Assignment

Q.1. Explain the Journey of Automotive with the help of flow chart from 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 Electric Vehicle by Gasoline Cars
(d) Coming of New Era in EV
(e) Introduction to Hybrid Electric Vehicles

Ans :-

Automobile means Auto + mobile. Auto means self and mobile means movable, i.e. self-movable.
A vehicle which can propel itself from one location to another.

(i) The 1st steam Engine vehicle developed by Nicolas Cugnot in 1768 also called as Cugnot's Vapour Engine Vehicle. This vehicle is used by French army having top speed as 4 km/hr and having payload capacity as 4 tonnes.

(ii) Then in 1806 the first Ever I.C. Engine vehicle invented by Isaac de Revaz. This is runs on Hydrogen gas.

(a) Invention of Electric Motor

(iii) In 1826 the austrian Scientist Anyos Zedlik files patent for indeginous electric Motor. Also some prototype like toy cars which uses this motor.

(b) Golden Era of EV

(iv) Thomas Parker provide technologies for London Underground and Electric tram in Burmingham in 1865.

(v) In 1886 he build the 1st production electric vehicle.

(vi) Around Same time in 1885 Karl Benz invented an I.C. Engine vehicle which runs on gasoline.

(viii) Also around that time production of Electric vehicles started in Germany and spread across Europe.

(viii) In 1890 Morrison Carriage build by William Morrision in U.S.A. This vehicle is 8 seater and having speed of 20 miles/hr. The motor specification for this electric vehicle is 4h.p. (3 KW). The battery specification are 58 V 112 Ah i.e. 6.5 kWh power. It has 4 speed control through voltage.

(ix) In 1st decade of 20th century the Electric vehicle present on Road having range of 100 miles and top speed of 45-50 kmph.

(x) In 1906 the market share of U.S.A. has 48% Steam Engine vehicle, 32% of Electric Vehicle and 20% of Gasoline vehicle.

(xi) The EVs are popular that time has some advantage than I.C. Engine and steam Engine as
1. No emmission 2. Efficient 3. Low cost. 4. Easy start.
As that time no envention of self start EV has more advantage.

(xii) Upto 1910 Golden Era of Electric vehicle.

(c) Domination of Electric Venhicle by Gasoline cars

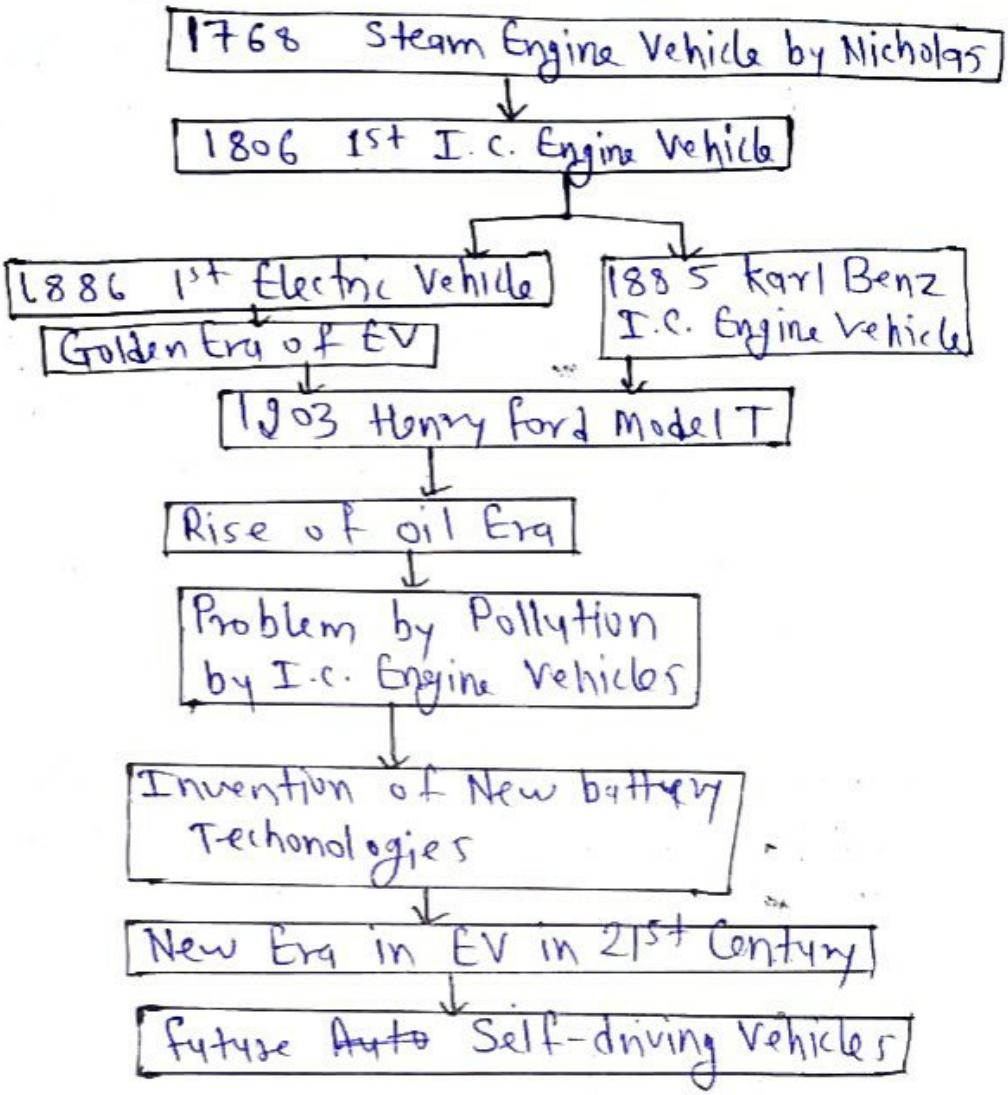
(xiii) Henry ford invented the Model T in 1903. Also he came up with Assembly line Production. Due to this I.C Engine vehicle price decreases drastically. And same not much possible for Electric vehicles.

(xiv) In 1912 Chevrolet imply Self start in I.C. Engine vehicle.

(xv) In the scenario of World War Range and charging time are drawbacks for Electric vehicle.

(xvi) Last reason is oil prices and oil lobby.

Journey of Automotive



~~(xviii)~~ (d) Coming of New Era in EV

① New Regulations Renew Electric Vehicle Interest
- New federal and state regulations create a renewed interest in electric vehicle. The result: Automakers begin modifying popular vehicle models into electric vehicles, enabling them to achieve speeds and performance much closer to gasoline-powered vehicles.

② GM realses the EV1. The EV1 quickly gains a cult following. Toyota introduces 1st mass-produced hybrid Prius.

③ Silicon Valley startup Takes on Electric cars Tesla Motors announces it will produce car with range of 200+ miles.

④ Developing a Nation wide charging Infrastructure.
⑤ Electric vehicle battery cost Drop. The battery is the most expensitive part in an EV, Helping make electric vehicles more affordable.

(e) Introduction to Hybrid Electric Vehicles

① In hybrid vehicles on basis of degree of hybridization (i) mirco (ii) mild and (iii) full hybrid vehicles.

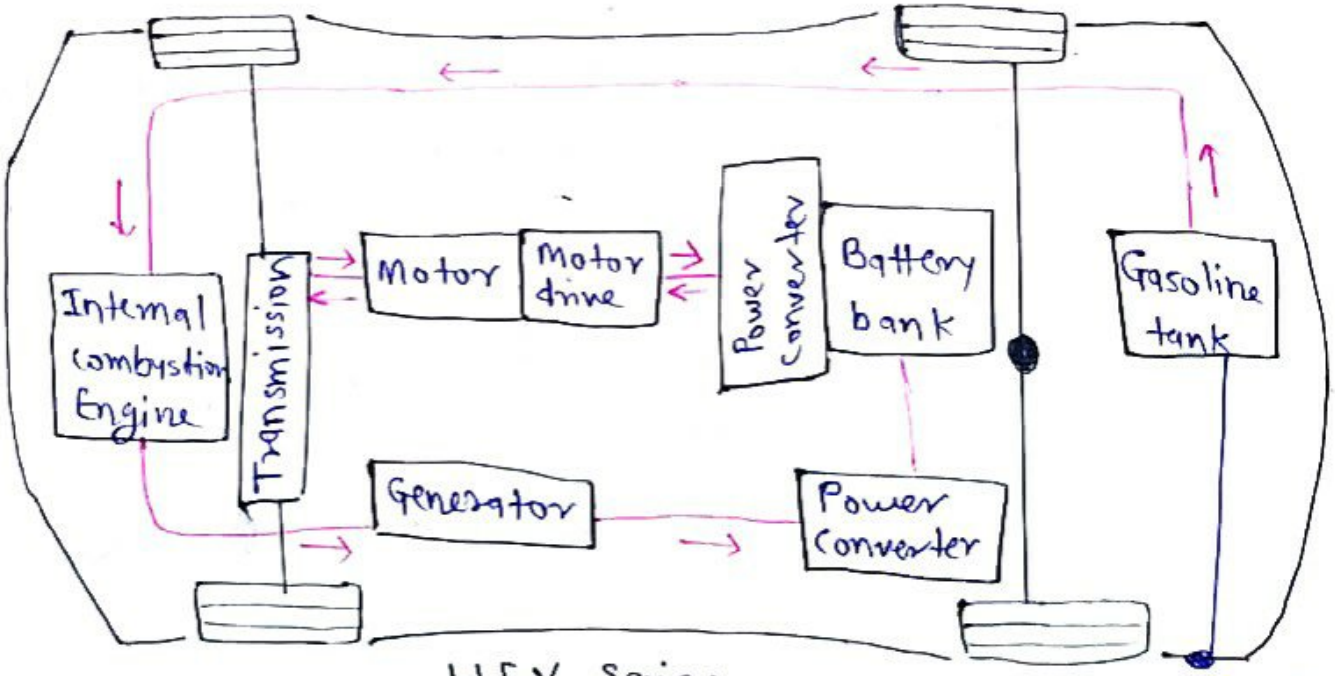
② on basis of Hybrid Architecture (i) Series (ii) Parallel, (iii) Series Parallel. and (iv) Plug-in hybrid vehicle.

Q.2. Explain and Draw the Layout of following Hybrid Electric Vehicles with their two Advantages, Disadvantage & Industrial application in automotive segment?

(a) Series Hybrid Electric vehicles
(b) Parallel Hybrid Electric vehicles
(c) Plug in Hybrid electric vehicle
(d) Series Parallel Hybrid Vehicle
(e) Fuel Cell Electric Vehicle.

Ans :-

(a) Series Hybrid Electric Vehicles



HEV Series

A series is one in which only one energy converter can provide propulsion power. IC engine acts as a prime mover. It drives an electric generator that delivers power to the battery or energy storage link and the propulsion motor. A downsized IC engine drives a generator, which supplements the batteries and can charge them when they fall below a certain SOC. The power required to propel the vehicle is provided solely by electric motor. Electric motor power requirements are exactly the same as electric vehicle.

Advantages of series hybrid:

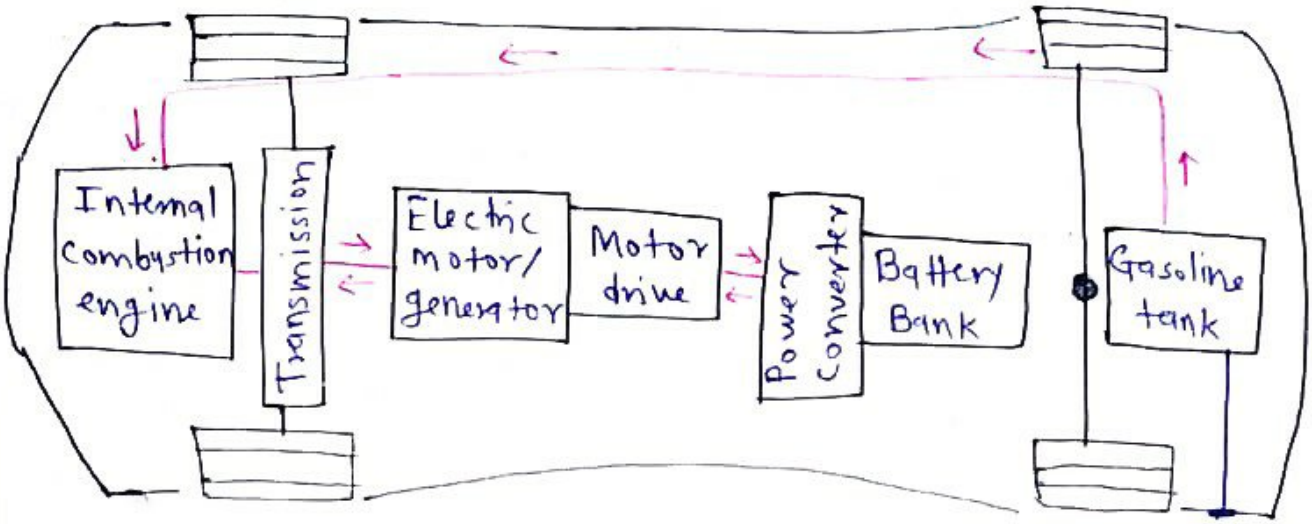
1) There is no mechanical link between the combustion engine and the wheels. The engine-generator group can be located everywhere.
2) The combustion engine can operate in a narrow rpm range (its most efficient range), even as the car changes speed.

Disadvantage of series hybrid:

1) The ICE, the generator and the electric motor are dimensioned to handle the full power of the vehicle. Therefore, the total weight, cost and size of the powertrain can be excessive.
2) The power from the combustion engine has to run through both the generator and electric motor. During long-distance highway driving, the total efficiency is inferior to a conventional transmission, due to the several energy conversions.

Example of SHEV: 1) Renault kangoo
2) BMW i3

(b) Parallel Hybrid Electric Vehicle



Hybrid Electric Vehicle (HEV) parallel

A parallel hybrid is one in which more than one conversion device can deliver propulsion power to the wheels. The IC engine and electric motor are configured in parallel with a mechanical coupling that blends the torque coming from two sources. In parallel HEV, the power requirements of the electric motor are lower than electric vehicle or Series hybrid; since IC engine complements to total power demand of the vehicle.

Advantages of parallel hybrid vehicles:

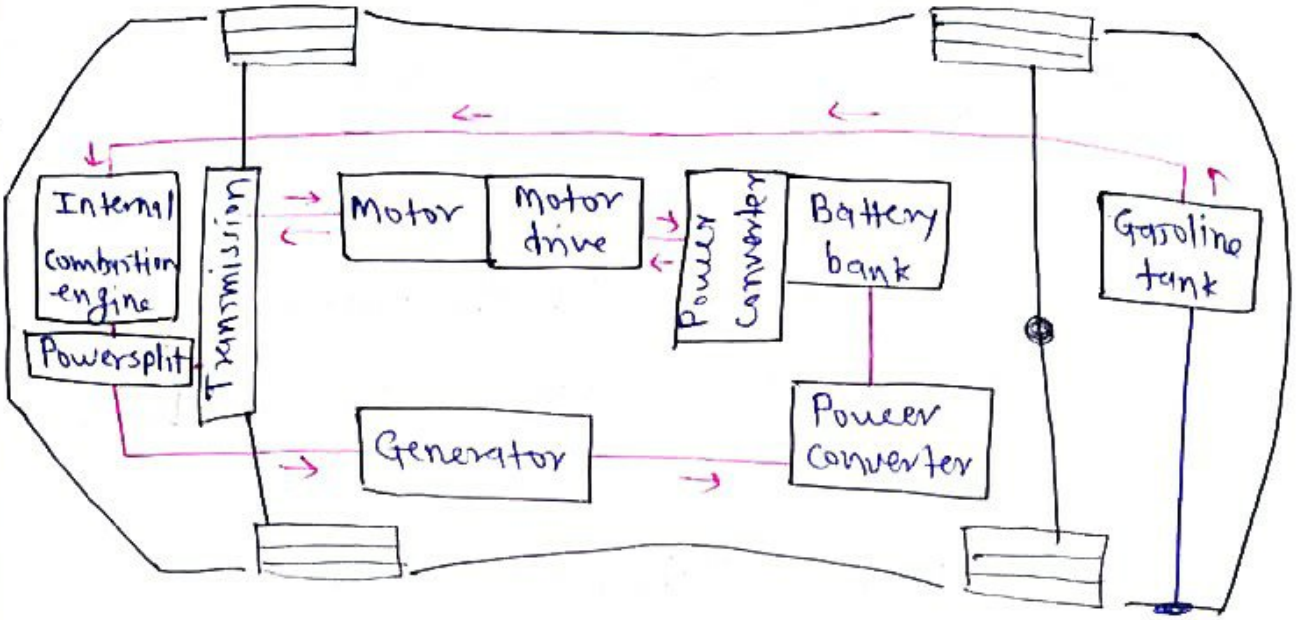
1) Total efficiency is higher during cruising and long-distance highway driving.
2) Large flexibility to switch between electric and ICE power.

Disadvantages of Parallel hybrid:

1) Rather complicated system.
2) As the ICE is not decoupled from the wheels, the battery cannot be charged at standstill.

Example of PHEV: 1) Honda Civic 2) BMW 7 series Active Hybrid.

(c) Series parallel Hybrid Vehicles



HEV Series-parallel

In S-P hybrids, the IC engine is also used to charge the battery. The architecture is more complicated, involving additional mechanical links and controls compared to series hybrid and an additional generator compared to parallel hybrid, S-P HEV is basically series HEV but with a small series element added to it. It ensures that the battery charge is sustained in prolonged wait periods in traffic jams. The power split device allocated power from IC engine to front wheels through driveshaft and electric generator depending on driving condition. For short bursts of acceleration, power can be delivered to the driveshaft from both IC engine and electric motor. A central control unit regulates power flow for the system using multiple feedback signals from various sensors.

Advantages of S-P hybrid:

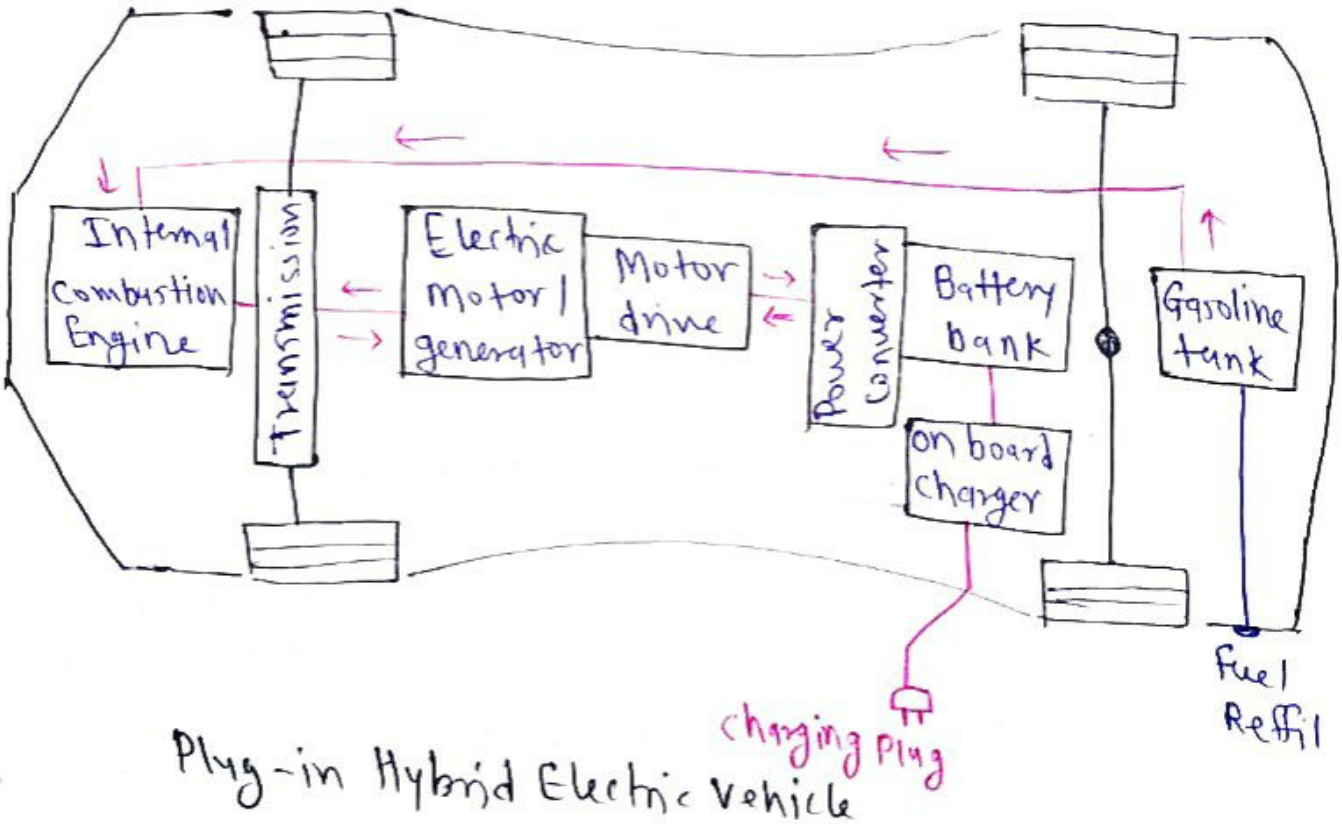
1) Maximum flexbility to switch between electric and ICE.
2) Decoupling of the power supplied by the engine from the power demanded by the driver allows for a smaller, lighter, and more efficient ICE design.

Disadvantages of S-P hybrid:

1) very complicated system, more expensive than parallel hybrid.
2) The efficiency of the power train transmission is dependent on the amount of power being transmitted over the electrical path, as multiple conversions, each with their own efficiency, lead to a lower efficiency of that path (~70%.) compared with the purely mechanical path (98%).

Examples of S-PHEV: 1) Toyota Prius 2) Lexus CT200h.

(d) Plug-in Hybrid Electric Vehicle



Plug-in Hybrid Electric Vehicle

A plug-in hybrid electric vehicle (PHEV) is a full hybrid, able to run in electric-only mode, with larger batteries and the ability to recharge from the electric power grid. Their main benifits is that they can be gasoline-indipendent for daily commuting, but also have the extented range of a hybrid for long trips.
It has same drive train architecture as Parallel hybrid addition to larger battery pack and on board charger.

Advantages of Plug-in hybrid:

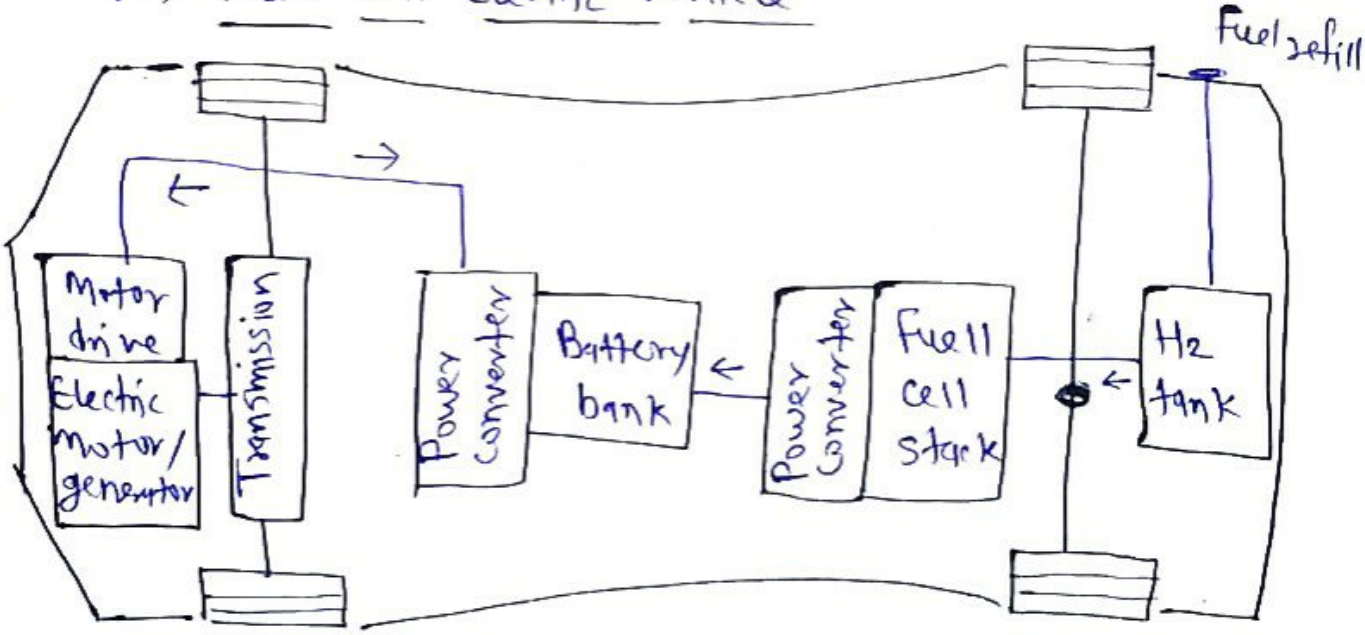
1) Unlike conventional hybrids, these hybrids can be plugged in and recharged from an outlet, allowing the vehicle to drive extended distances using just electricity.
2) It has large range compared to other hybrid vehicles.

Disadvantages of PHEV:

1) As it charge directly from grid additional charging system required.
2) Battery pack size is large compared to other hybrid EV, therefore cost is more.

Examples of PHEV: 1) Mercedes Blue ZERO E-CELL PLUS
2) Opel Ampera.

(e) Fuell Cell Electric Vehicle



Fuell Cell eletric vehicle (FCEV)

Fuel cell electric vehicles use fuel cell stacks to convert onboard gaseous hydrogen to electricity, which is then stored in a battery to power the vehicle's electric motor.

Advantages of FCEV:

1) Unlike Electric Vehicle runs on battery problem related with range is not same with fuel cell EV.

2) Also for Battery EV charging time is these but for fuel cell it can refill in 3-5 mins.

Disadvantage of FCEV:

1) The cost of FCEV is high than other EVs, as fuel cell stacks are made of platinum.

2) The availability of fuel (hydrogen) is difficult as hydrogen economy is in intial stages. Also techology for hydrogen storage is very expensive.

Example of FCEV: 1) Toyota Mirai 2) Hyundai Nexo

Q.3. Explain with Diagram the construction & working principle of Brushless Motor BLDC?

Ans:-

A brushless DC motor (known as BLDC) is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system instead of a mechanically commutation system. BLDC motors are also referred as trapezoidal permanent magnet motors.

Construction:

BLDC motors have many similarities to AC induction motors and brushed DC motors in terms of construction and working principles respectively. Like all other motors, BLDC motors also have a rotor and a stator. BLDC motors can be constructed in different physical configurations. Depending on the stator windings, these can be configured as sig single-phase, two-phase, or three-phase motors. However, three-phase BLDC motors with permanent magnet rotor are most commonly used.

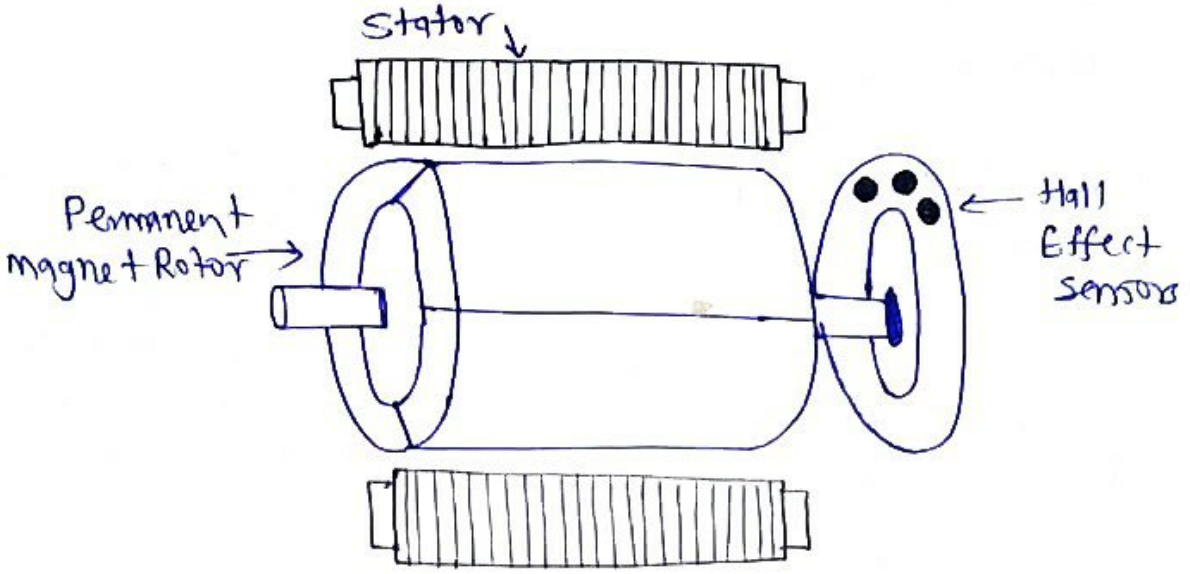


Fig: BLDC motor

Stator

Stator of a BLDC motor made up of stacked steel laminations to carry the windings. These windings are placed in slots which are axially cut along the inner periphery of the stator. These windings can be arranged in either star (Y) or Delta (Δ). The major difference between the two patterns is that the Y patterns gives high torque at low RPM and the Δ patterns gives low torque at low RPM. Most BLDC motors have three phase star connected stator.

Rotor

BLDC motor incorporates a permanent magnet in the rotor. The number of poles in the rotor can vary from 2 to 8 poles pairs with alternate south and north poles depending on the application requirement. A proper magnetic material for the rotor is needed to produce required magnetic field density. The rotor can be constructed with different core configurations, such as the circular core with permanent magnet on the periphery, circular core with rectangular magnets, etc.

Hall Sensors

Hall Sensor provides the information to synchronize stator armature excitation with rotor position. Since the commutation of BLDC motor is controlled electronically, the stator windings should be energized in sequence in order to rotate the motor. Before energizing a particular stator winding, acknowledgment of rotor position is necessary. So the Hall Effect sensor embedded in stator senses the rotor position.

Working Principle and Operation of BLDC Motor

BLDC motor works on the principles similar to that of a conventional DC motor, i.e., the Lorentz force law which states that whenever a current carrying conductor placed in a magnetic field it experiences a force. As a consequence of reaction force, the magnet will experience an equal and opposite force. In case 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 air gap. Though the source of supply is DC, switching makes to generate an AC voltage waveform with trapezoidal shape. Due to the force of interaction between electromagnet stator and permanent magnet rotor, the rotor continues to rotate.

Advantages: 1) It has no mechanical commutator and associated problems.
2) Quite operation due to absence of brushes.

Disadvantages: 1) These motors are costly.
2) Need of additional sensors.

Applications: 1) Computer hard drives and DVD/CD players
2) Electric vehicles, hybrid vehicles, and electric bicycles.

Q.4. Explain Battery Pack Composition with initial component discription as well as Advantages & disadvantages of Battery Pack in Electric Vehicle Installation?

Ans :-

1) Components of battery packs include the individual batteries or cells, and the interconnects which provide electrical conductivity between them. Rechargeable battery packs often contain a temperature sensor, which the battery charger uses to detect the end of charging. Interconnects are also found in batteries as they are the part which connects each cell, though batteries are most often only arranged in series strings.

2) For an incline package, cells are selected and stacked with solder in between them. The cells are pressed together and a current pulse generates heat to solder them together and to weld all connections internal to the cell.

3) Life of a battery-pack is primarily dependent on life-cycle of the battery-cells.
Cycle-life of a battery cell is a fundamental parameter, depending upon its chemistry, but also on many others factors such as
(i) C-rate of charging-discharging.
(ii) Temperature of its charging-discharging and also its storage temperature.
(iii) Depth of discharge (DoD).

Battery Pack Development

4) No. of cells assembled to form a battery-pack for required voltage and capacity.
- Safety issues
- Cell balancing
- Carefull electrical design so that every cell gets equally charged / discharge.

5) Battery Mangement system (BMS):
- Only balanced cells used in pack.

- Pack should get cut off if temperature increases for safety.
- Communicates with charger to decide charging strategy.

6) Building Packs from cells:

Generally cells has to be connected in series & parallel to make a pack.

- mpns implies m cells in parallel to form Modules and then connecting n modules in series.
- nsmp implies n cells in series to form Strings and the connecting m strings in parallel.

Advantages

1) An advantage of a battery pack is the ease with which it can be swapped into or out of a device. This allows multiple packs to deliver extented runtimes, freeing up the device for continued use while charging the removed pack separately.

2) Another advantage is the flexibility of their design and implementation, allowing the use of cheaper high-production cells or batteries to be combined into a pack for nearly any application.

3) At the end of product life, batteries can be removed and recycled separately, reducing the total volume of hazardous waste.

Disadvantages

1) Thermal mangement of battery pack is very difficult.

2) Packs are often simpler for end users to repair or tamper. Though it is important to take safety precautions as they pose danger as potential chemical, electrical, and fire risks.