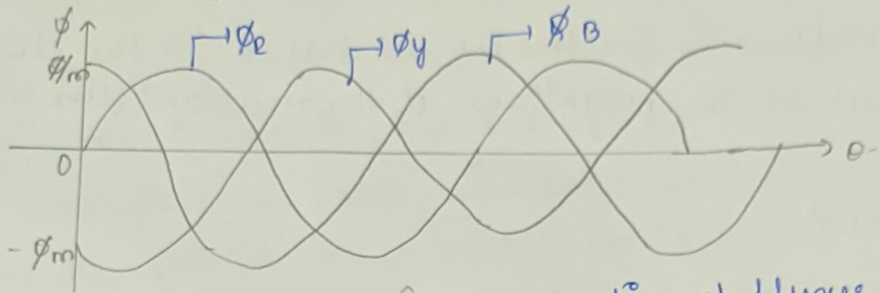
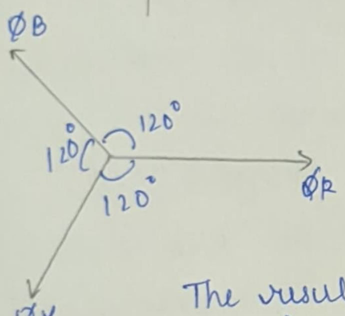
1) Explain the concept of Rotating magnetic field of induction motor with suitable vector diagram

→ when a three phase supply is given to the three windings of the stator, three fluxes are produced in the three windings. The assumed positive directions of fluxes.





The three equation of fluxes are:-

$\phi_R = \phi_m \sin \omega t$

$\phi_Y = \phi_m \sin(\omega t - 120°)$

$\phi_B = \phi_m \sin(\omega t - 240°)$

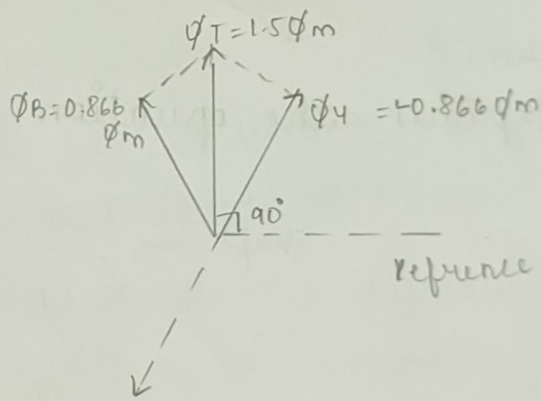
The resultant flux ϕ_T of these three fluxes at any instant is given by vector sum of individual fluxes.

Case i):- At $\omega t = 0$

$\phi_R = 0$

$\phi_Y = \phi_m \sin(-120°) = -\frac{\sqrt{3}}{2}\phi_m$

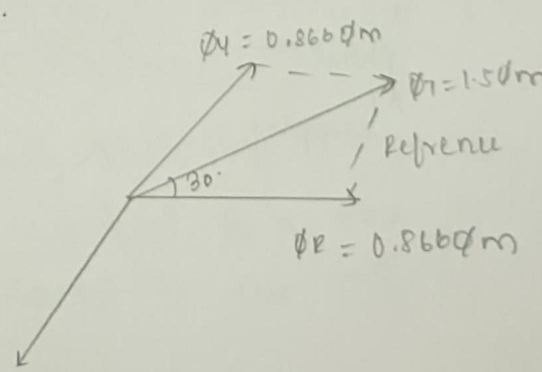
$\phi_B = \phi_m \sin(-240°) = \frac{\sqrt{3}}{2}\phi_m$



$\phi_T = \sqrt{\phi_B^2 + \phi_Y^2 + 2\phi_B\phi_Y \cos 60°}$

$= \sqrt{\frac{3}{4}\phi_m^2 + \frac{3}{4}\phi_m^2 + \frac{3}{4}\phi_m^2}$

$= \frac{3}{2}\phi_m = 1.5\phi_m$



Case ii) when $\omega t = 60°$

$\phi_R = \frac{\sqrt{3}}{2}\phi_m$ $\phi_B = 0$

$\phi_Y = -\frac{\sqrt{3}}{2}\phi_m$ $\phi_T = \frac{3}{2}\phi_m = 1.5\phi_m$

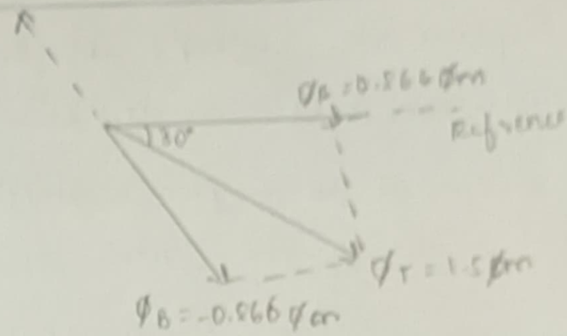
Case iii) $\omega t = 120^\circ$

$\phi_R = \frac{\sqrt{3}}{2}\phi_m$

$\phi_Y = 0$

$\phi_B = -\frac{\sqrt{3}}{2}\phi_m$

$\phi_T = \frac{3}{2}\phi_m = 1.5\phi_m$



The resultant flux is further moved by 60° in the clockwise direction where as the magnitude of the resultant flux remains same

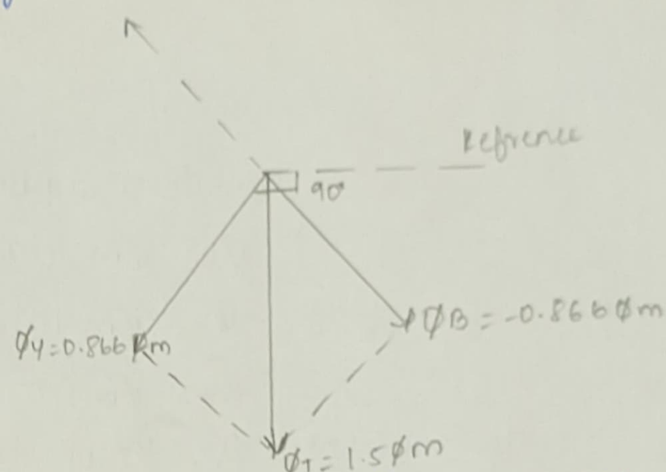
Case (iv):- $\omega t = 180^\circ$

$\phi_R = 0$

$\phi_Y = \frac{\sqrt{3}}{2}\phi_m$

$\phi_B = -\frac{\sqrt{3}}{2}\phi_m$

$\phi_T = \frac{3}{2}\phi_m = 1.5\phi_m$



Resultant flux rotated by 180° from origenal position

~~WAA~~

2) Explain the operation of a 3 phase induction motor.

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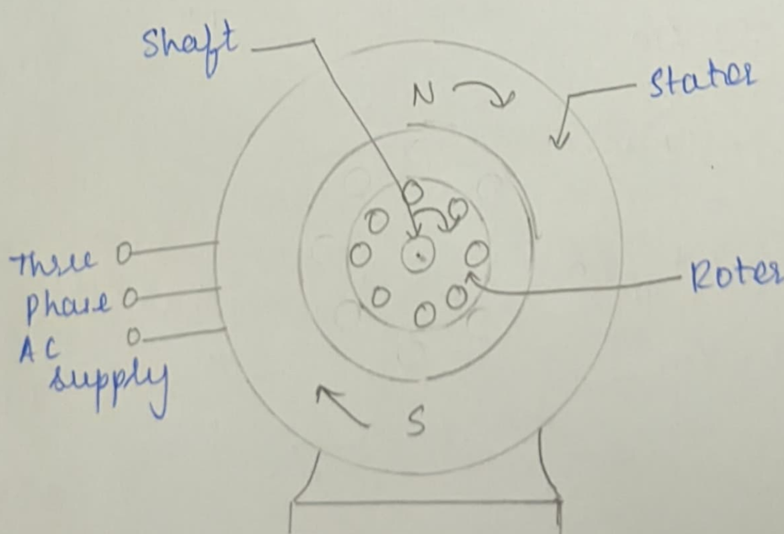

when a three phase supply is given the 3-ϕ stator winding, a magnetic field of constant magnitude $1.5\phi_m$ and rotating with the synchronous speed Ns is produced. The same field links with the rotor conductors. The rotor conductors cut the magnetic field and an emf is induced in these conductors in accordance with Faradays laws of electromagnetic induction. The direction of induced emf is to oppose the very cause of it i.e the relative speed between the rotating magnetic field and the static rotor. As the rotor conductors are short circuited, the induced emf sets up a current in the rotor conductors in a such a direction as to produce a torque which rotates the rotor in the same direction as the magnetic field so that the relative speed decreases. The speed of the rotor gradually increases and tries to catch up with the speed of the rotating magnetic field, but it fails to reach the synchronous speed because if it catches up with speed of magnetic field, the relative speed becomes zero & hence no emf will be induced in the rotor conductors. The torque becomes 0. Hence the rotor will not be able to catch up with speed of magnetic field but rotates at a speed slightly less than the synchronous speed. the difference between the synchronous speed Ns of the Magnetic field and the actual speed of rotor N is called as slip speed

slip speed $= N_s - N$

the difference between the speed of rotating Magnetic field and the rotor speed is referred to as the slip speed to the synchronous speed is the slip of of an induction motor usually denoted by "s"

$s = \frac{N_s - N}{N_s}$ slips becomes unity, rotor speed will be zero

3) Explain the different components of electric vehicle with suitable block diagram.

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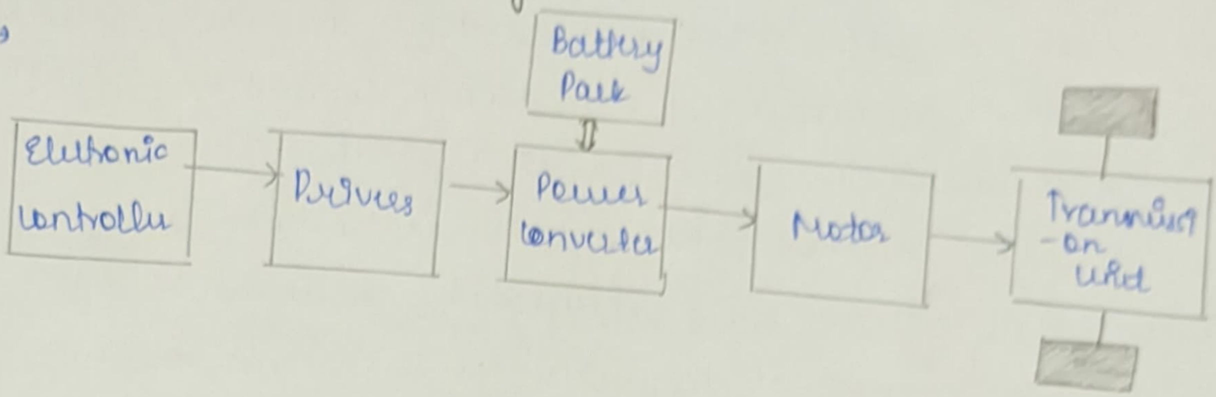


Battery :- Batteries are the most important component of an EV because it determines the weight, cost, driving range & performance of EV. These are rechargeable batteries.

Electronic controller :- It monitors and controls all the required functions of EV. It is a computer based system that has the main function of optimizing the charging & energy output of batteries. It increases the maximum operating range, improves the performance of EVs and can also predict the available range based on the current state of the battery charge

Drivers :- Is a circuit that accepts a low power input from electronic controller and provides the appropriate current to drive the power converter.

Power converter :- Modulates flow of power from the battery pack to the motor in such a manner that motor is imparted speed torque characteristics required by th load. During transient operations such as starting brakin and speed reversal.

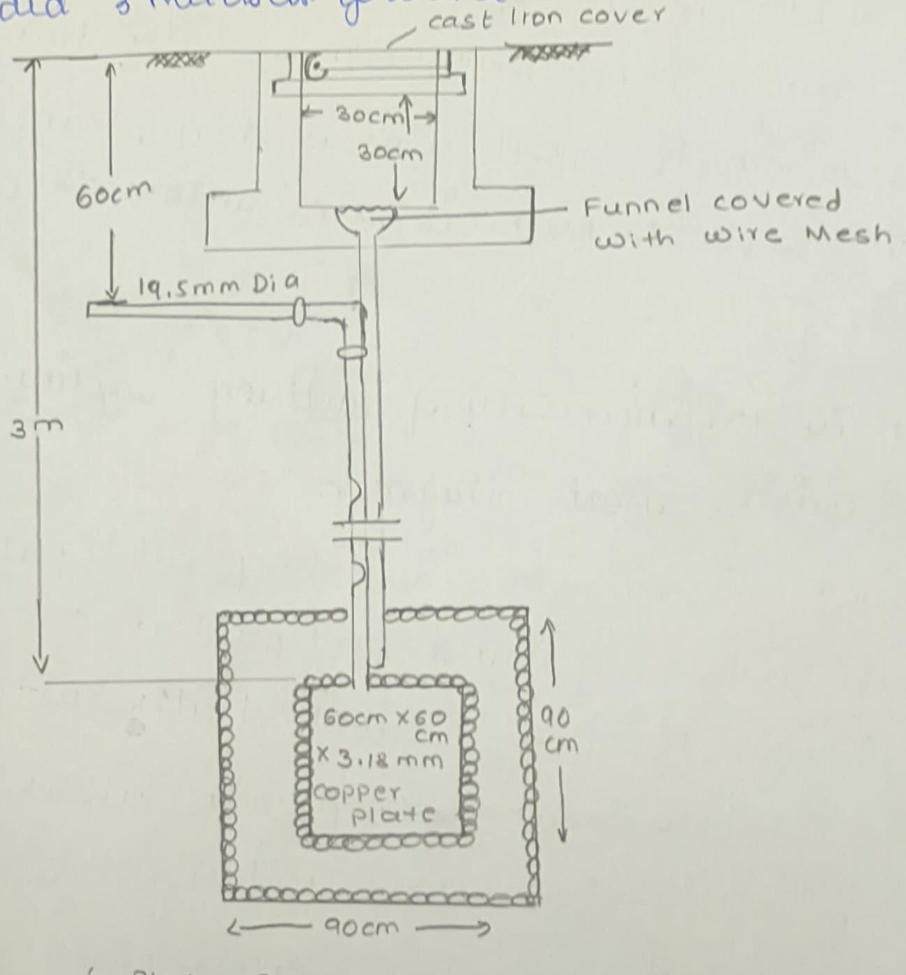
Motor:- It is used as prime mover in an EV. Its function is to convert the energy stored in the battery pack into mechincal motion. This motion must have high starting torque, to ensure a quick acceleration o the output power of the motor is delivered to wheels through a tramission unit. Brushless DC motors, Permanent magnet synchronous motors, Three phase induction motors, and switched reluctance motor are eg for motors that are emp -loyed in EV vehicle

Transmission unit:- also called as gearbox is a mechincal device which uses gear to change the speed or dirn of rotation in EV. Many transmissions have multiple gear ratios, but there are also transmissions that use a single fixed gear ration, Transmission unit in EV can be manual, semi automatic or fully automatic.

) what is the necessity of earthing explain plate earthing with neat diagram.

→ Earthing is a necessary to provide path to the leakage current to ground and protect the personnel from danger of shock or ~~death~~ death. Earth effectively blows out the fuse of any apparatus which becomes leaky. It protects the large buildings and all machinery ed from overhead lines from atmospheric lightining by taking all voltages of lighting through the lightning arrester. Good earthing is one which gives low resistance to flow of heavy current of given circuit. Earth potential is always considered as zero for all practical purposes. A wire coming from the ground 2.5 to 3 meters deep from an electrode is called earthing. Double earth is used for 3 phase machine and equipment. When double earth is used, there is an advantage of redundancy. Pipe earthing, plate earthing etc are the different types of earthing. In summer, the plate area, increasing the depth or by keeping the electrodes in parallel

Plate Earthing: For good earthing in electric substations, plate earthing is used. Here the looping wire is bolted effectively with earth plate made up of cu of size (60x60x0.318)cm and embedded 3 meters in ground

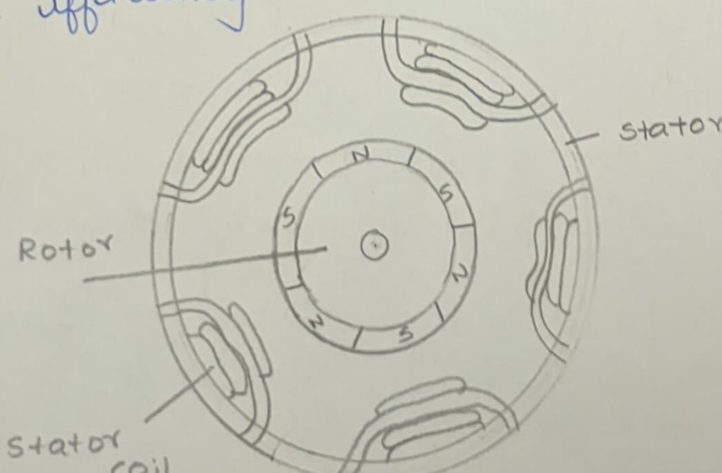


∴ Plate Earthing

The contact surface of GI pipe with the coil is more copper plates are found to be most effective earth electrodes and are the not affected by soil moisture But due to hight material cost galvanized iron plate are preferred and used to normal works. The plate is kept vertical and so arranged that it is embedded in an alternate layer of coke and salt for a minimum thickness of around 15cm. Bolts and nuts should be of Cu for Cu plates and of galvanized iron for GI plates Earthing efficiency increases with the increase of plate area and depth of embedding

5) with a neat diagram explain the working of permanent magnet synchronous motor

→ PMSM comprises of a Permanent magnet as a Rotor and a stator with a coil wound over it. The working of PMSM motor is also quite similar to the BLDC Motor. PMSM Motors on the other hand has every attribute of BLDC Motor with added advantage of lesser noise and higher efficiency



Permanent Magnet Synchronous Motor

PMSM motors are available for higher power ratings. PMSM is the best ~~white~~ choice for high performance applications like cars, buses, Despite the high cost, PMSM is providing stiff competitions to induction motors due to increased efficiency than the latter. Most of the automotive manufactures use PMSM motors for hybrid and electric vehicles

Working:- A permanent magnet synchronous motor consist of a rotor and stator. The rotating part and the stator is the fixed part. Usualy, the rotor is placed inside the stator of the electric motor as shown. The working of PMSM is based on the interaction of rotating magnetic field of the stator and the constant magnetic field of rotor. When 3-Ø AC supply is applied to the windings of the stator coils a rotating magnetic field is generated that rotates at a speed proportional to frequency of supply voltage. The permanent magnets on the PMSM motors create a constant magnetic field the interaction between the rotating magnetic field of stator and the constant magnetic field of the rotor creats a torque thereby forcing the rotor to rotate. Suppose an initial rotation is given to the rotor in same direction as that of the rotating magnetic field. In that case, the opposite poles of rotating magnetic field and ~~rotor~~ rotor will be attracted to each other leading to the interlocking of rotor poles with rotating magnetic field of the stator. Thus a PMSM cannot start itself when it is connected directly to the three phase current network.