

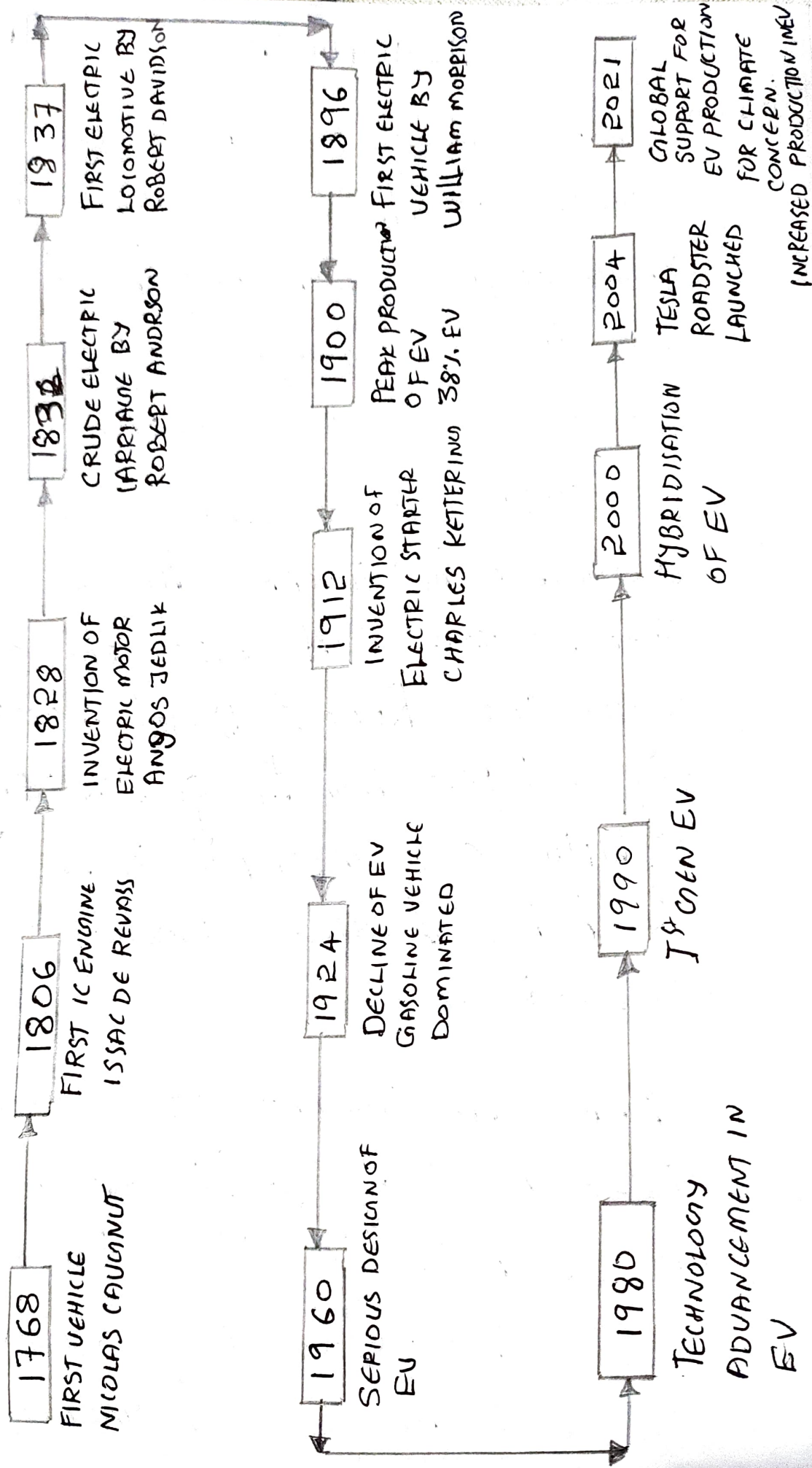
Q1(a)

Automotives are basic necessity of humans in the 21st Century. The history of automotives starts from the 18th century, till it goes through many developments to reach at current designs.

Nicolas Cugnot Consider as Father of automobile he invented the first vehicle in 1768. Nicolas Auro made the first petrol engine and Rudolf Diesel made first Diesel engine. Apart from the gasoline engine electric vehicle also invented in the same period. The history of ~~electric~~ automobiles are shown below diagram.

After the invention of electric motor in 1828 by Anegor Jedlik electric vehicle invention started. In 1832 Robert Anderson made first electric curule Carriage. And in 1837 first electric locomotive made by

HISTORY OF AUTOMOBILES



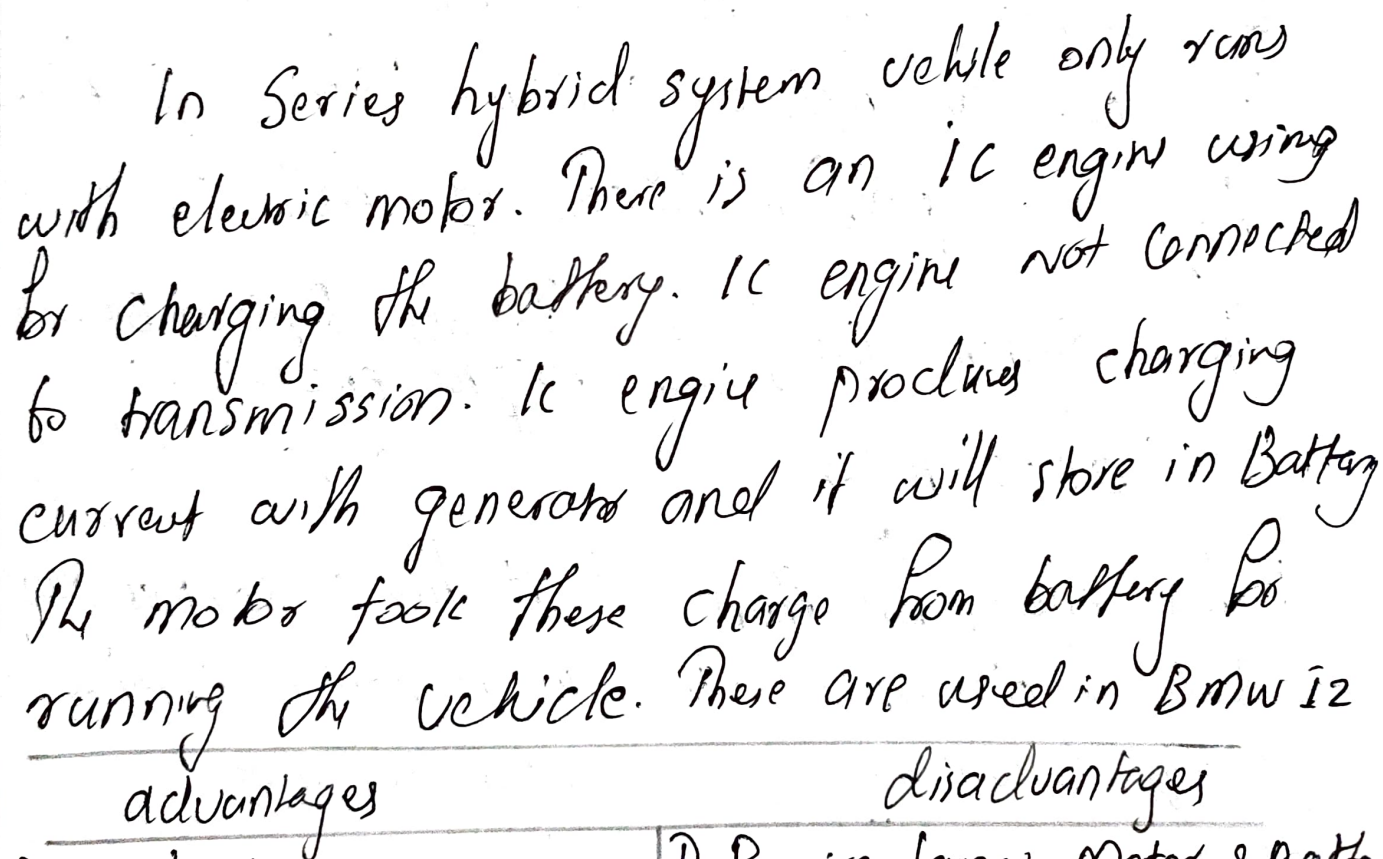
Robert Davidson. The first successful electric vehicle was made by William Morrison.

In 1900 electric vehicle dominated the gasoline vehicle in total vehicle share 38% was electric vehicle at that time gasoline vehicle only have 22%. The invention of electric starter by Charles Kettering in 1912 made a change in the history of EV. The gasoline vehicle with electric starter dominated electric vehicle. Also electric vehicle having the issue of battery backup and charging time. So from 1924 EV production reduced. But from 1960 there is some environmental concern development in EV started. 1837 - 1924 was the peak time of EV. So it is called as Golden years of EV.

In 1990 first generation EV Vehicle produced. In 2000 Hybridisation started in Gasoline Vehicle. 2004 Tesla made ROADSTER model, it was a great change in EV industry. After that many companies started serious research in EV production.

In 2020-22, there is a global concern about climate change & pollution. This made global organizations started working for renewable energy and pollution free concept. This fasten EV production in 21st century. Currently ~~the~~ Government also supports EV production by giving subsidies. So the new era of EV started again.

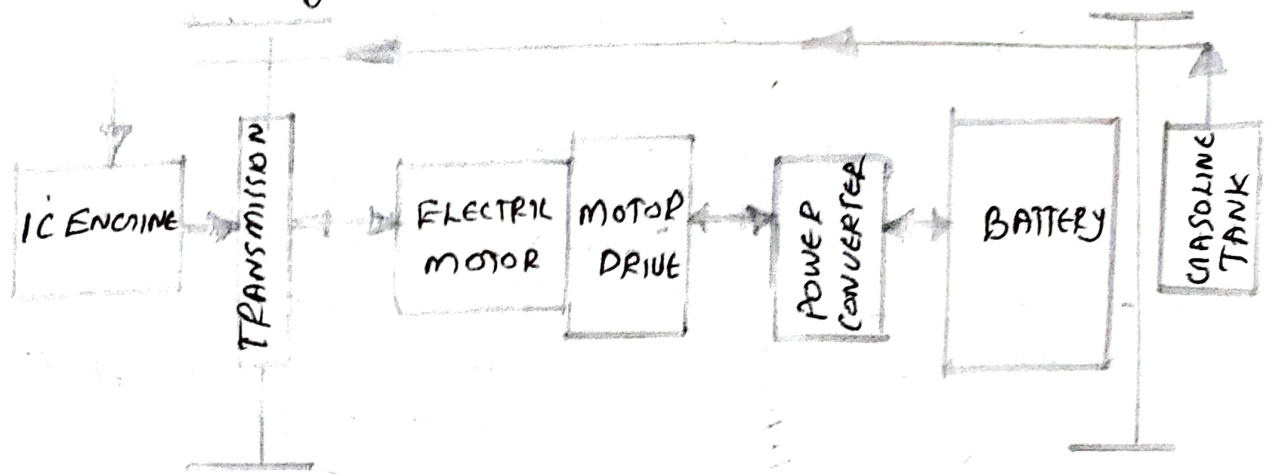
Q1. Series Hybrid Electric Vehicle



disadvantages

- 1) Require larger Motor & Battery for producing high freq.
- 2) More Costly
- 3) Need separate inverter

b) Parallel Hybrid Vehicle



In parallel hybrid system both motor and IC engine drives the vehicle, both are connected to transmission. There is no separate generator in parallel hybrid system. Vehicle get high torque and performance because of both power source. These system used in ~~Toyota Prius~~ ~~BMW~~ ~~etc~~ HONDA insight, civic, etc.

advantages

1) Less energy loss than series because of no direct energy conversion.

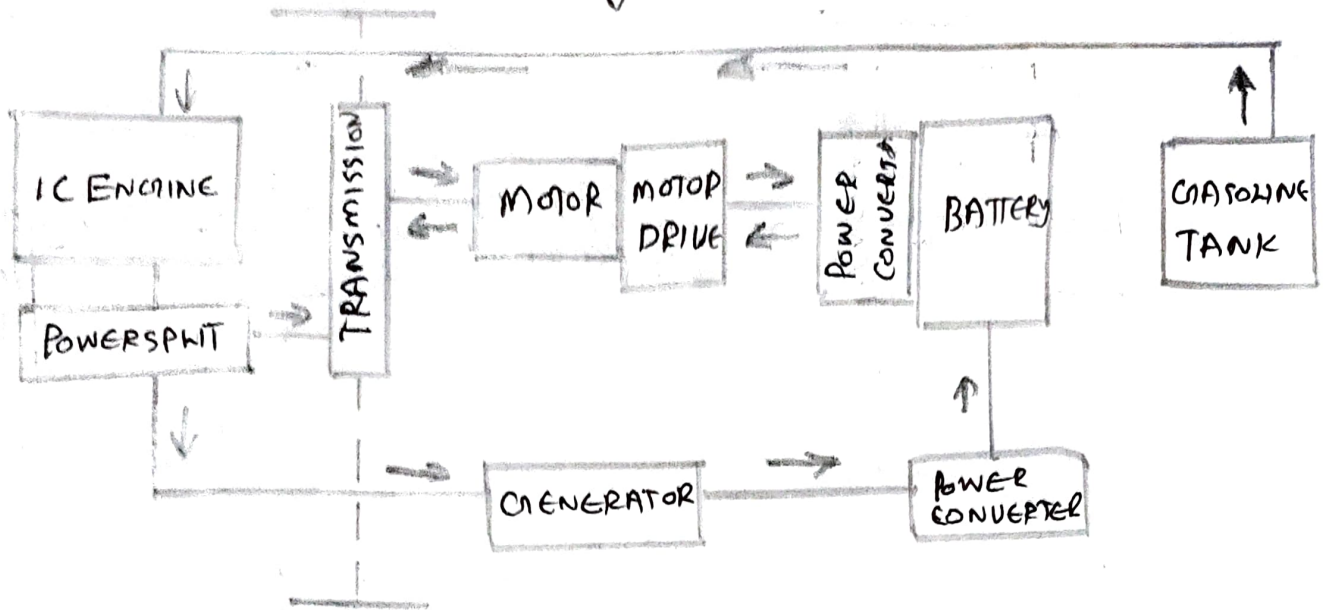
2) Smaller traction motor can be used and can be eliminated separate generator

disadvantages

1) It has a complex design in mechanical coupling with engine and motor.

2) Control system are complicated than series system

(c) Series Parallel Hybrid Vehicle.



It is a combination of both series and parallel system. It can be configured in different mode. Apart from the parallel system it consists of a power split. It will supply power to the transmission and in a separate generator. So the IC engine power split to both use, and motor is also connected to transmission. This system is used in Toyota Prius.

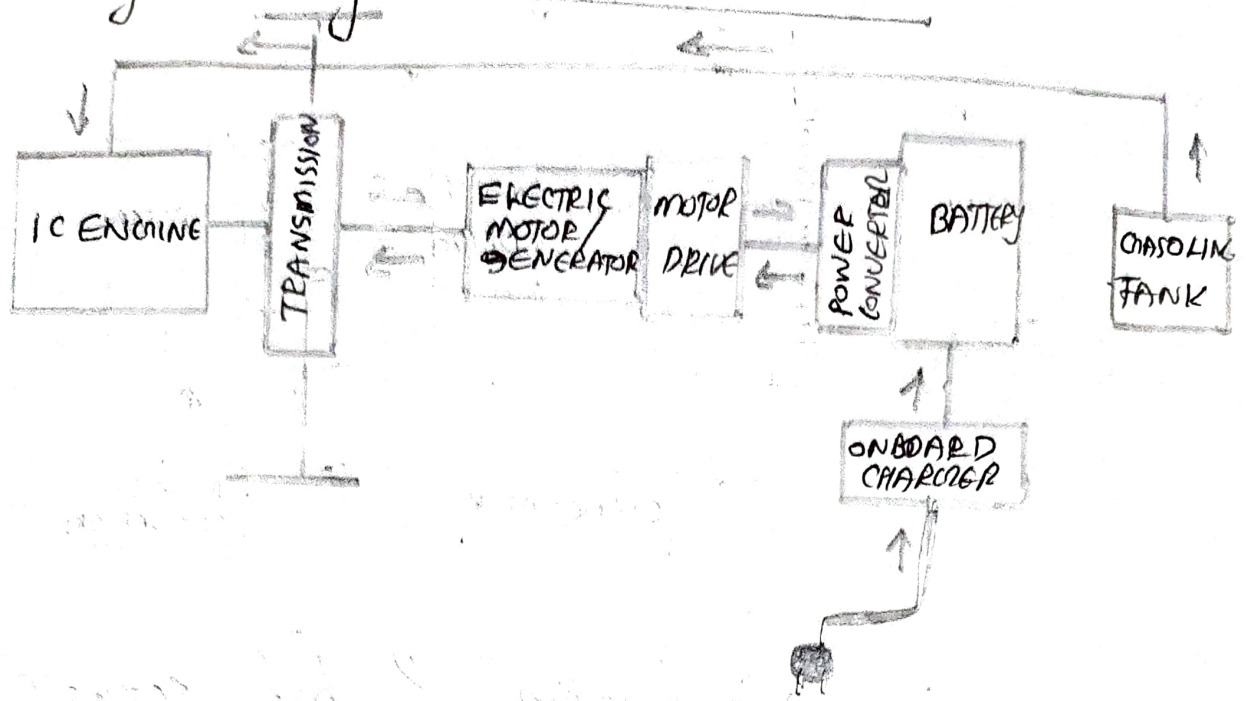
Advantages

- 1) Different mode of drive can be used as it has both series and parallel system.
- 2) Efficient in city driving and highway running than parallel or series system.

Disadvantages

- 1) Complicated system.
- 2) Costly.
- 3) Heavy design because of power split, separate generator need.

(d) Plug in Hybrid electric vehicle



Plug in Hybrid electric vehicle. consist of an external on Board charger. apart from the parallel hybrid system. Vehicle runs with both IC engine and motor. BMW i8 is an example of this system.

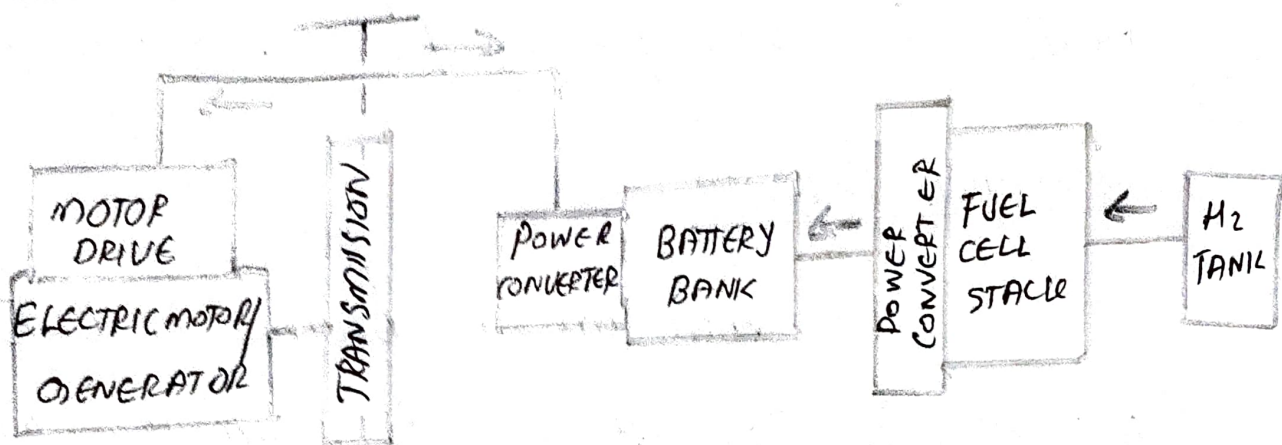
ADVANTAGES

- 1) Fuel Consumption is less than gasoline engine.
- 2) Efficient in city drive
- 3) less emission

DISADVANTAGES

- 1) Very high cost
- 2) Battery life not economical.
- 3) Complex & systems & Controls.

e) Fuel cell electric vehicle



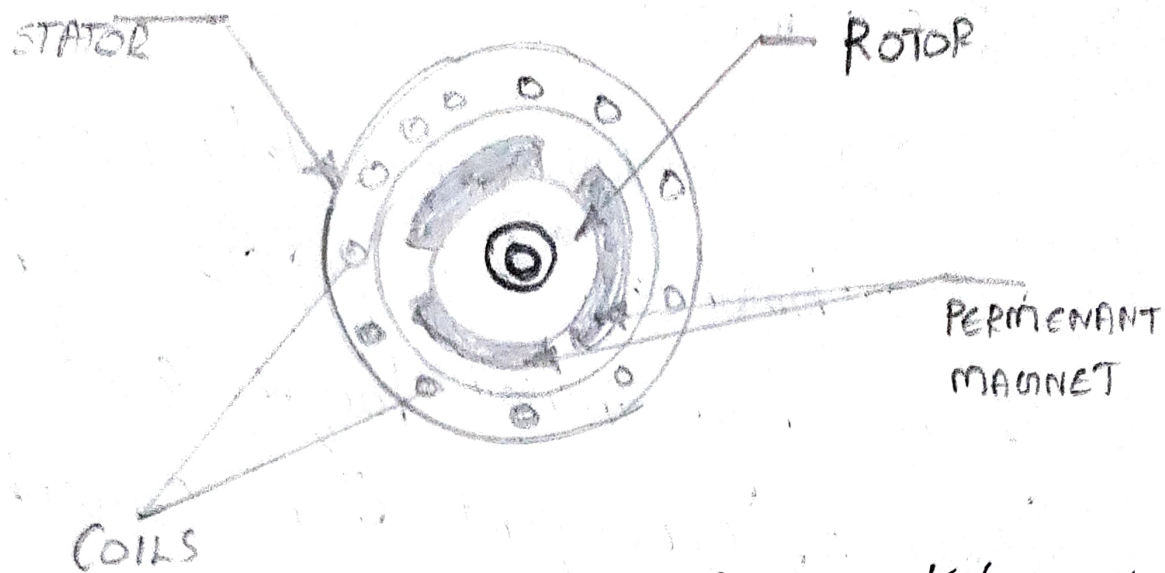
In Fuel cell electric vehicle fuel cell using for producing electricity for charging the battery. motor is driving the vehicle with this charge. Hydrogen is the fuel used in fuel cell. The Hydrogen passes through the fuel cell react with oxygen produces free electrons thus it charges the battery. Hyundai nexo, Toyota mirai having this system.

Advantages	Disadvantages
1) High energy density and productivity	1) Hydrogen production is costly and old
2) Zero emissions	2) Hydrogen storage and transportation not easy.

Q 3
(9)

BLDC MOTOR

BLDC motors are widely using in Industry and automobiles. It is popular because of its high initial torque and brushless system of arrangement than conventional motors. The BLDC motor doesn't use brushes for commutation but rather they are electrically commutated. In conventional motor brushes are used to transmit the power to the rotor as they turn in a fixed magnetic field. The BLDC motor is a type of synchronous motor in the sense that the magnetic field generated by the stator and the rotor revolve at the same frequency.



BLDC motor having a stator, rotor, and position sensors (Hall sensors).

STATOR

The stator is similar to other motors it having a wound coil made up of stamped steel laminations with axially cut slots. The winding gets power from the connectors - usually 48V rated motors are used in automotive and robotics.

Rotor

Rotor is the rotating part. In BLDC the rotor is made up of permanent magnets. Based on the application the number of poles

can vary between two and eight with north and south poles placed alternately.

Position Sensors

Since there are no brushes in BLDC motors the commutation is controlled electronically. In order to rotate the motor, the windings of the stator must be energized in a sequence and the position of the rotor must be known to precisely energize a particular set of stator windings. Usually a Hall Sensor used to detect the position of the rotor and transform it into an electrical signal.

If we supply current to the coil, it will generate a magnetic field and attract the rotor magnet. The position of the rotor magnet will shift slightly clockwise and align