

# ELECTRIC VEHICLE POWER TRAIN

## Questionnaires

Q1. Explain the Journey of Automotive with the help of flow chart from the Beginning of 18th Century to The 21st Century & give brief description on the following milestones in the Automotive

### Journey

- Invention of Electric motor
- Golden Era of EV
- Domination of Electric Vehicle by Gasoline Cars
- Coming of New Era in EV
- Introduction to Hybrid Electric Vehicles.

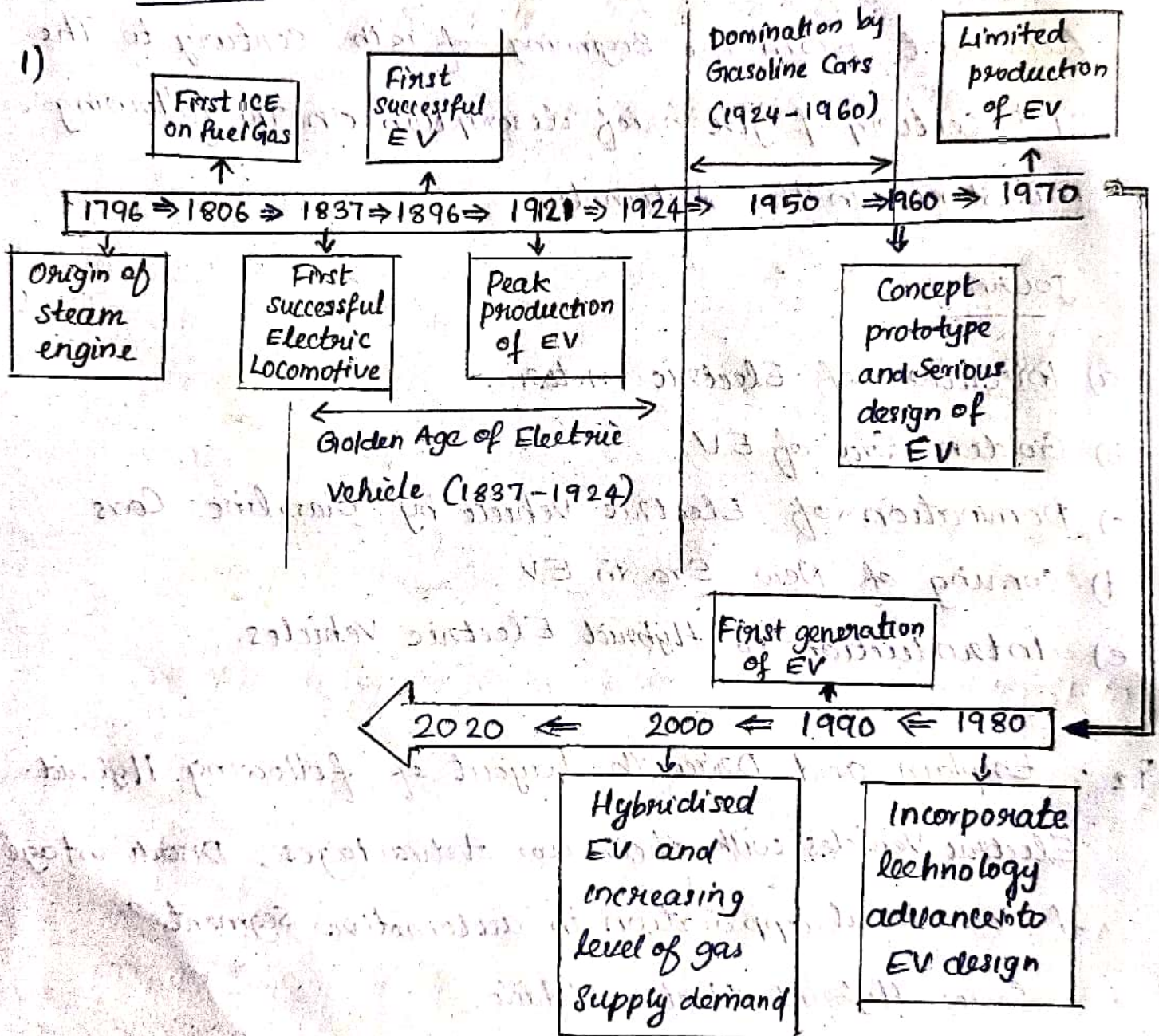
Q2. Explain and Draw the layout of following Hybrid Electric Vehicles with their two Advantages, Disadvantages & Industrial application in automotive segment?

- Series Hybrid Electric Vehicle.
- Parallel Hybrid Electric Vehicle
- Series parallel Hybrid vehicle
- Plug in Hybrid electric vehicle
- Fuel cell Electric Vehicle



Q3. Explain with Diagram the construction & working principle of Brushless motor BLDC ?

### ANSWERS



### Invention of Electric motor

• In 1828, Anyos Jedlik was invented an worlds first electric motor. He is an Hungarian inventor. And the



Created a small model of car which will work on electric motor.

- In between 1832 and 1839, Scottish inventor Robert - Anderson also invented crude electric carriage.

In 1835, Professor Sibrandus Stratingh of Groningen, the Netherlands and his assistant Christophen Becker from Germany also created a small-scale electric car, powered by non rechargeable primary cells.

### Golden Era of EV

The Golden age of Electric Vehicle is in the range of - 1837-1924.

The first know electric locomotive was built in 1837, in - Scotland by a chemist Robert Davidson, of Aberdeen.

- The invention of the improved battery technology in France on 1881, Gaston plante.

There is an good level of growth in EV may starts on 1837 to 1924. The first successful EV was built in 1896, in US by Willion Morrison.

- Then the vehicle will design for carrying 2 peoples and which controlled by an driver. Total 3 person carrying capacity vehicle will built.
- In the begining of 1900, Electric cars were even labelled as "Women's car".
- At the turn of Century, 40% of American cars were powered by



Steam, 38% by electrically and 22% by petrol. And Commercial EV were produced primarily in Europe.

On 1912, petrol powered cars are easier to drive, which may be invented by Charles Kettering and his electric 'starter'. On this cause Electric cars began to lose its position of market at America in 1920.

### Domination of Electric Vehicle by Gasoline Cars

Electric cars began to lose their position in the car market at America in 1920.

Then EV was dominated by Gasoline cars in between (1924 - 1960)

### Coming of New Era in EV

On the energy crisis in 21<sup>st</sup> century they interest to renew electric cars. And A lot of smaller companies may start to design electrical cars. On November 22, 2002 Toyota offered its RAV4-EVS. After this century Electric cars are get more profitable market also.

- Californian manufacturer may will start Tesla motors in 2004, they develop Tesla Roadster model which was first delivered to customer in 2008. Tesla also introduce firstly lithium ion battery in its car production.



In 2022 many other MNC are take initiative on the production of EV such as TATA motors, kinetic Green, Mahindra electric etc.

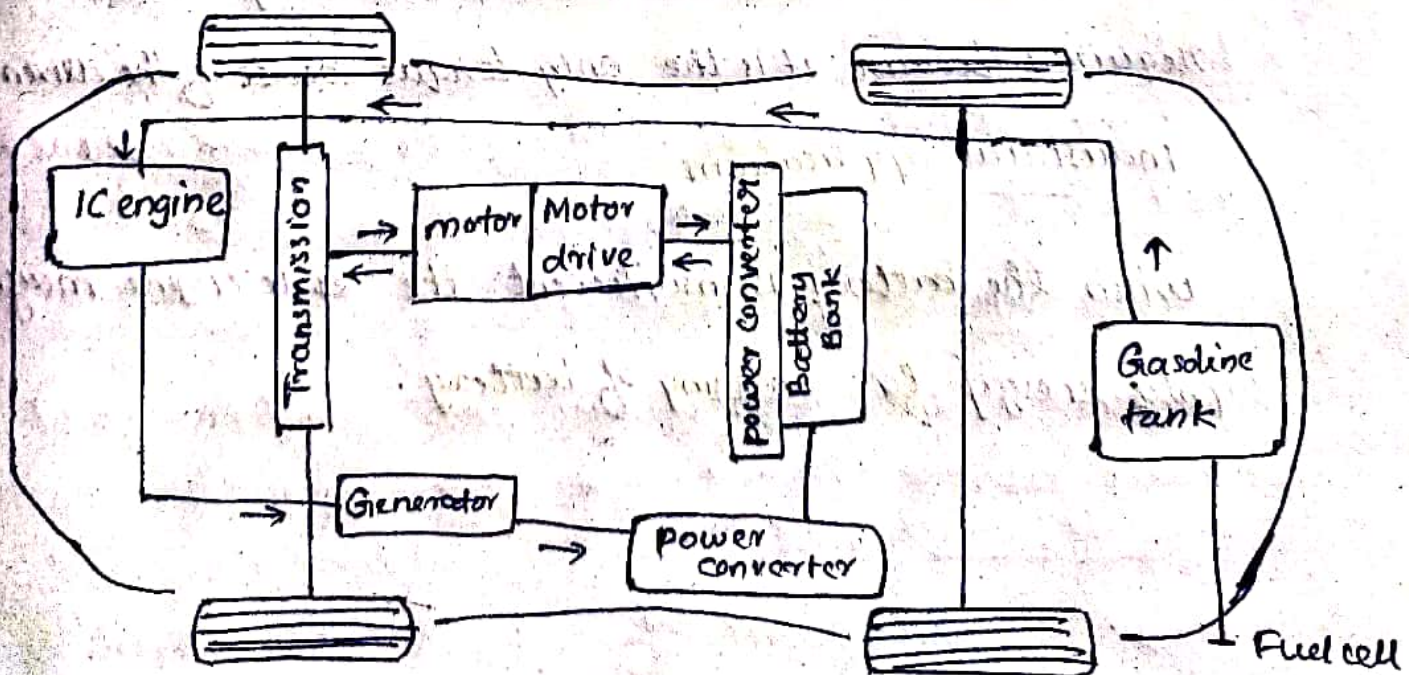
### Introduction to Hybrid electric vehicle

Hybrid electric vehicle may defines the combination of conventional internal combustion engine (ICE) system with an electric propulsion system. The presence of electric ~~propul~~ power train is intended to achieve either better fuel economy than conventional vehicle or better performance.

In Hybrid EV, there is efficiency and effectiveness of vehicle will more. The most common HEV is the hybrid electric cars. It is very useful to efficiency improving technology with regenerative braking. IC engine which will also help to charge the battery pack.

②

#### a) Series hybrid Electric vehicle





Series hybrid EV which IC engine is not directly connected to transmission. The IC engine which may directly connect to generator and also power converter which may help to charge the battery pack and which battery may connect to motor and motor will drive the vehicle or which motor is connected to the transmission.

### Parallel Hybrid EV

#### Advantages of series hybrid EV

- mechanical decoupling between the ICE and driven wheels <sup>allows</sup> the IC engine operating at its very narrow optimal region
- Nearly ideal torque-speed characteristics of electric motor make multi-gear transmission unnecessary

#### Disadvantages

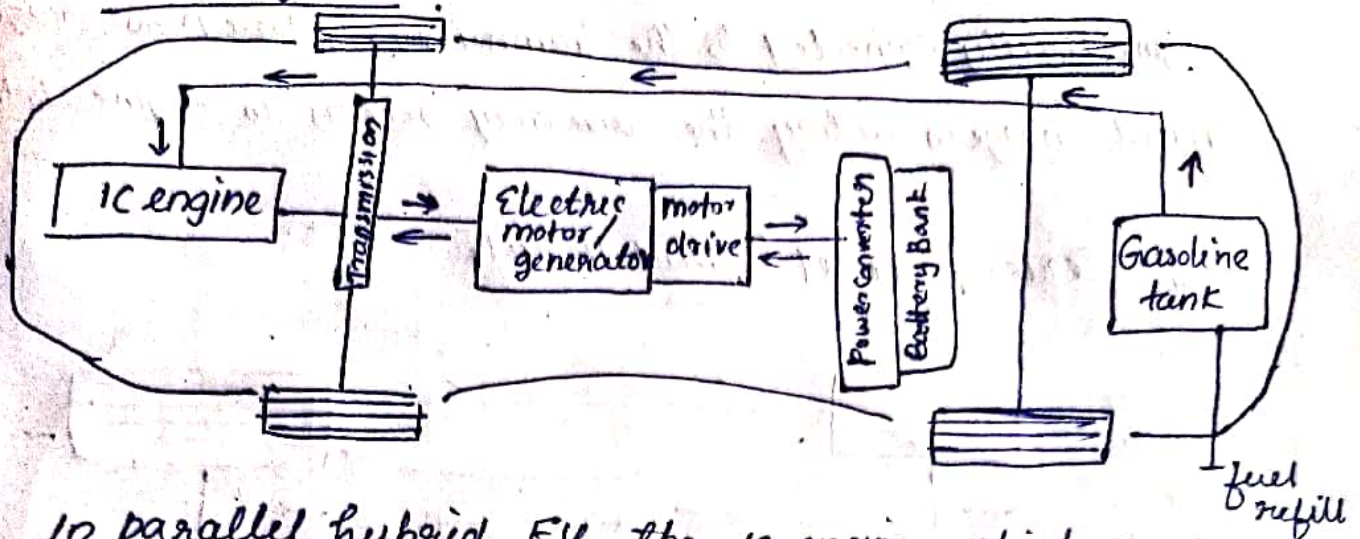
- It reduces efficiency due to The energy is converted into twice (mechanical to electrical and then again to mechanical)
  - Two electric machines are needed and a big traction motor is required because it is the only torque source of the driven wheels
- #### Industrial applications

When the battery is insufficient the IC engine may supply energy for charging of battery.

Automobile industries, aerospace industry.



## b) Parallel hybrid EV



In parallel hybrid EV the IC engine which may performing ~~and~~ drive, which directly connected to transmission. And also motor ~~is~~ charging in ~~electric drive~~ IC engine drive. And in electric drive motor performing drive and IC engine in rest condition.

### Advantages of parallel hybrid EV

- Both engine and electric motor directly supply torque to the driven wheels and no energy from conversion occurs, hence energy loss is less.
- Compactness due to no need of the generator and smaller traction motor.

### Disadvantages of the parallel Hybrid Vehicle.

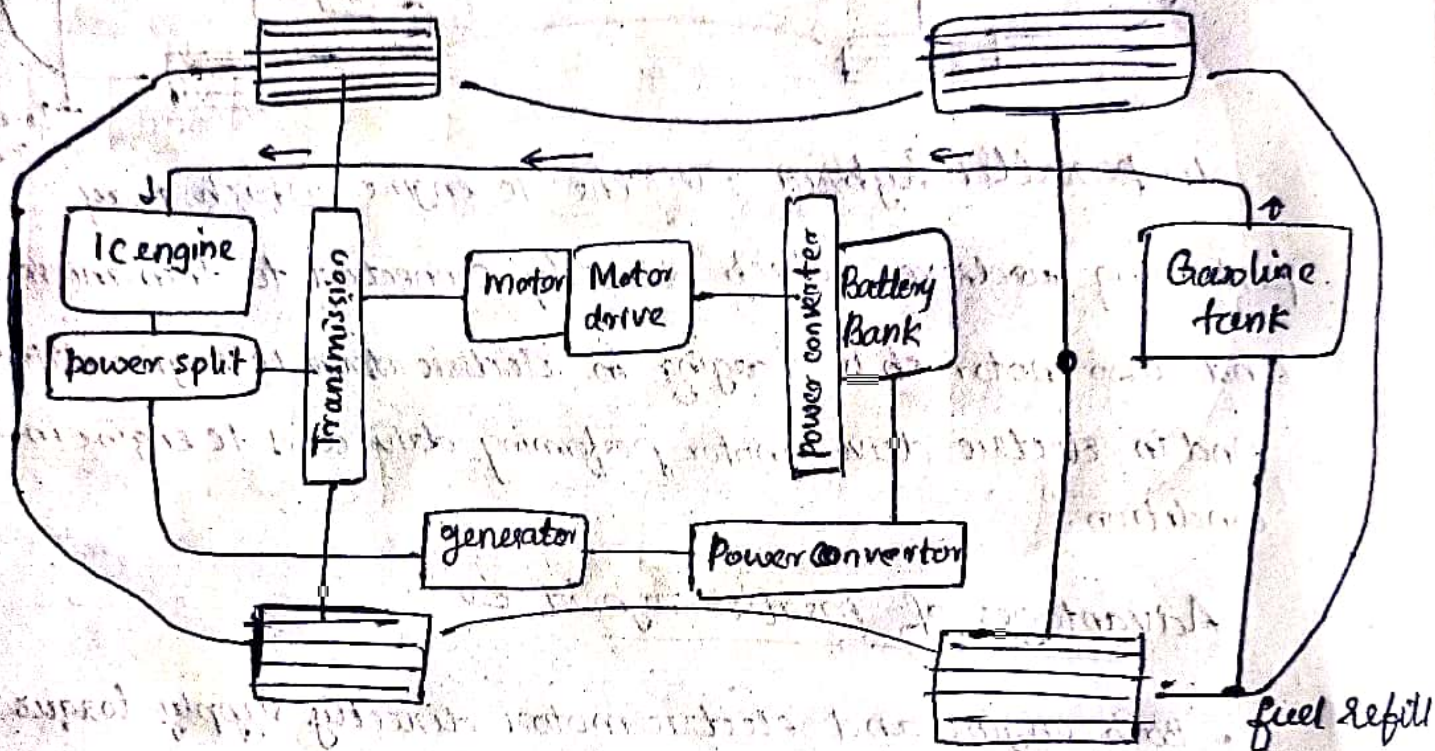
- mechanical coupling between the engines and the driven wheels, thus the engine operating points cannot be fixed in a narrow speed region.
- The mechanical configuration and the control strategy are complex compared to series hybrid drivetrain.



## Industrial applications

Engine directly connected to the transmission, There is no charge or limited charge in battery the drive may occurs in engine to transmission

### c) Series parallel hybrid vehicle



Series parallel hybrid is the feature of both series and parallel hybrid.

many different modes of driving are possible under ICE dominant hybrid vehicle and under motor dominant drive mode.

### Advantages

- Combines the advantages of series and parallel hybrid.
- more effectiveness and high efficiency

### Disadvantages

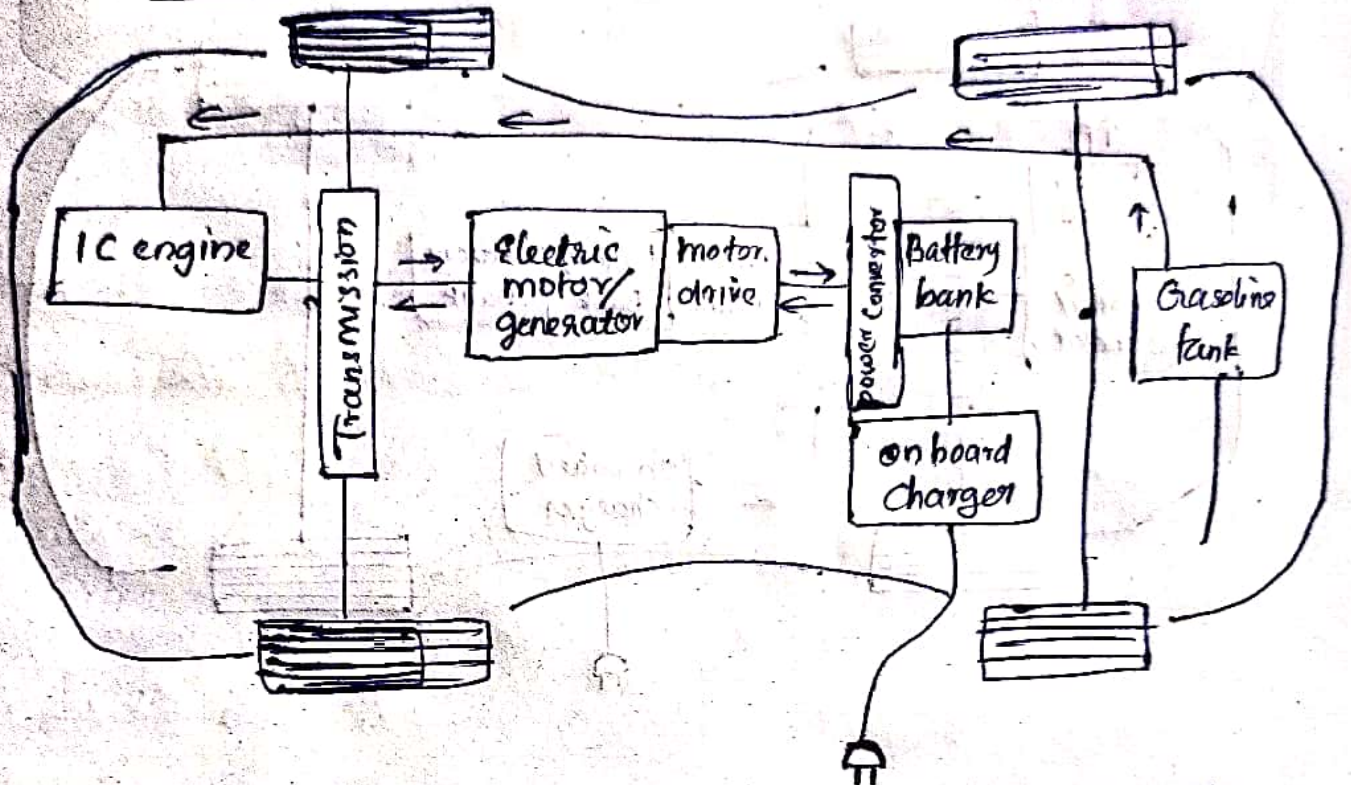
- Design are looking complex than other two hybrids
- controlling mechanism are difficult comparing others.



Industrial application.

Both series and parallel hybrid are more efficient in industrial applications.

#### d) Plug-in Hybrid Electric Vehicle



In plug-in hybrid EV, the IC engine will drive the vehicle and also the motor will drive. Here there is the battery bank will charging by using on board charger which may have charging plug.

#### Advantages of plug-in hybrid EV

- Zero emission when driving on batteries.
- Easy to drive
- fuel efficient in traffic

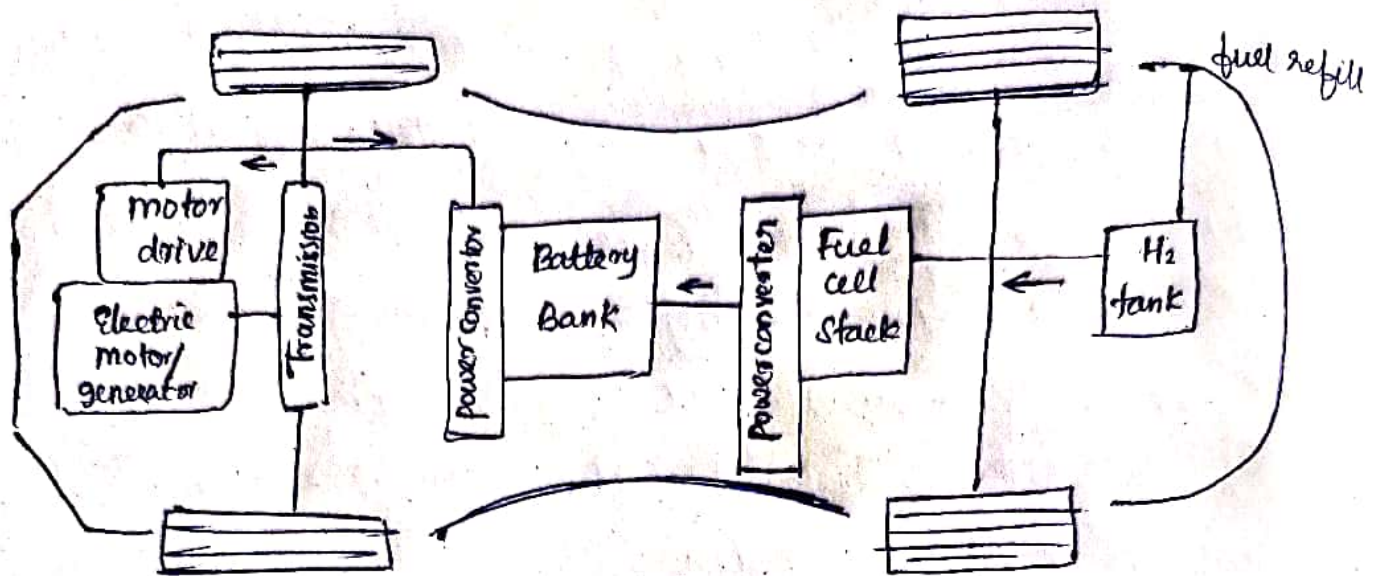
#### Disadvantages

- Battery life concerns
- relatively expensive & complex to maintain



Industrial application :- Automobile Industries, buses, aerospace Industries.

### e) Fuel cell EV



In fuel cell EV there is no IC engine used. here uses fuel cell that generate electricity. Have to refilled at hydrogen charging station. water and heat produces as a byproduct.

#### Advantages

- Less fuel consumption and high efficiency.
- Pollution is prevented, availability.

#### Disadvantages

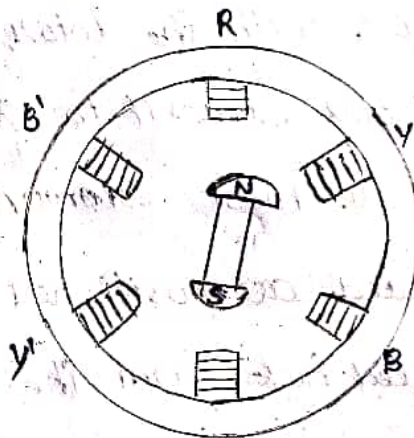
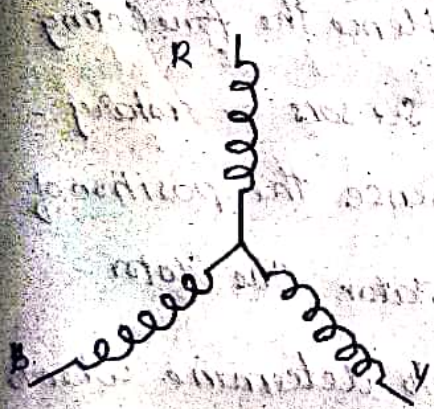
- Hydrogen gas carries more ease which is highly inflammable.
- Difficulty in transportation.
- Hydrogen Extraction is very dangerous.
- Overall cost high.

#### Industrial applications

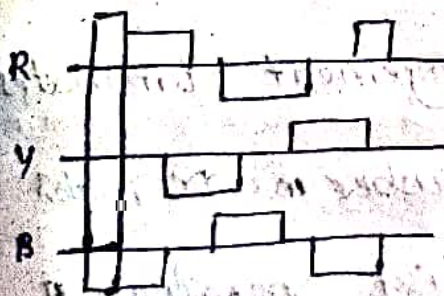
Automobiles, buses, Aeroplanes, motorcycles and bicycles.  
Boats, submarines.



③ Brushless DC motor is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system. Commutation is the process of producing rotational torque in the motor by changing phase currents through it at appropriate times instead of a mechanically commutation system. BLDC motors are also referred as trapezoidal permanent magnet motors.



BLDC motor



Switching Sequence

Here the conventional brushed type DC motor, where in the brushes make the mechanical contact with commutator.



on the rotor so as to form an electric path between a DC electric source and rotor armature windings, BLDC motor employs electrical commutation with permanent magnet rotor and a stator with a sequence of coils. In this motor stator and current carrying conductors are fixed.

The armature coils are switched electronically by ~~are~~ transistors or silicon controlled rectifiers at the correct rotor position in such a way that armature field is in space quadrature with the rotor field poles. Hence the force acting on the rotor causes it to rotate. Hall sensors or rotating encoders are most commonly used to sense the position of the rotor and are positioned around the stator. The rotor position feed back from the sensor helps to determine when to switch the armature current.

This electronic commutation arrangement eliminates the commutator arrangement and brushes in a DC motor and hence more reliable and less noisy operation is achieved.