ASSIGNMENT - I

ELECTRIC VEHICLE POWERTRAIN

SUBMITTED BY

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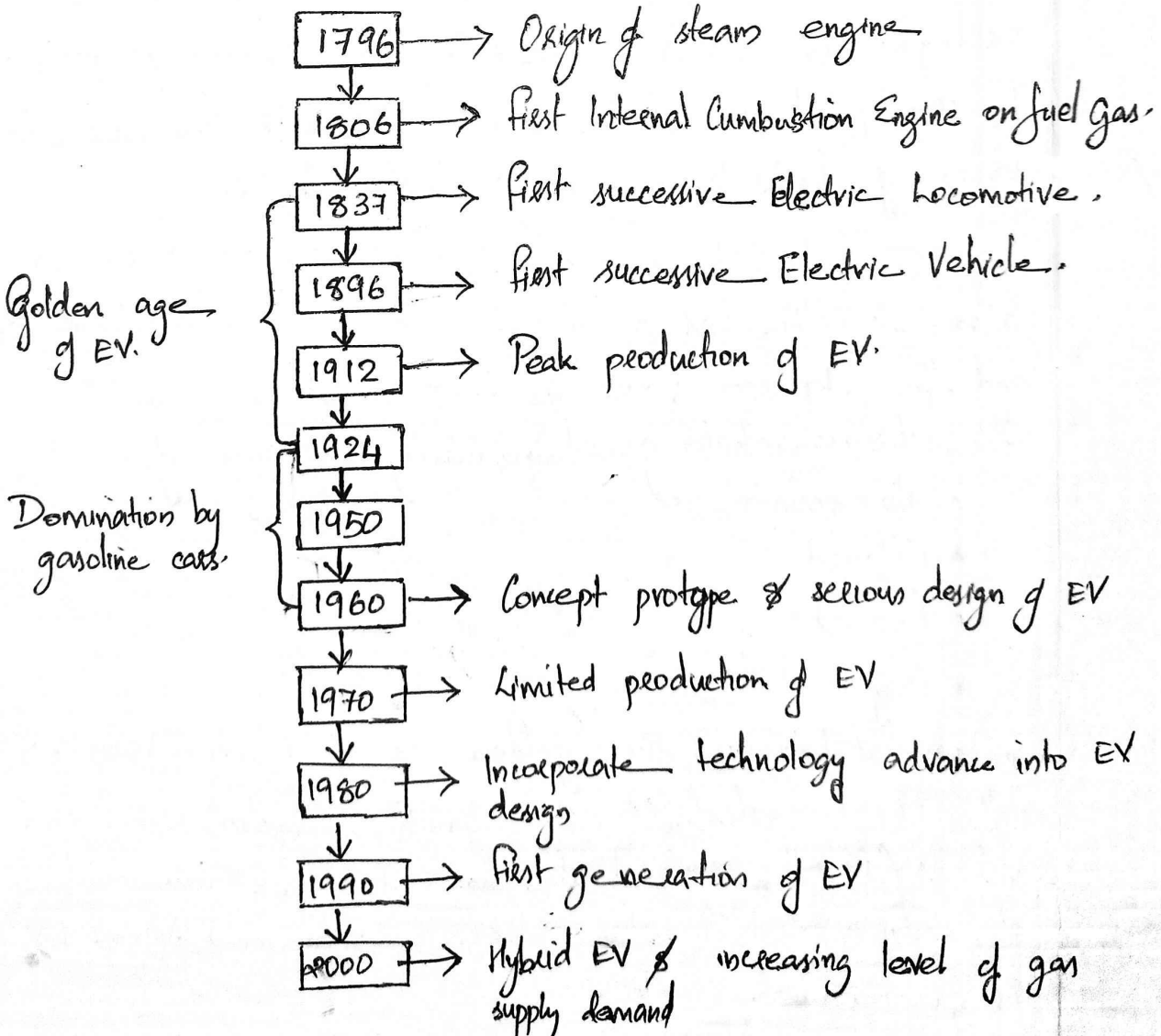
Q1 Explain the journey of Automotive with the help of flow chart from the beginning of 18th century to the 21st century & give brief description on the following milestones in the Automotive Journey:-

a) Invention of electric motor
b) Golden Era of EV
c) Domination of EV by Gasoline Cars.
d) Coming of New Era in EV
e) Introduction to Hybrid Electric Vehicles.

Development of the automobile started in 1672 with the invention of the first steam powered vehicle, which led to the creation of the first steam powered automobile capable of human transportation, built by Nicolas Joseph Cugnot in 1769.

The journey of automotive from the 18th century to 21st century is listed below:



The French Engineer Nicolas Cugnot built the very first steam vehicle, known as Cugnot's vapour engine vehicle. and it is also the very first automobile to be registered. The reservoir of the vehicle is in front of it. The top speed of this vehicle was 4 km/hr. It was used by French army. The maximum load it would carry is 4 tons.
The first IC engine was built by Isaac de Revas in 1806. Hydrogen gas is the fuel used here.
In 1828, Anyos Istvan Jedlik from Austria filed patent for electric motor. He invented a toy car with Electric motor.
In 1885 Carl Benz built the very first production automobile.
In 1886, Thomas Parker Built the very first electric vehicle to undergo production in England.
In 1890 in US, ~~Morrison~~ William Morrison built a vehicle named Morrison Carriage. It was an 8 seater. Its speed was 32 kmph. This was a multispeed vehicle having 4 speed control.
In 1912 petrol-powered cars became easier to drive due to the invention of Charles Kettering and his electric starter.

In 1906 the electric vehicle became very advance. They had a range of 100 miles in a single charge. and the top speed was 45 - 50 kmph.
The electric vehicles gained popularity because of :

* No emission
* Efficient
* low cost
* Easy to start.

In 1910 it became the golden era of Electric Vehicle.
After 1910 EV declined and gasoline vehicles win over electric vehicles fig. It happened because the gasoline ~~was~~ was cheaper than electricity at that time and made the choice between EV and or gasoline much simpler.

At this point, as EVs began to feel the effects of the scandal, buyers began to realise that gas cars were, from a practical & financial point of view atleast a superior form of transport.
And also a reason for EV's declination is world war. Because it consume a lot of time to charge.

In London in 1950's the Great Smog (thick and dense smog) happened causing the death of 12000 lives.
In 1960's in the state of California, 600 cases per day diseases related to pollution were reported. In study 48% were due to automobiles.
To control this they started an organisation called CARB (California Air Resources Board) in 1970's.
From 70's to 2000 ie in the time span of 40 years the California was able to control the pollution by 80%.
Every 10 years they come up with new set of regulations.
There were LEV I programs (1993 - 2003), LEV II programs in 2003
They made catogory of low emission vehicles, ULEV (Ultra Low Emission Vehicle), PZEV (Pure Zero Emission Vehicle)
ULEV include ~~in 2006~~ hybrid vehicles, PZEV include battery/hybrid vehicle eh...

In 2006 in Santa Monica Expo, Tesla Roaster was displayed. People went crazy on this vehicle.
The Hybrid Electric Vehicle was catogorised based on the degree of hybrid digestion. In this case they are of 3 types :-

* micro
* Mild
* Full

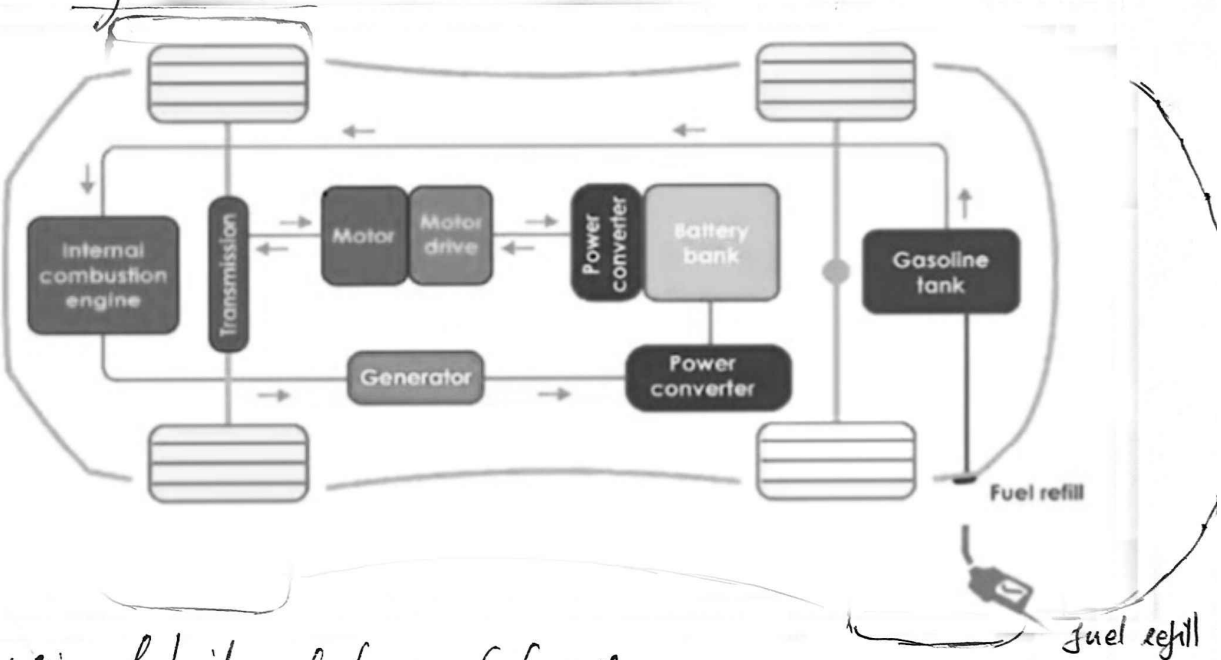
Another basis of catogorisation is hybrid architecture. In this case also they are of divided into 3 types

* Series
* Parallel
* Series - parallel.

P2 Explain and Draw the layout of following Hybrid Electric vehicles with their two advantages, Disadvantages & industrial applications in automotive segment?

a) Series Hybrid Electric Vehicle.
b) Parallel Hybrid Electric Vehicle.
c) Series Parallel Hybrid Vehicle.
d) Plug in Hybrid Electric Vehicle.
e) Fuel cell Electric vehicle.

(a) Series Hybrid Electric Vehicle



In series hybrid electric vehicle the ICE is not connected to transmission but it is connected to generator. And the generator is charging the battery bank and the motor will use energy from battery bank. This is called series combination. ie motor is driving the vehicle and the engine is generating battery bank. Here motor is primary source & engine is secondary source.

Advantages

* Mechanical decoupling between the ICE and driven wheels allows the IC engine operating at its very narrow optimal region.
* Nearly ideal torque-speed characteristics of electric motor make the multi-gear transmission unnecessary

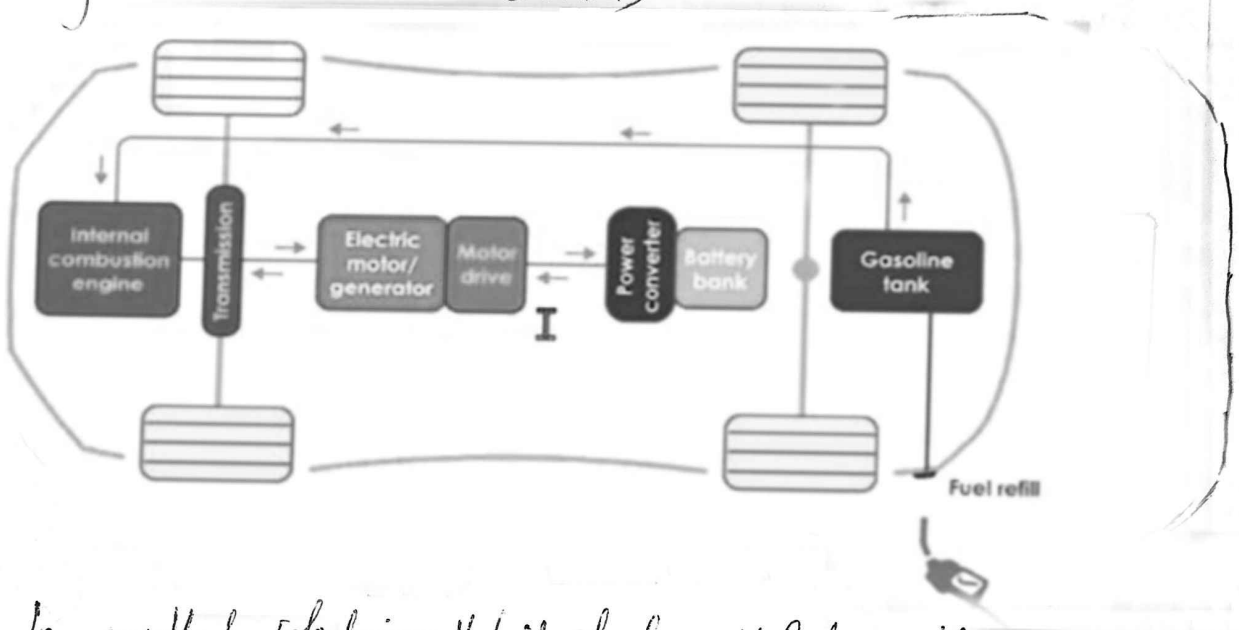
Industrial applications

BMW i3., Larger vehicle such as heavy duty bus.

Disadvantages

* The energy is coveted twice and this reduces the overall efficiency
* Two electric machines are needed & a big traction motor is required because it is the only torque source of the driven wheels.

(b) Hybrid Electric Vehicle (Parallel)



In parallel ~~Electric~~ Hybrid Electric Vehicle the ICE is fitted with the powerful electric motor to assist the engine.

Advantages

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

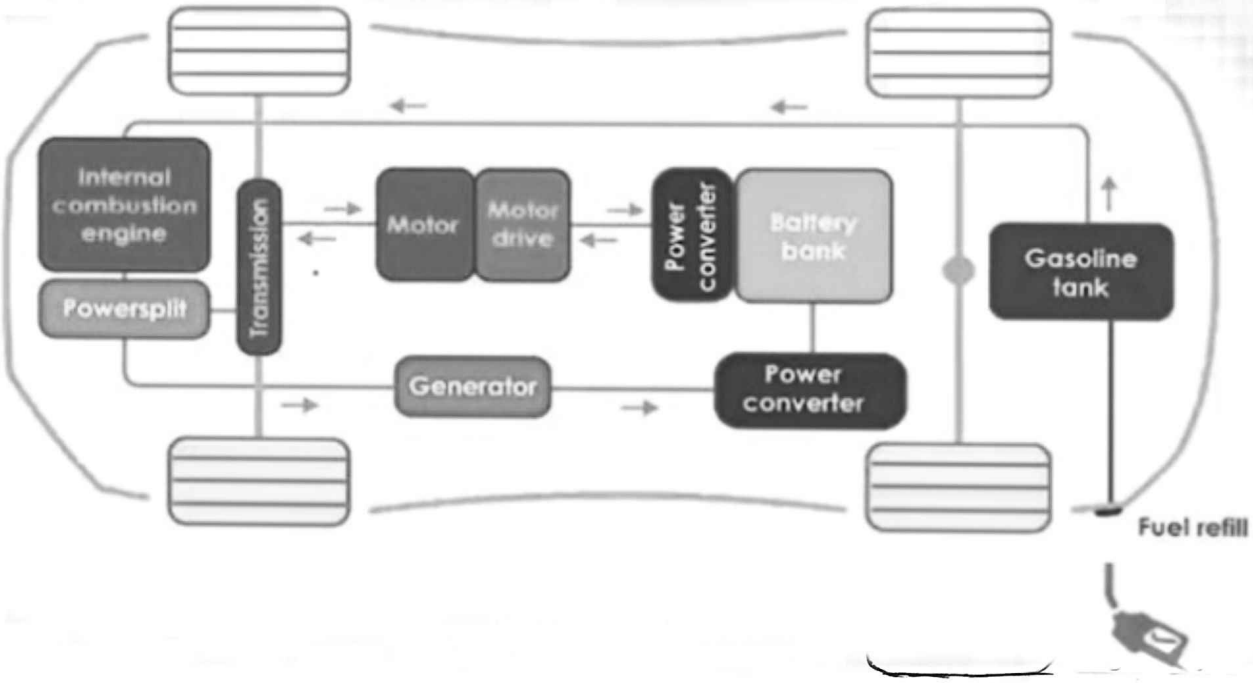
Disadvantage:

* Mechanical coupling b/w the engines & the driven wheels, thus the engine operating point cannot be fixed in a narrow speed region.
* The mechanical configuration & the control strategy are complex compared to series hybrid drivetrain.

Industrial application

Honda Civic Hybrid, Mercedes Benz S400 Blue Hybrid, Urban passenger cars.

(c) Series-parallel Hybrid Vehicle.



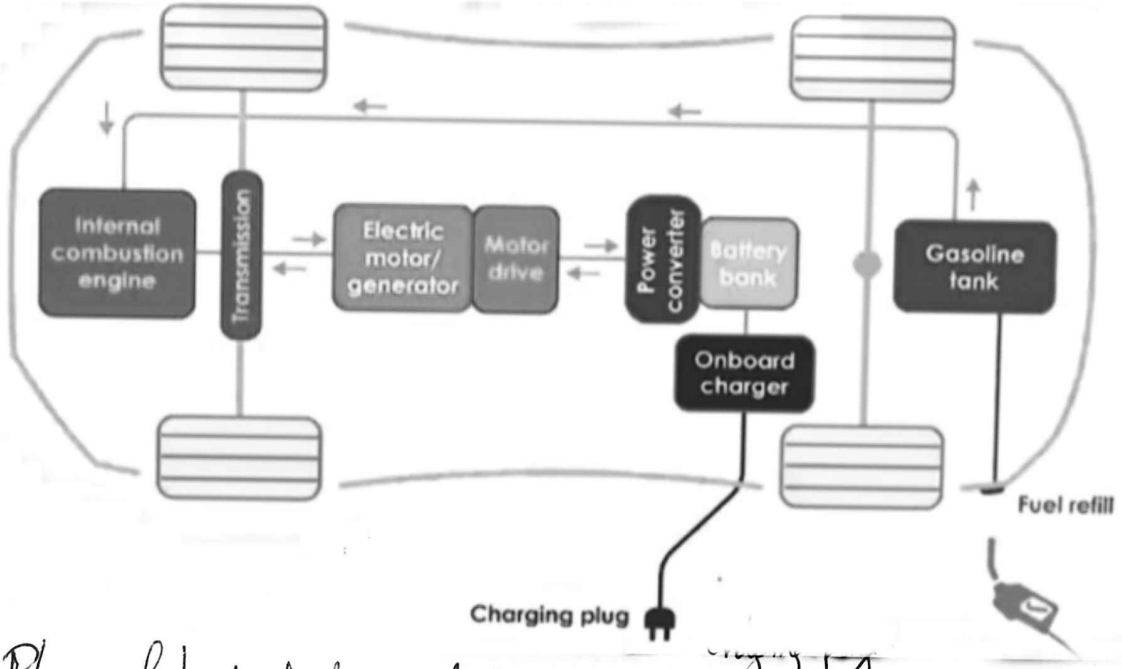
Series parallel hybrid vehicle is the best hybrid vehicle.
Here the motor is connected to transmission
The ICE is connected to a device called powersplit. The powersplit will divide the power to the generator & transmission.
When the battery is low & we want to recharge the battery bank the power split will direct the power to the generator.
Basically we can use this full setup either way possible due to the ~~transm~~ power split, we can use this setup in parallel combination where the motor & engine both are powering the transmission or can use it in series combination where we can drive the vehicle using motor & use the engine to recharge the battery bank.

Application
Toyota Prius, light duty vehicles.

Advantages
* Series-parallel drive train enable the engine & electric motor to provide power independently or in conjuction with one another.
* Zero emission operation is possible.

Disadvantages
* Very expensive system
* Complex space packaging.

(d) Plug-in - Hybrid Electric Vehicle



Plugin hybrid Electric vehicle is nothing but it have an option to ~~plug~~ plug in for charging. In addition to internally by its on board internal combustion engine - powered generator PHEV have a larger battery pack that can be charged from the power grid, which ~~can be~~ is also more efficient and can cost less than using only the on-board generator and also often have a more powerful electric output capable of longer and more frequent EV mode driving.

Advantages

* Easy to drive.
* Fuel efficient in traffic

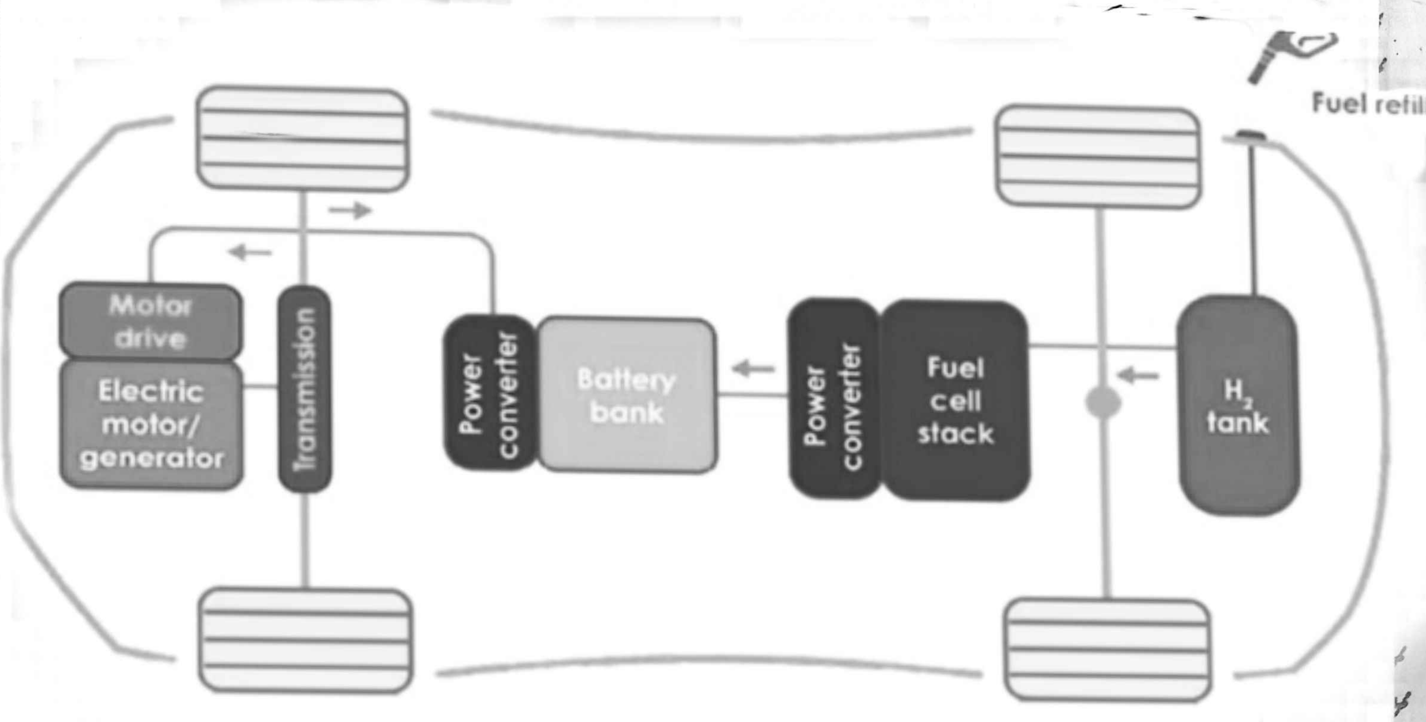
Disadvantages

* Fuel economy not very good on motorway journeys
* Relatively expensive & complex to maintain.

Application

Bmw- i8, passenger cars, commercial vehicles, vans, etc...

(e) Fuel Cell Electric Vehicle



Here we have electric motor connected to transmission and have power converter which convert DC to AC & gives to the motor drives & through transmission runs the vehicle.
Fuel cell EV is the concept similar to Hybrid EV. The only difference is instead of engine fuel cell is used to recharge the battery bank.
Here we have fuel cell tank and H_2 tank. H_2 will come to fuel cell & will generate electricity & charge the battery bank & then the battery bank will power the motor.

Advantages
* ~~No har~~ Produce no harmful tailpipe emissions.
* Highly efficient when compared to others

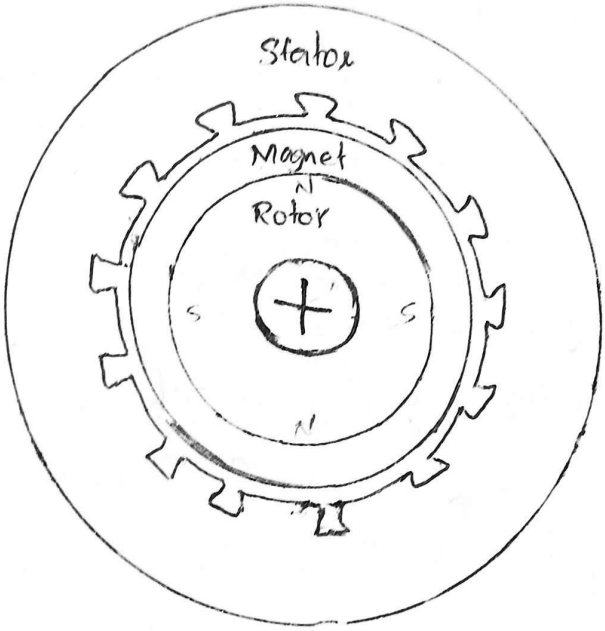
Disadvantages
* Difficult to handle H_2 fuel
* Space - in sense of battery
* Cost

Application

Hyundai Nexo, Toyota Mirai etc...

Q3. Explain with diagram the construction and working principle of Brushless Motor BLDC.

Brushless DC motor drive use DC power source. Its maximum efficiency is 95% and minimum efficiency is 35%. BLDC have a weight of 0.3 to 0.4 kg. It is the lightest motor and is seen in vehicles below 15 kw. 2wheeler and 3 wheeler mainly use BLDC because it consume only small space. ~~and it keep moto~~



CONSTRUCTION

The stator of BLDC motor is made up of silicon steel stampings with slots in its interior surface. These slots accomodate either a closed or opened distributed winding usually it is closed. This windig is to be wound for a specified number of poles. This winding is suitably connected to a DC supply through a power electronic switching circuitry named electronic commutator.

Rotor is made up of forged steel, Rotor accomodates permanent magnets. Number of poles of the rotor is the same as that of stator. The rotor shaft carries a rotor position sensor. This position sensor provides information about the position of the shaft at any instant to the controller which sends suitable signals to the electronic commutator

WORKING PRINCIPLE

BLDC motor works on the principle of similar to that of a conventional DC motor ie, the Lorentz force law which states that whenever a current carrying conductor placed in a magnetic field it experience a force. As a consequence of reaction force, the magnet will experience an equal and opposite force. The in case the BLDC motor, the current carrying conductor is stationary while the permanent magnet moves. When the stator coils are electrically switched by a supply source, it becomes electromagnet and starts producing the uniform field in the airgap. Though the source of supply is DC, switching makes to generate an AC voltage waveform with trapezoidal shape. Due to the force of interaction b/w electromagnet stator & permanent magnet rotor, the rotor continues to rotate.