Q1) Explain the journey of Automotive with the help of flow chart from the Begining of 18th centuary to the 21st centuary and give brief description on the following milestones in the Automotive.

Journey:-

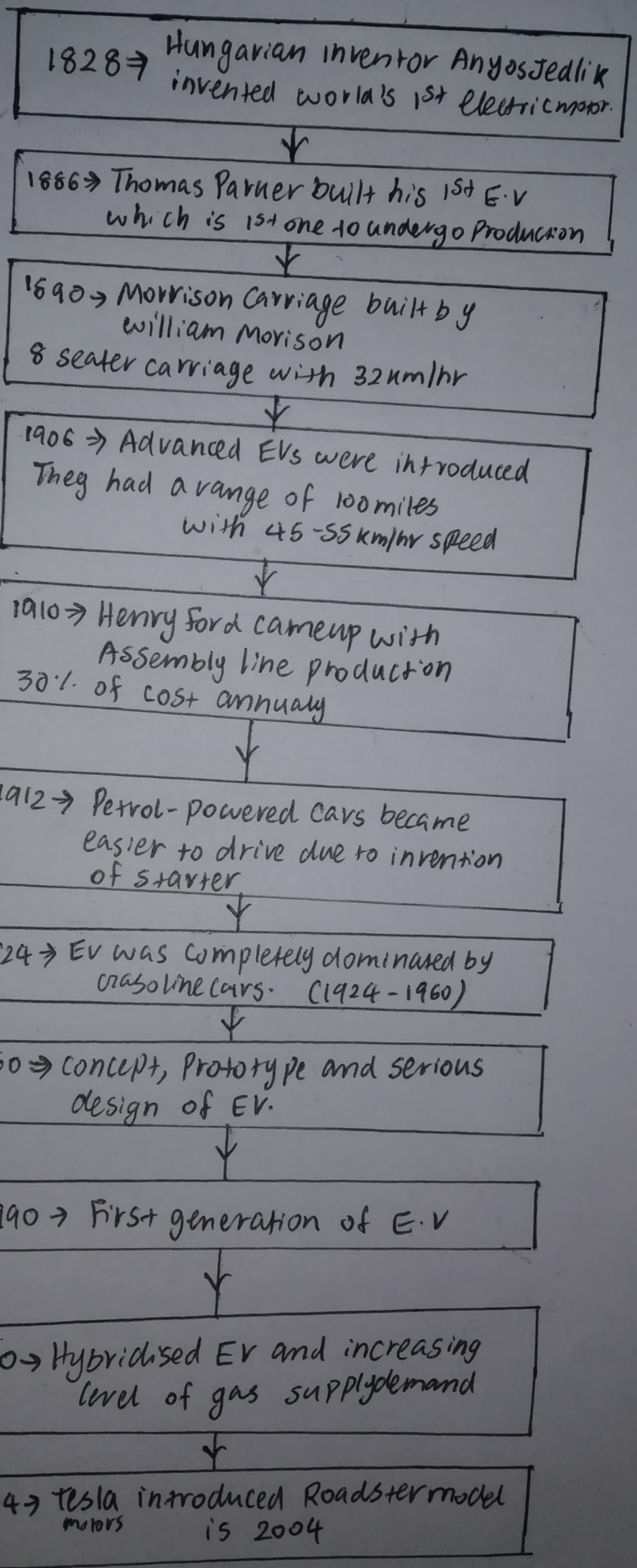
a) Invention of electric motor.

b) Golden Era of EV

c) Domination of Electric vehicle by Gasoline cars.

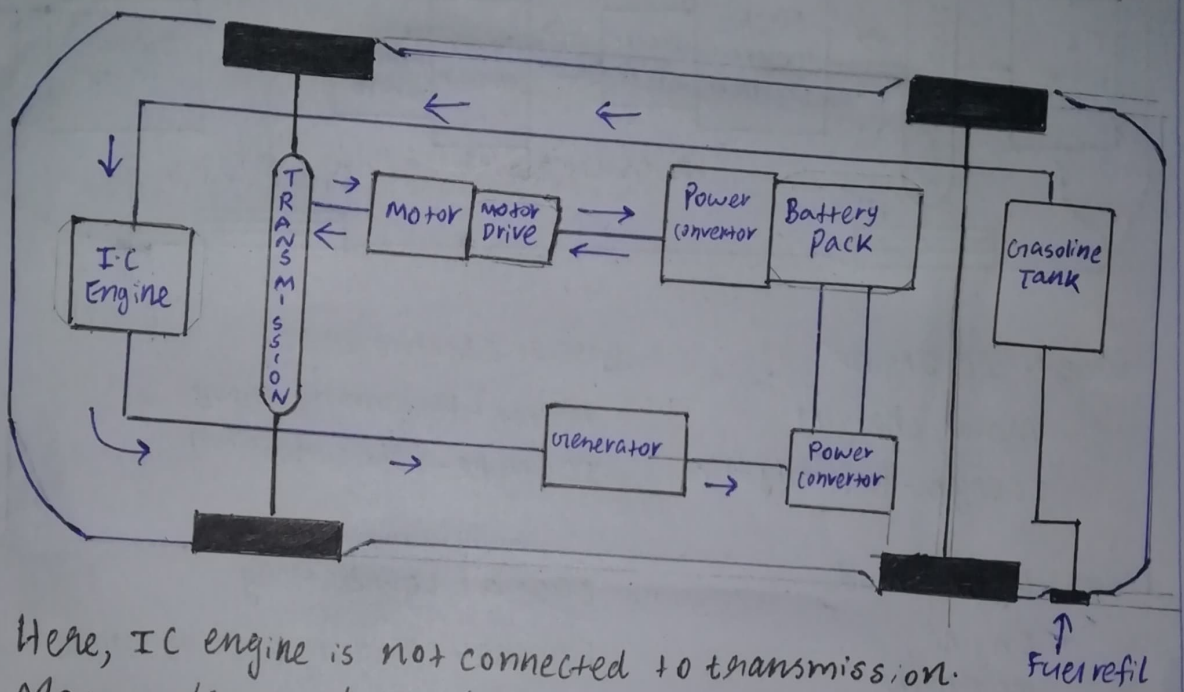
d) Coming of new era in EV

e) Introduction to Hybrid Electric vehicles.


1828 ⇒ Hungarian inventor Anyos Jedlik invented world's 1st electric motor.
1886 ⇒ Thomas Parker built his 1st E.V which is 1st one to undergo Production
1890 → Morrison Carriage built by william Morison
8 seater carriage with 32 km/hr
1906 ⇒ Advanced EVs were introduced Theg had a range of 100 miles with 45-55 km/hr speed
1910 ⇒ Henry Ford came up with Assembly line production 30% of cost annualy
1912 → Petrol-powered cars became easier to drive due to invention of starter
1924 ⇒ EV was completely dominated by crasoline cars. (1924-1960)
1960 ⇒ concept, Prototype and serious design of EV.
1990 → First generation of E.V
2000 → Hybridised Ev and increasing level of gas supply demand
2004 → Tesla motors introduced Roadster model is 2004

(Q2) Explain and Draw the layout of following Hybrid Electric vehicles with their two Advantages, Disadvantages & Industrial application in automative Segment?

1) Series Hybrid Electric vehicles

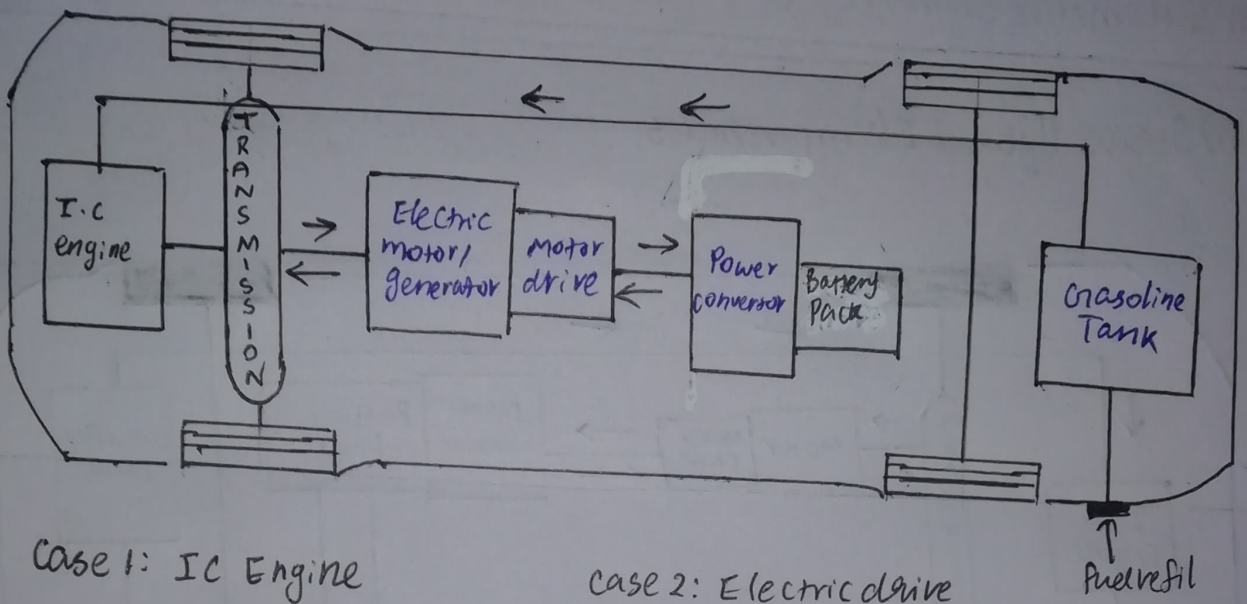


Here, IC engine is not connected to transmission.
Motor drives the vehicle
IC engine is not connected to the transmission, instead the I·C engine drives generator which charges the battery.
Motor is primary source and engine is secondary source.
Motor will have higher power, as it drives the vehicle.

Advantages: The vehicles can operate best in urban areas.
It can operate in warmer temperatures.

Disadvantages: weight is higher when compared to other models.
The level of complexity of vehicle is higher.

b) Parallell hybrid vehicles



Case 1: IC Engine

Motor - charging

IC Engine - Performing drive

Case 2: Electric drive

Motor - Performing drive

IC Engine - Rest condition

Case 3: Hybrid mode

Engine

IC Engine

Case 4: Low battery

Engine - Charging & drive mode

(Motor might be a generator of there is a seperase one).

Case 5: Regenerative breaking

Motor - Grenator, power stored in battery.

while breaking, IC engine is off and motor will be acting as generator, Inorder to replace vehicle's inertia, motor is used as generator to charge the batteries.

Advantages:

→ compactness due to no need of generator and small traction motor.

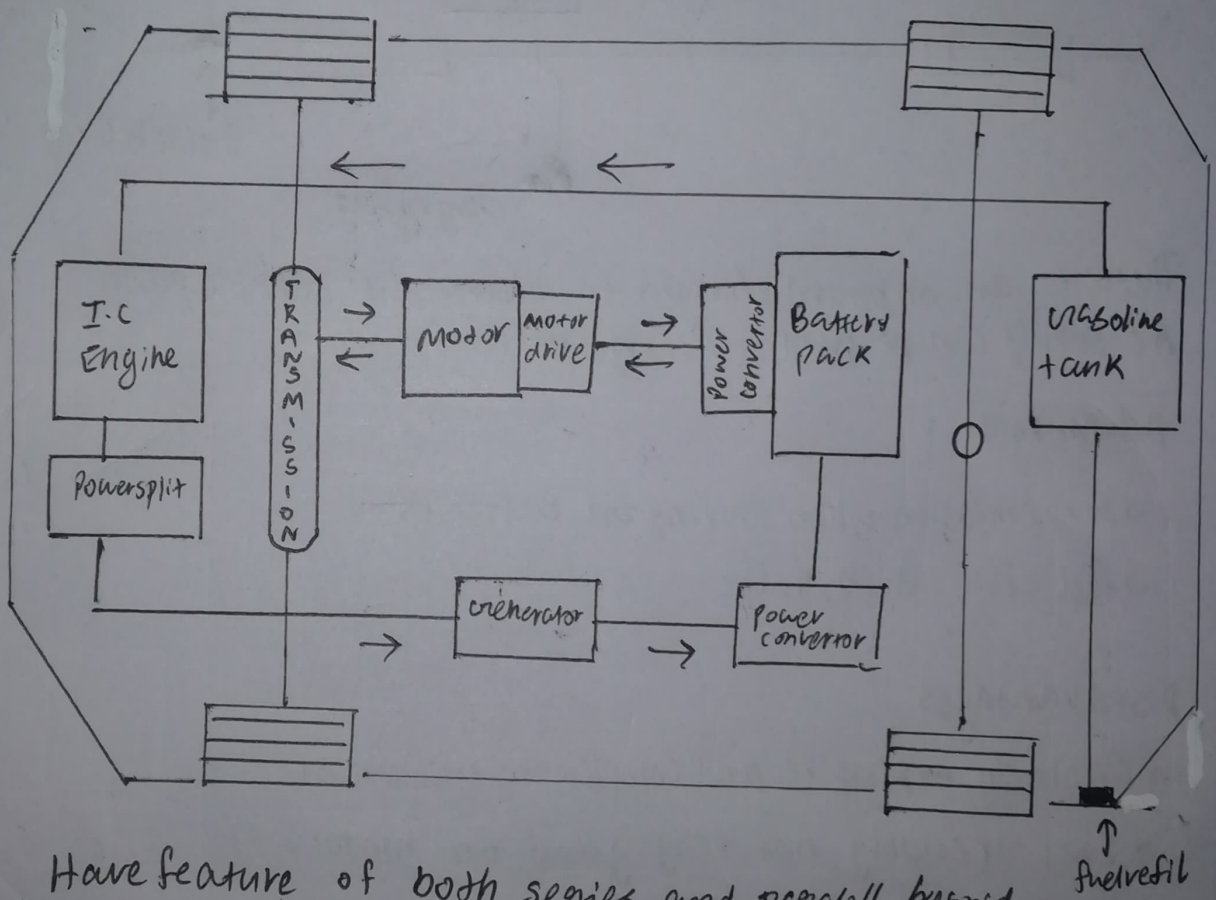
→ Both engine and motor directly supply torques to the deriven wheels and no energy form conversion occurs, hence energy loss is less.

Disadvantages:

→ 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 drive train

c) Series Parallel hybrid vehicle

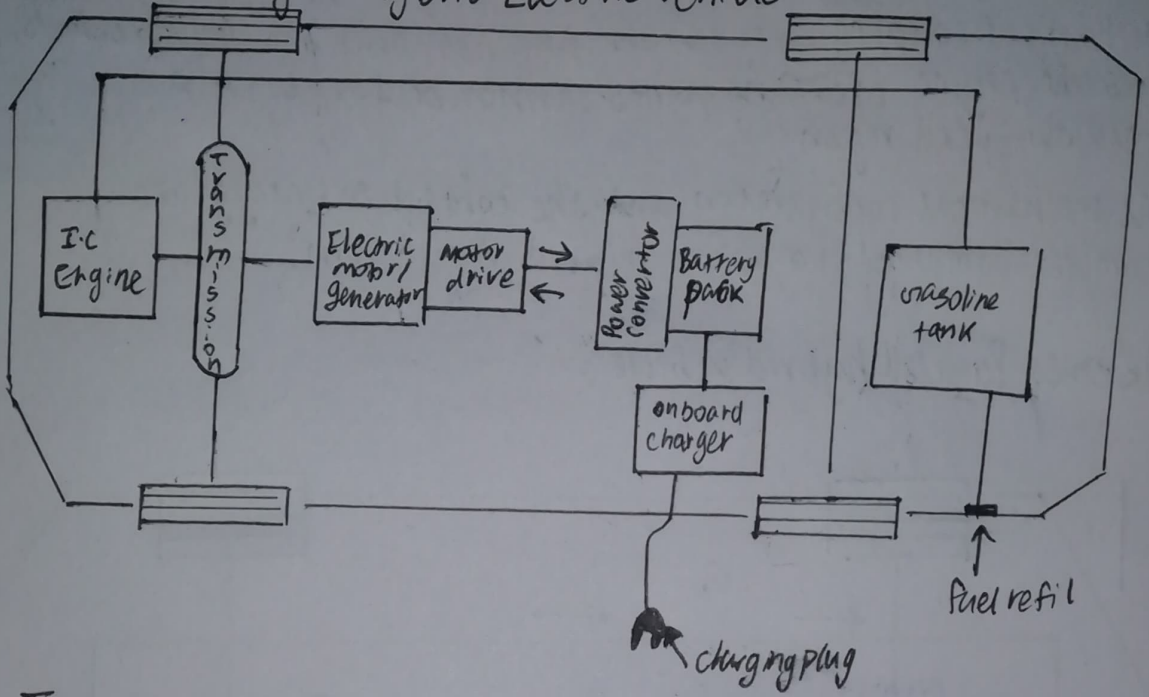


Have feature of both series and parallel hybrid

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

First model → Toyata Prius (1995).

d) PHEV → Plug in Hybrid Electric Vehicle



There is an onboard charger to charge the battery pack. AC supply can be used to charge battery.

Advantages:

→ zero emission when driving on batteries

→ fuel efficient in traffic

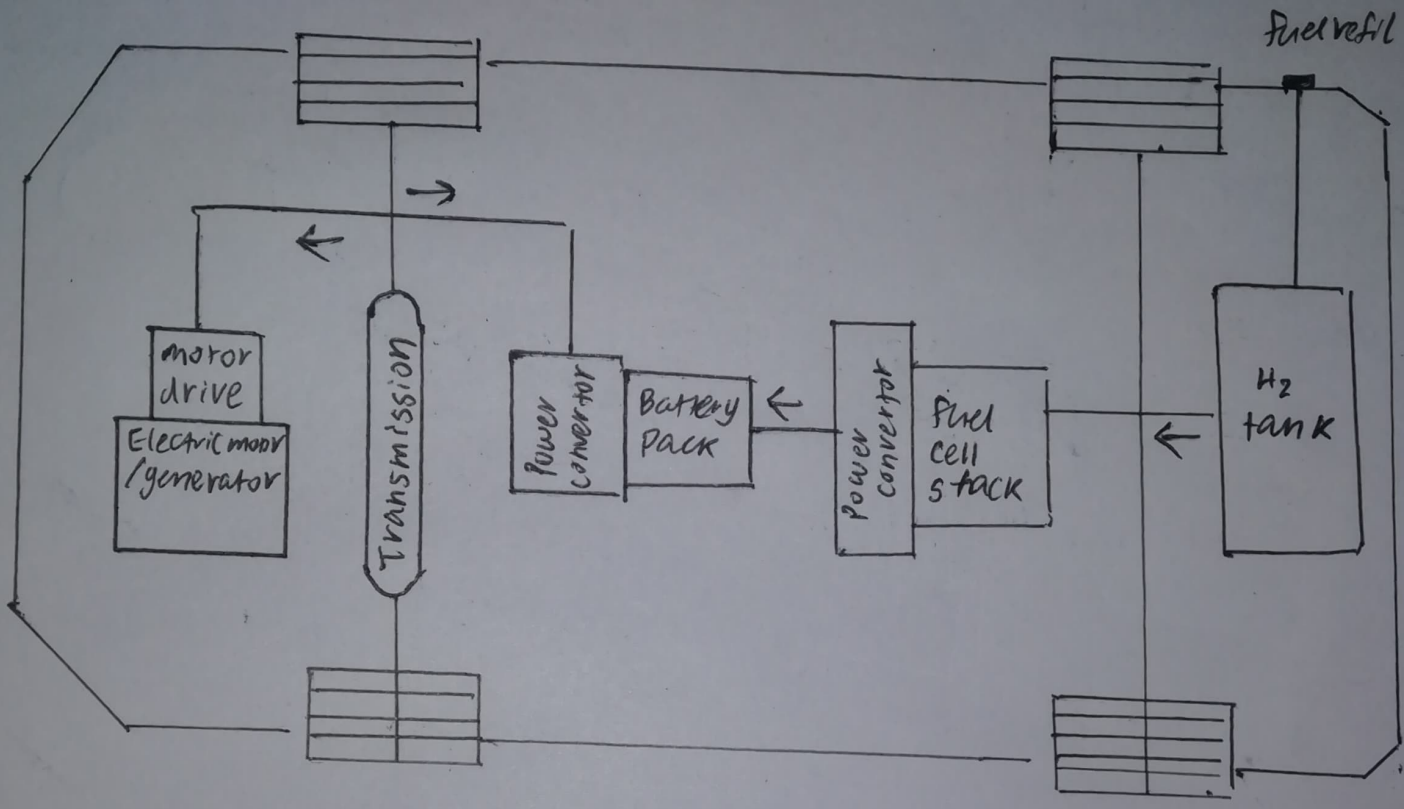
Disadvantages

→ Relatively expensive and complex to maintain

→ Fuel ecenomy not very good on motorway journeys.

Here, IC engine is not used to charge the battery pack due to the presence of onboard charger.

e) Fuelcell EV



→ Uses Hydrogen - oxygen fuelcell to generate the power, which is converted and charges the battery pack.

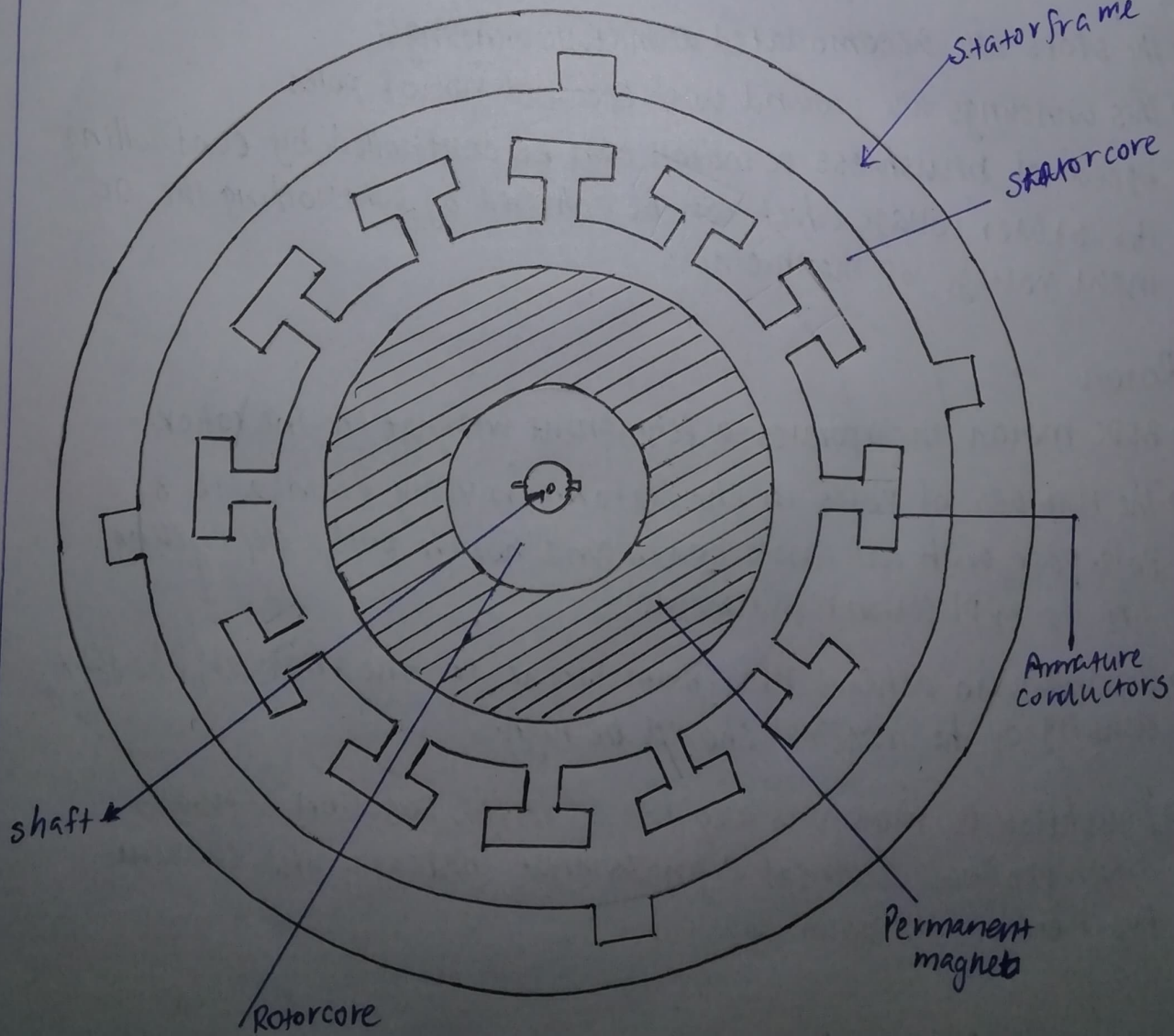
Advantage: → Hydrogen fuel burns completely, which doesn't leave emission.

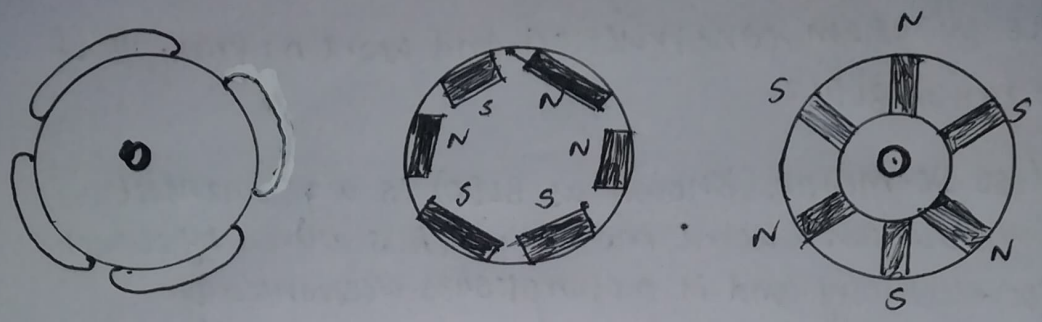
Disadvantage: Difficult handle hydrogen fuel
costly (vehicle and fuel).

Q 3) Explain the diagram, construction and working principle of Brushless motor BLDC?

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 commutator system (Commutation is the process of producing rational torque in the motor by changing phase current through it at appropriate times).

BLDC motors are also reffered as trapezoidal permanent magnet motors. Highspeed of operation even in loaded and unloaded conditions due to the absence of brushes that limits the speed. It has less electromagnetic interference.





BLDC motor can be constructed in different physical configurations depending on the stator windings. These can be configured as single-phase, two-phase, or 3-phase motors. However, three phrase BLDC motors with permanent magnet rotor are commonly used.

Stator

→ Stator is madeup of Silicon steel stampings with slots
→ The slots are accomodated armature windings.
→ This windings are wound with specified no. of poles.
→ Speed of brushless DC motor can be controlled by controlling its stator voltage which can be acheived by controlling the DC input voltage of the inverter.

Rotor

→ BLDC motor incorporates a permanent magnet in the rotor.
→ The number of poles in the rotor can vary from 2 to 8 Pole pair with alternate south and north poles depending on the application requirement.
→ In order to acheive maximum torque in the motor, the flux density of the material should be high.
→ Brushless DC motor is also having rotor position sensors which produce electrical signals that indicates the current position of the rotor.

Hall Sensors

Hall sensors 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. So the hall effect sensor embedded in stator senses the rotor position.

Most BLDC motors incorporate three hall sensors which are embedded into the stator each sensor generates toward high signals whenever the rotor poles pass near to it.

The exact commutation sequence to stator winding can be determined based on the combination of these three sensors response.

working principle of BLDC motor

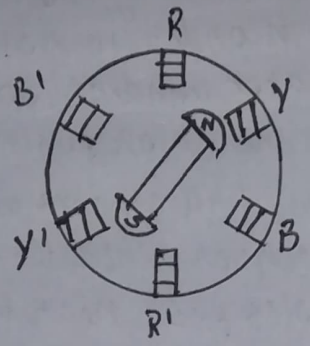
BLDC motor works on the principle similar to that of a conventional DC motor.

ie, the lorentz force law which states 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.

In case of BLDC motor, the current carrying conductor is stationary while the permanent magnet moves.

when the stator coils are electrically switched by supply source. It becomes electromagnet and start 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 rotor the motor continues to rotate.

Consider the figure below in which motor stator is excited based on different switching states. with the switching of windings as high and low signals corresponding windings energized as north and south poles. The permanent magnet rotor with north and south poles align with stator poles causing motor to rotate.



Advantages of BLDC motor

→ It has no mechanical commutator and associated problems.
→ High efficiency due to the use of permanent magnet rotor.
→ High speed of operation even in loaded and unloaded conditions, due to the absence of brushes that limits the speed.
→ Higher dynamic response due to low inertia and carrying windings in the stator.
→ Noiseless operation.

Disadvantages

→ These motors are costly.
→ Electronic controller required control this motor is expensive.
→ Requires complex drive circuitry.
→ Need of additional sensors.

Applications:

→ Computer harddrives and DVD/CD players.
→ Electric vehicles, hybrid vehicles, and electric bicycles
→ Industrial robots, CNC machine tools, and simple belt driven systems.
→ Washing machines, compressors and dryers.
→ Fans, pumps and blowers.