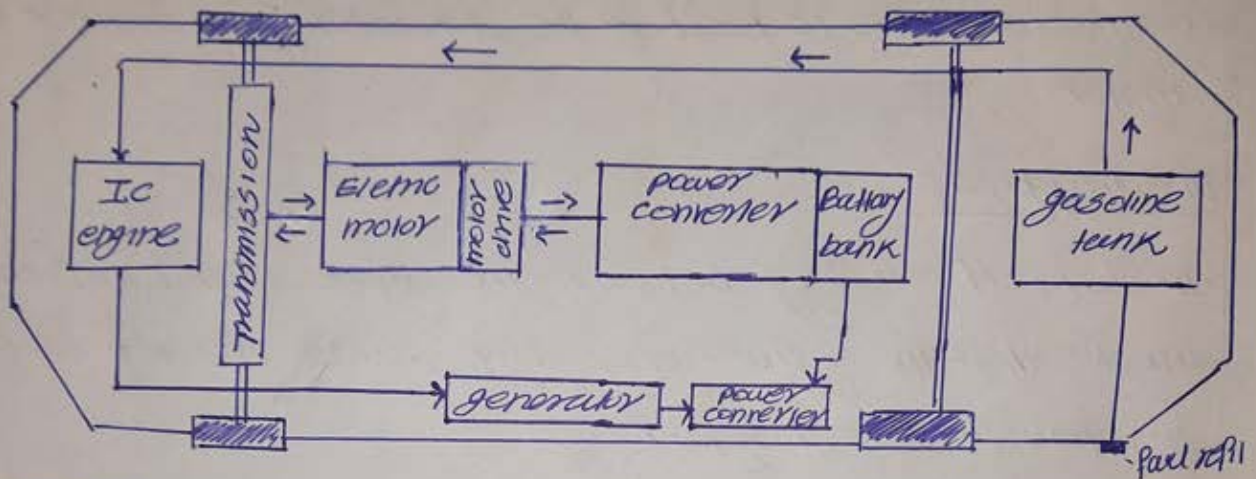


4 Journey of automobile

- 1672 - invention of the first steam powered vehicle
↓
- 1769 - steam powered automobile capable of human transportation
↓
- 1826 - Samuel Brown tested first industrially applied IC engine
↓
- 1886 - Thomas Pinner invented first EV
↓
- 1886 - large scale production of EV
↓
- 1890 - Morrison carriage (8 people carriage vehicle) was invented by William Morrison
↓
- 1906 - Advanced EV were introduced range of 100 miles, 45-55 km/hr.
↓
- 1910 - EV started declining due to several reasons like → world war
Henry Ford came up with assembly line production
↓
- 1912 - Petrol-powered cars became easier to drive due to invention of starter.
↓
- 1924 - EV was completely dominated by gasoline cars (1924 - 1960)
↓
- 1960 - concept, prototype and serious design of EV
↓
- 1990 - first generation of EV
↓
- 2000 - hybridized EV and increasing level of gas supply demand
↓
- 2004 → Tesla introduced Roadster model in 2004.

2) Explain and draw the layout of following hybrid electric vehicles with their two advantages, disadvantages & industrial applications in automotive segment?

a) series hybrid electric vehicles



Advantages

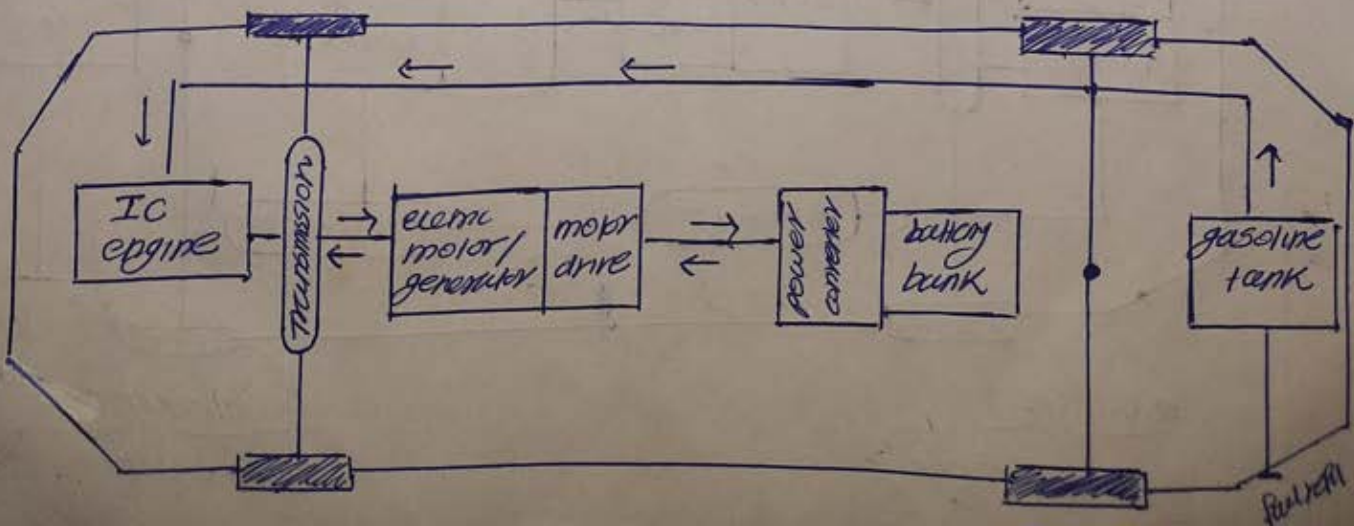
- smaller and efficient engine
- reduce harmful gas emission
- nearly ideal torque-speed charact of electric motor make multi-gear transmission unnecessary.

Disadvantages

- The energy is converted twice this reduce the overall efficiency.
- Two electric machines are needed and a big traction motor is required because

it is the only torque source of the given wheels.

parallel hybrid vehicle



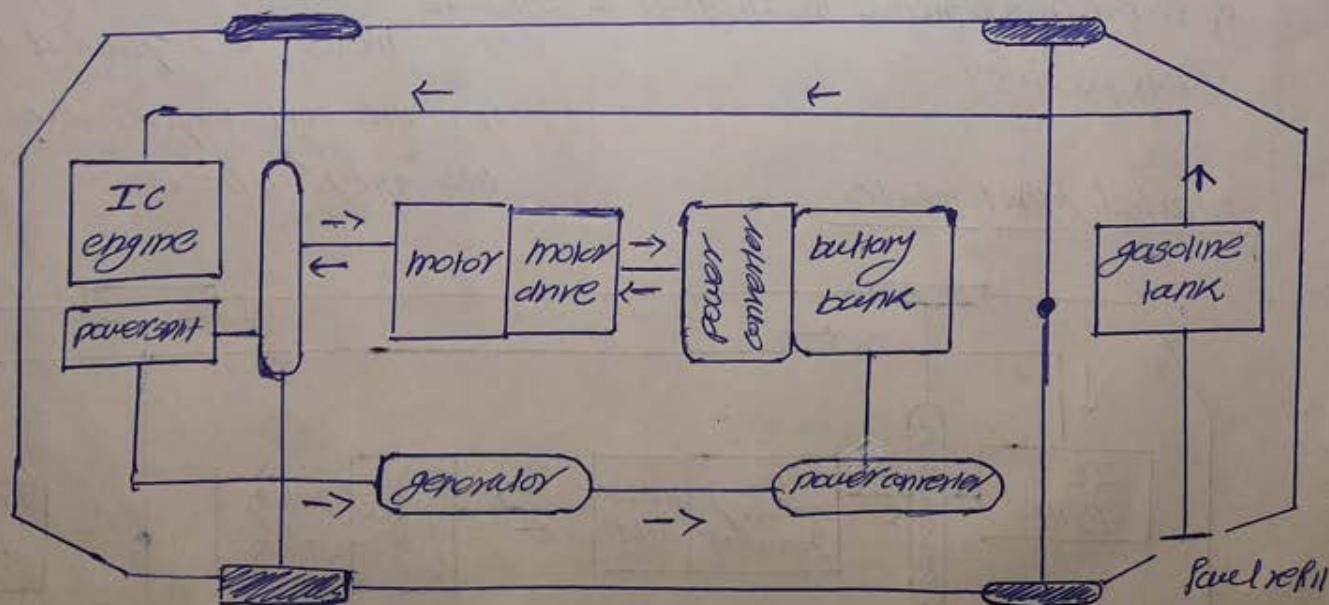
Advantages

- both engine and electric motor directly supply torques to the driven wheels and no energy form conversions occurs, hence energy loss is less
- compactness due to need of the generator and smaller traction motor

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 configurations and the control strategy are complex compared to series hybrid drivetrain

series-parallel hybrid vehicles



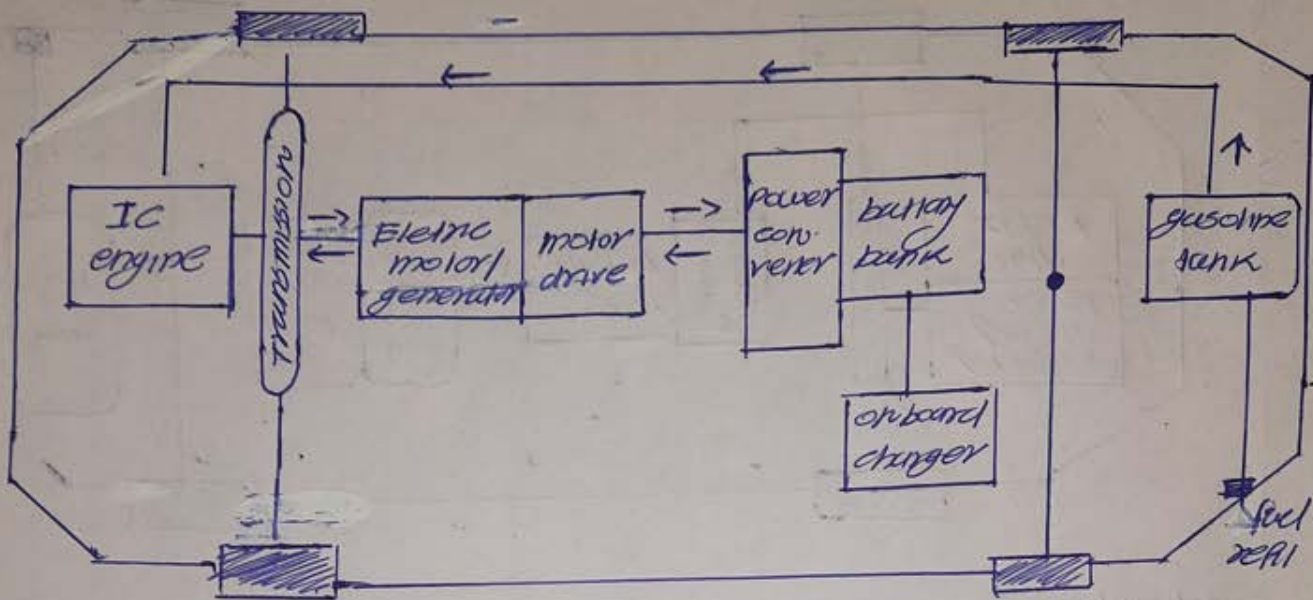
advantages

- high efficiency

Disadvantages

- high cost

plug in hybrid electric vehicle



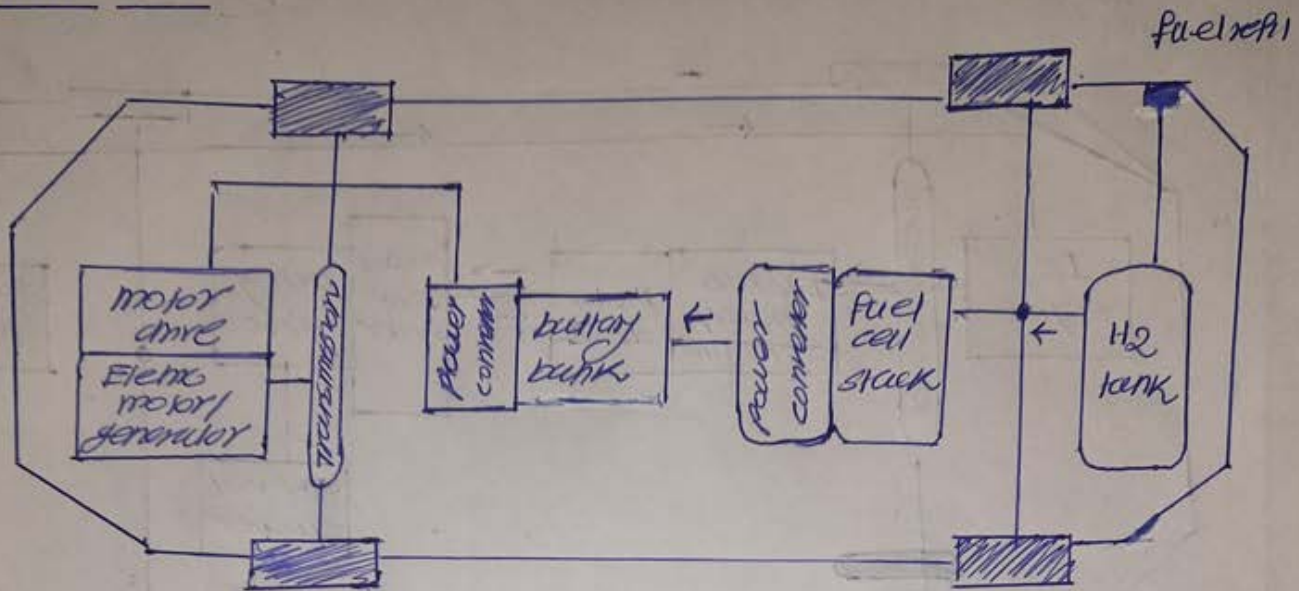
Advantages

- zero emissions when driving on batteries
- fuel efficient in traffic
- easy to drive
- cheap to run if doing regular 10/15 miles commutes

disadvantages

- relatively expensive & complex to maintain
- fuel economy not very good on motorway journeys
- battery life concerns

Fuel cell EV



Advantages

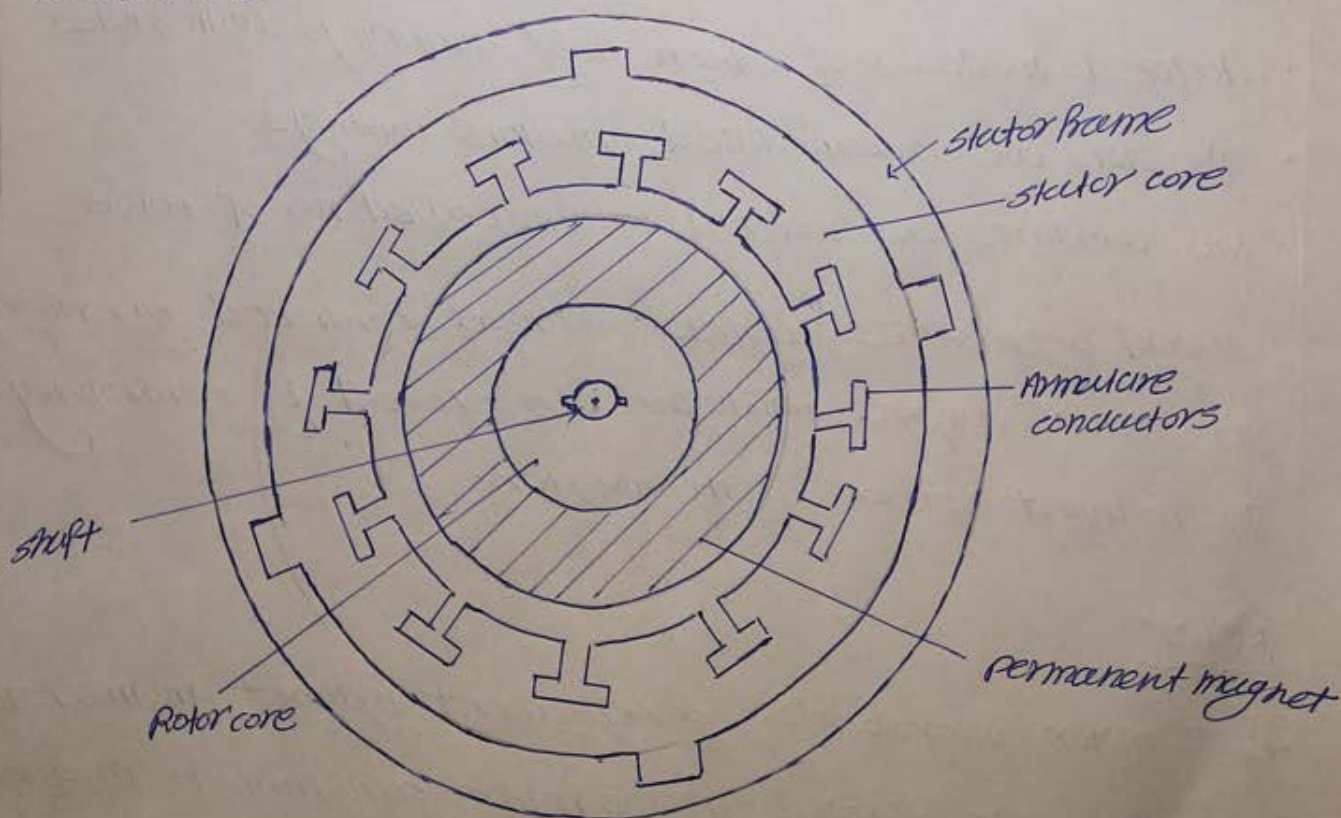
- no harmful emission
- Renewable & readily available fuel

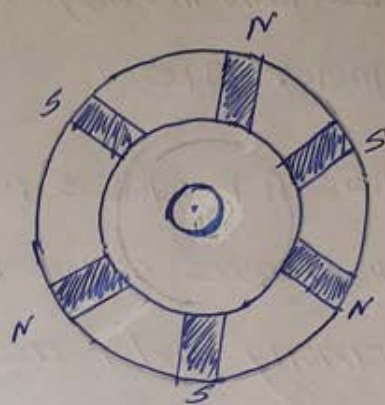
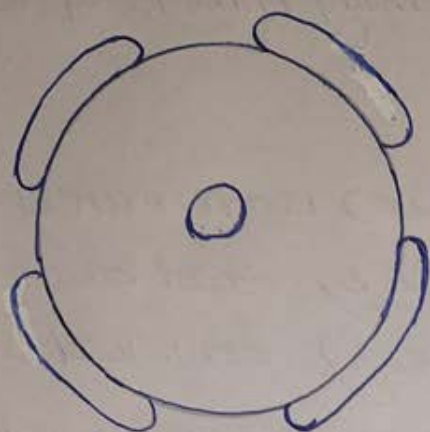
Disadvantages

- storage and transportation of hydrogen
- fuel cell efficiency.

3) Explain the diagram, 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 (commutation is the process of producing rotational torque in the motor by changing phase current through it at appropriate times). BLDC motors are also referred as trapezoidal permanent magnet motors. High speed 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 three phase motors. However, three phase BLDC motors with permanent magnet rotor are commonly used.

Stator

- Stator is made up of silicon steel stampings with slots
- The slots are accommodated 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 achieved 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 achieve 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 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. 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 low and 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 sensor's response.

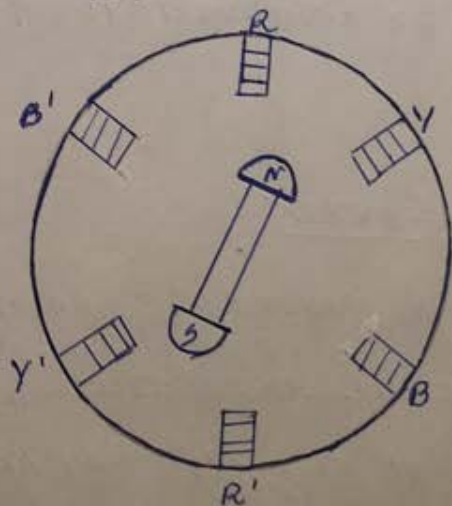
Working principle of BLDC motor

BLDC motor works on the principle 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 experience 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 electronically switched by supply source. it becomes electromagnet and start producing the uniform field in the air gap. through 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 rotor 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.



Advantage 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 hard drives 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.