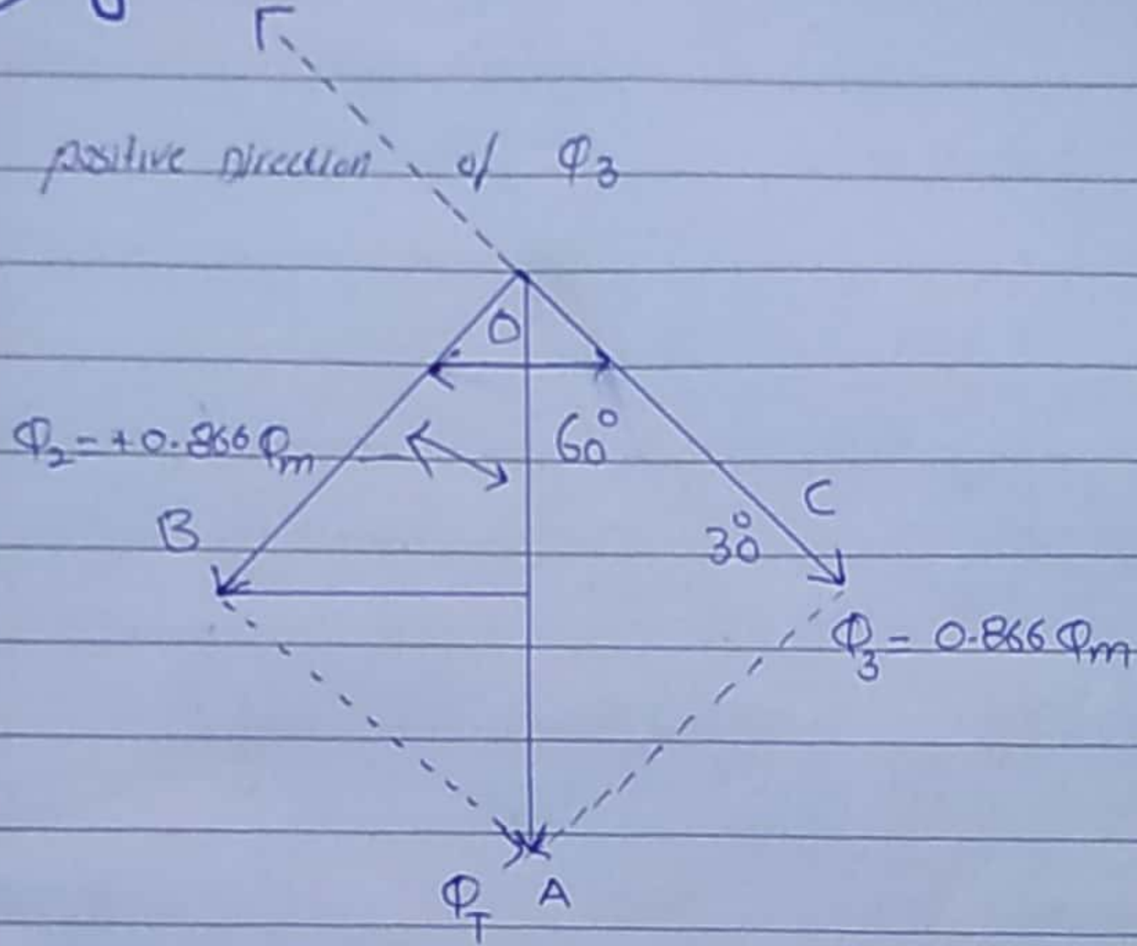
ΔOBD the angle of $BOD = 30^\circ$

So $\cos 30^\circ = OD/OB = (\Phi_T/2)/0.866\,\Phi_m$

$\Phi_T = 2 \times 0.866\,\Phi_m \cos 30^\circ = 1.5\,\Phi_m$

So the magnitude of the resultant flux is $1.5\,\Phi_m$ time maximum value of the flux

Diagrame


positive direction of Φ_3
O
60°
$\Phi_2 = +0.866\,\Phi_m$
B
C
30°
$\Phi_3 = 0.866\,\Phi_m$
Φ_T
A

Questio # 3 Discuss different type of Starter for three phase induction motor

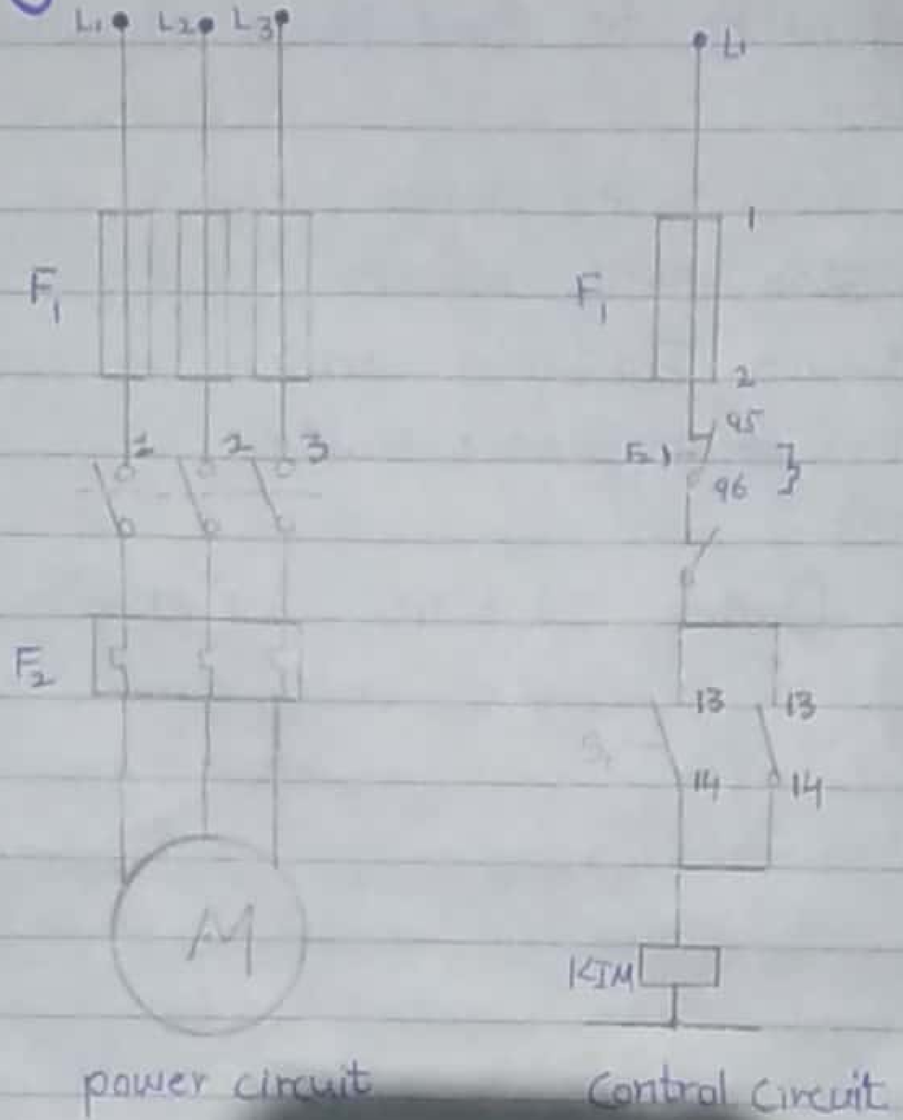
(i) Direct on line starter (DoL)
(ii) Star - Delta starter
(iii) Auto Transformer starter
(iv) Rotor impedance starter

Ans:

(i) Direct ON Line Starter (DoL)

The Direct on Line starter is the Simplest and the most inexpensive of all startings methods. and is used usually for Squirrel cage induction motor. it directly connects the contacts of the motor to the 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 the excessive voltage drop in the supply line due to high starting

Diagrame

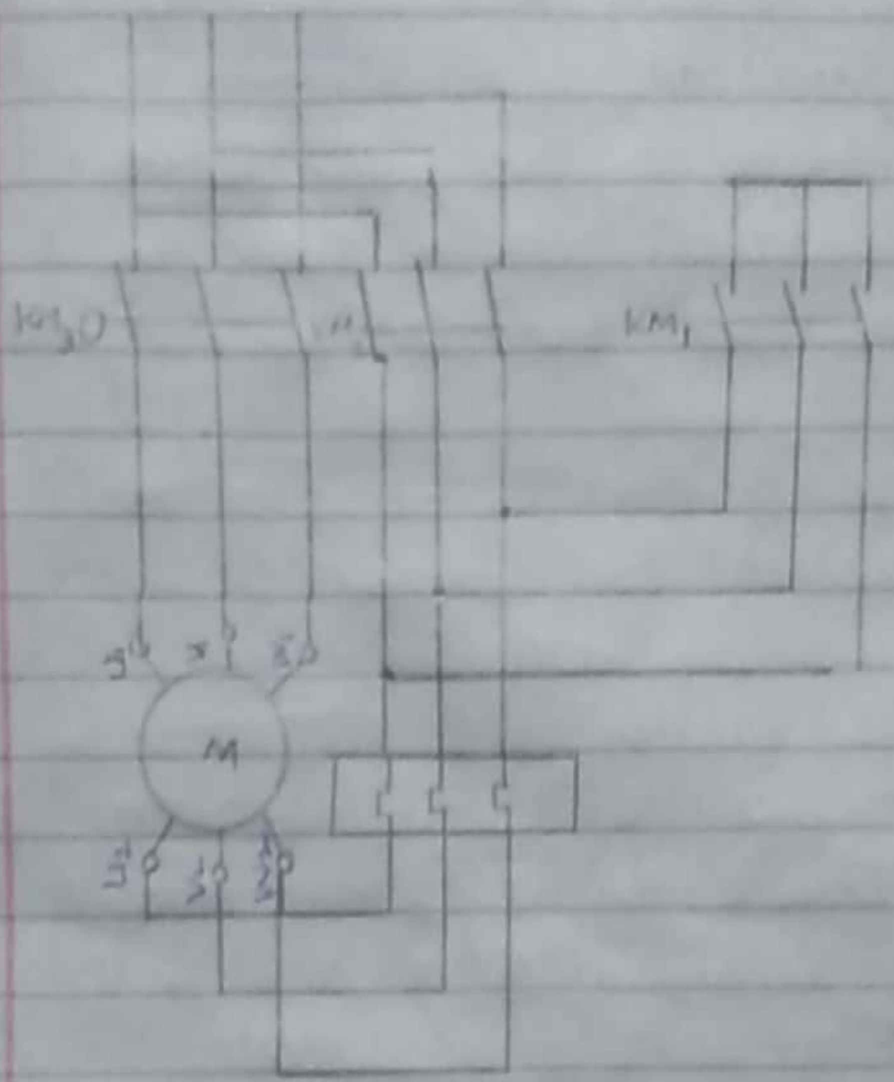


The DOL starter consist of a coil operated contactor K1M controlled by a start and stop push button. on pressing the start push button S_1 the contactor coil K1M is energized from the line. L_1 and the three main contacts are closed. The motor is connected to supply.

(ii) Star-Delta Starter

The star Delta starter is very common type of starter and use compared to other type of the starter. This method is used to reduce the voltage in starting. The connection of three phase induction motor with star Delta-Starter. The method achived low current by first connecting the stator winding in star configration after the motor reaches the certain speed through switch changes the winding arrangements from star to Delta configration. By connecting the stator winding first in star and delta the line current drawn by the motor At the time of starting when the stator winding are star connected each stator phase gets voltag $V_L/\sqrt{3}$ where V_L is the line voltage.

Diagrame



Control Circuit Diagrame

(iii) Auto transformer starter

The operation principal of Auto transformer method is Similar. The starting current is limited by reduce the intial stator applied voltage. The auto transformer starter is use expensive more complicated in opperational and in construction when compared with star delta starter

operation

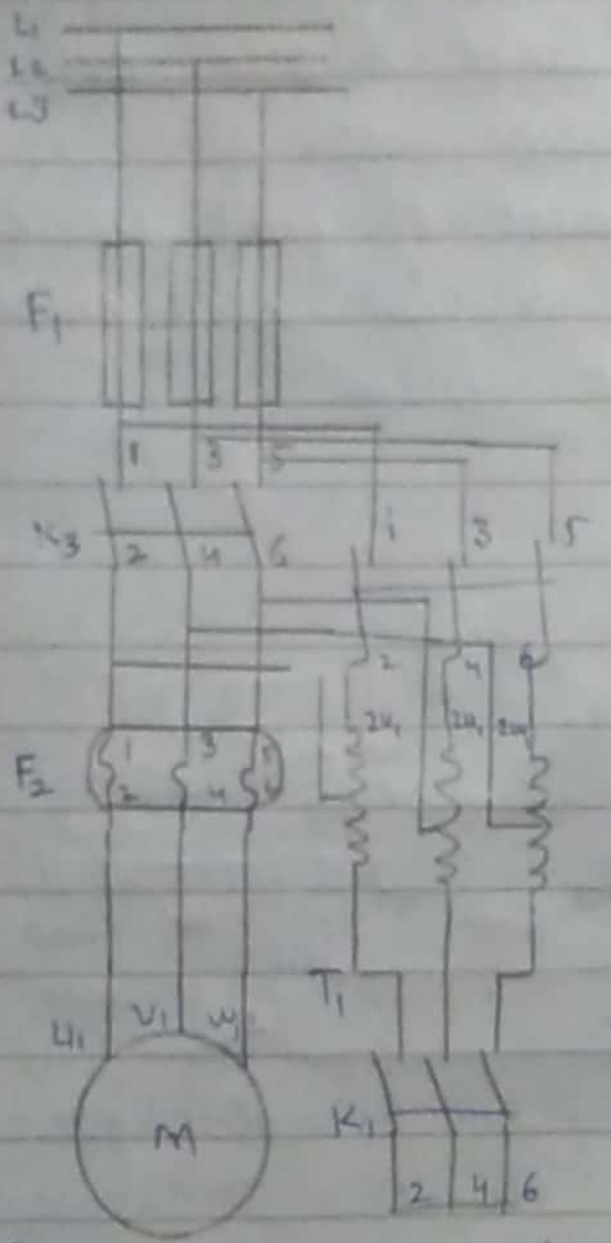
1- operated by two positive Switch automatically using a timer to change over from star to run position

2- in starting position supply is connected to stator winding through an autor transformer when reaches supply voltag 50 to 60 and 70% of normal value.

3- Reduce voltage Reduce current in motor winding with 50% tapping used motor current is havlel and supply current will be half of the motor current

4- For an induction motor torque T is developed by the U_2 thus on 50% tapping are used starting is only $(0.5V)^2$

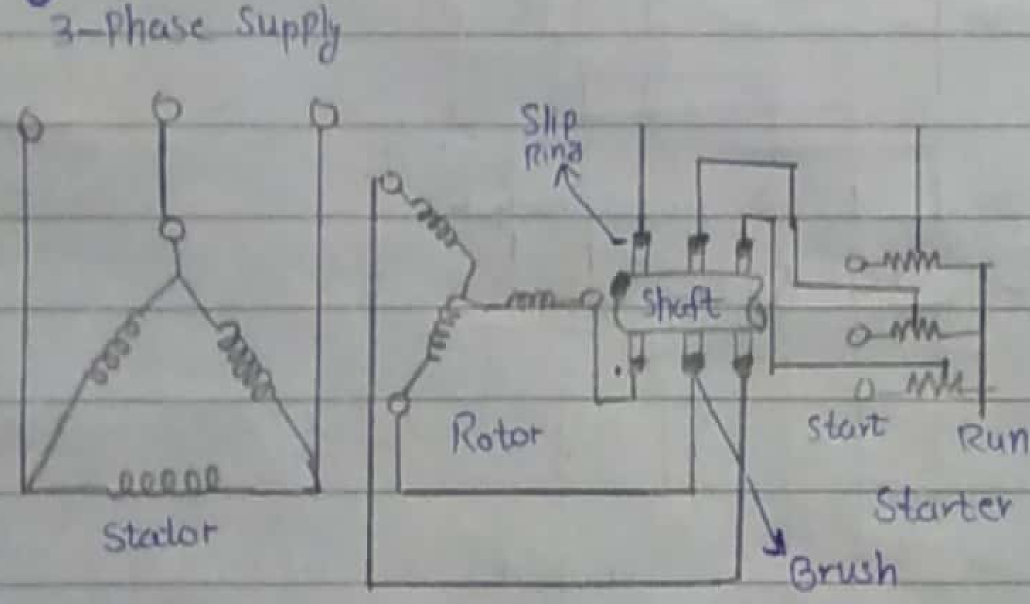
Diagrame



(ii) Rotor Impedance Stator

This method allows external resistance is set to maximum and is than gradually decrease the motor speed increase untill become to a zero. The rotor impedance starting machines is usually very bulki when compared with othe method it also has very maintenance cost. Also is considerable amount of heat generated through the Resistors when current runs through them

Diagrame



induction motor with Rotor Resistance starter