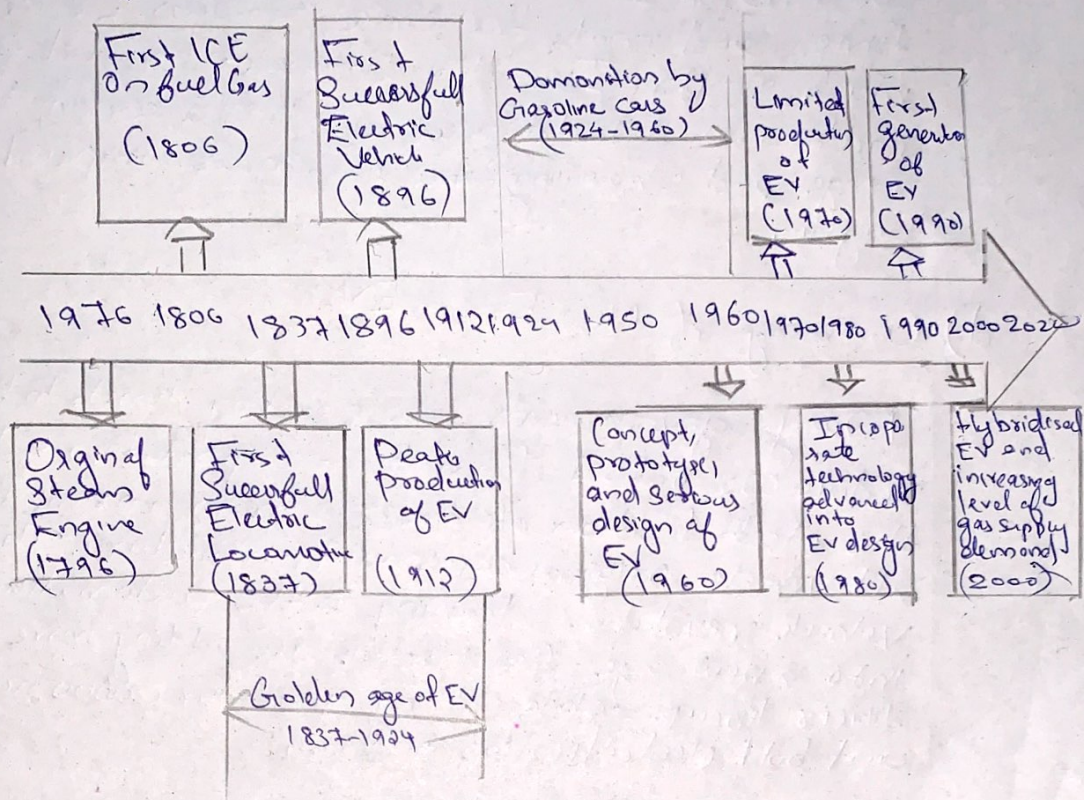


Q.1 Explain the Journey of Automotive with the help of Flow chart from the beginning of the 18th century to the 21st century & give brief description.

Answer



a). Invention of Electric Motor.

In 1828, the Hungarian inventor Anyos Jedlik invented the world's first Electric motor and he used his motor by creating a small electric car.

b). Golden Era of EV

Golden age of Electric vehicle marked from 1890 to 1924 with peak production of electric vehicle, they made up more than one third of car sales in the U.S.

The EV gained popularity by its

- No emission
- Efficient
- Low cost
- Easy Start

In that time, 45 mins to start the ^{steam} engine, 15 mins to start the gasoline engine.

c). Domination of Electric Vehicle by Gasoline Cars

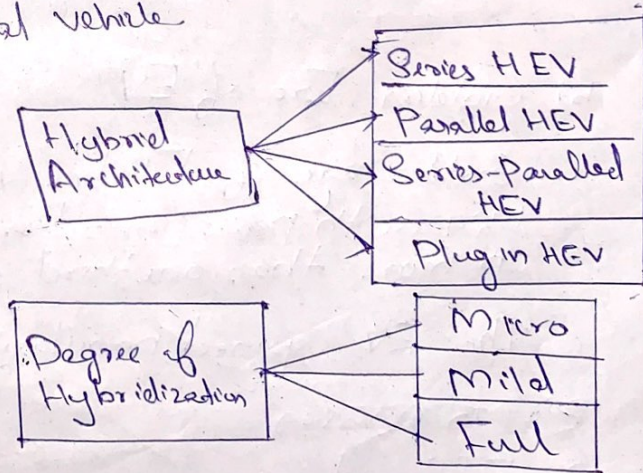
Hendry Ford in 190, he came up with assembly line production, gasoline-powered vehicles suddenly got a lot cheaper. It was cheaper than electricity at that time and made the choice between EV or gasoline much simpler. In 1912 Chevrolet invented self-started mechanism. World war also had a reason that its range and charging time is less as compared to IC Engine.

d). Coming of New Era in EV

Many governments are exacting limits to help reduce CO₂ output from the transportation sector, making the electrification of the powertrain a prime focus for all vehicle original equipments manufacturers. The electric vehicle revolution is leading to the automotive industry into a new age. Car makers are adding more EVs to their lineups while setting goals for carbon neutrality and bold electrification strategies.

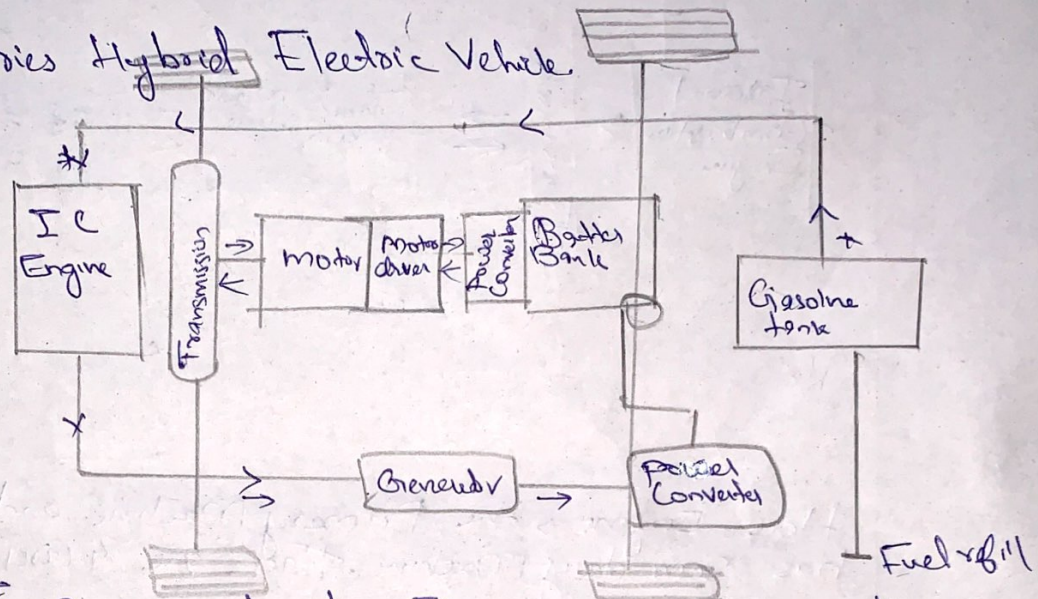
e). Introduction to Hybrid Electric Vehicle.

A hybrid electric vehicle is a type of hybrid vehicle that combines a conventional ICE system with an electric propulsion system. The presence of the electric powertrain is intended to achieve better fuel economy than a conventional vehicle.



2) Explain and Draw the Layout of Following Hybrid Vehicles with their two Advantages, Disadvantages & Industrial application in automotive segment?

a) Series Hybrid Electric Vehicle



- In series combination IC engine will charge the pack by power generation.
- Here ~~battery~~ motor is the primary source and engine is the secondary source.
- Motor has higher power than the engine that motor drive the vehicle.

Advantages

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

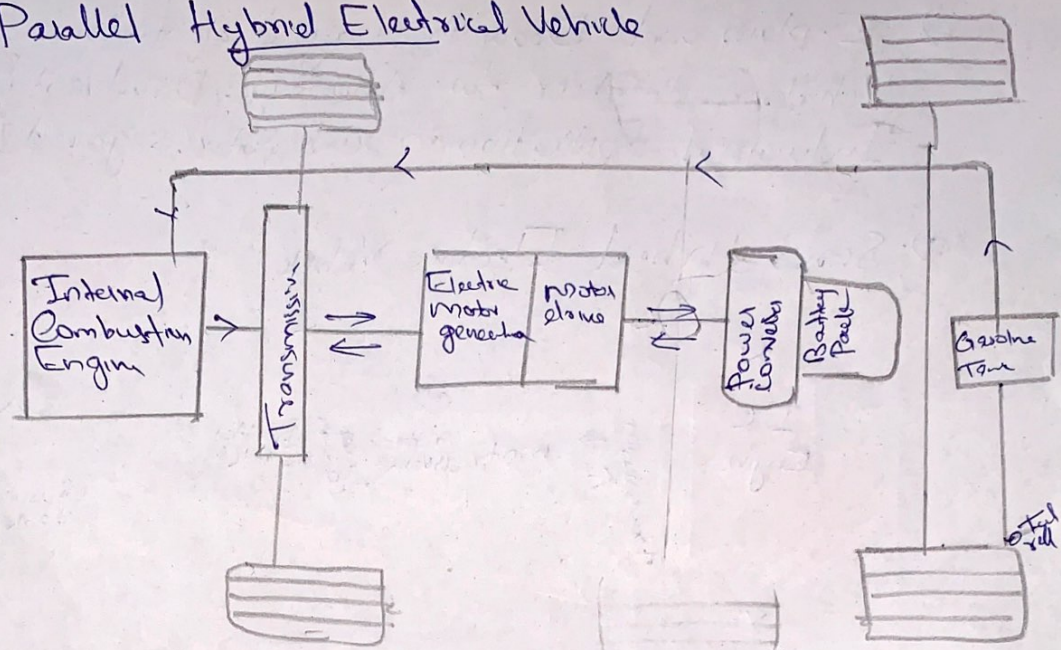
Disadvantages

- The energy is converted twice and this reduce efficiency.
- Two electrical machines are needed and a big traction motor is required because it is the only torque source.

Application

- ~~Best for Battery~~ Best for City Drives
- Economical.

b). Parallel Hybrid Electrical Vehicle



Here Engine is the Primary Machine and Motor has Secondary Machine. There are 4 cases

Case I - IC Engine Drive.

Here the IC engine runs the vehicle while motor not rotating

Case II - Electric Drive

Here the Engine will be off and motor drive

Case III - Hybrid Motor

Here IC Engine and motor will be running together

Case IV - Battery Low

IC engine will act as generator charge the battery

Case V - Regenerative Braking

Advantages

- Both engine and electric motor directly supply torque to wheel
- Compactness due to no need of generator & smaller traction motor

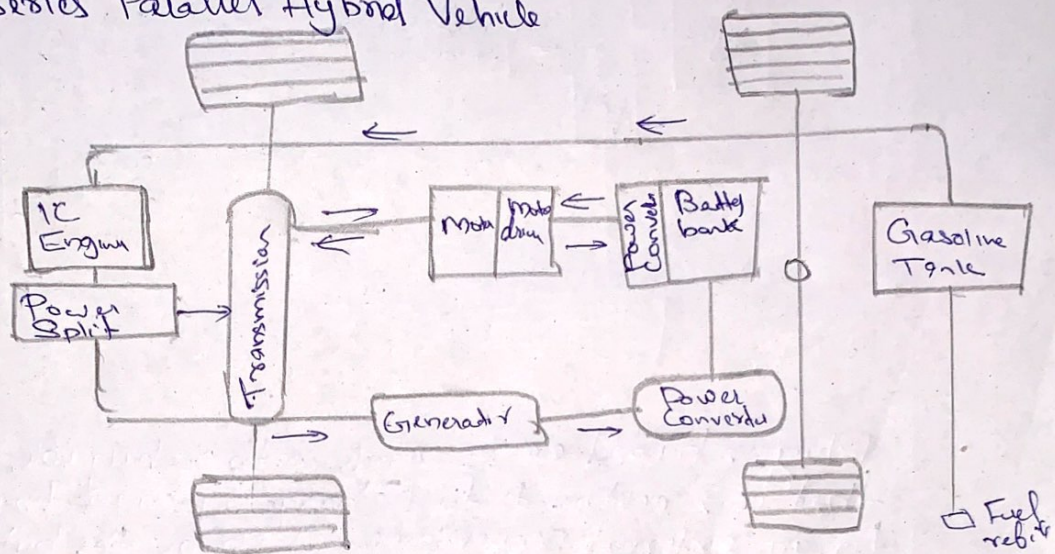
Disadvantages

- Mechanical coupling between the engine and the driven wheel, thus engine point cannot be fixed a narrow speed region
- The mechanical strategy and configuration and the control strategy are complex.

Applications

- More Efficient in City and long rides
- Less Pollution.

c) Series Parallel Hybrid Vehicle



Here motor is connected to transmission & engine is connected to power split. The powersplit divide power between generator and transmission. When the battery is low, the power split direct power to generator or either shift to transmission. Both the modes were also possible

Advantage

- Every mode is possible
- Both engine & motor supply power

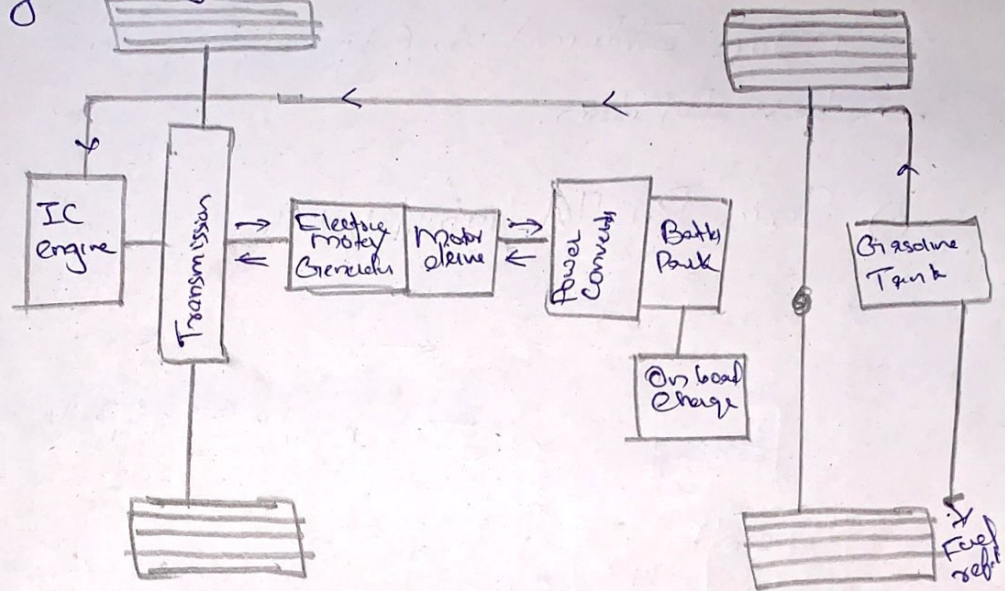
Disadvantage

- Expense is high
- Complicated parts.

Applications

- Many different modes of driving are possible.
- Efficient

d. Plug in Hybrid Electric Vehicle



Plug in hybrid electric vehicle with rechargeable batteries that can restore to full charge by connecting a plug to an external power source. It shows the both the characteristics of both series and parallel electric vehicles.

Advantages

- Zero emission when driving on battery
- Fuel efficient in traffic.

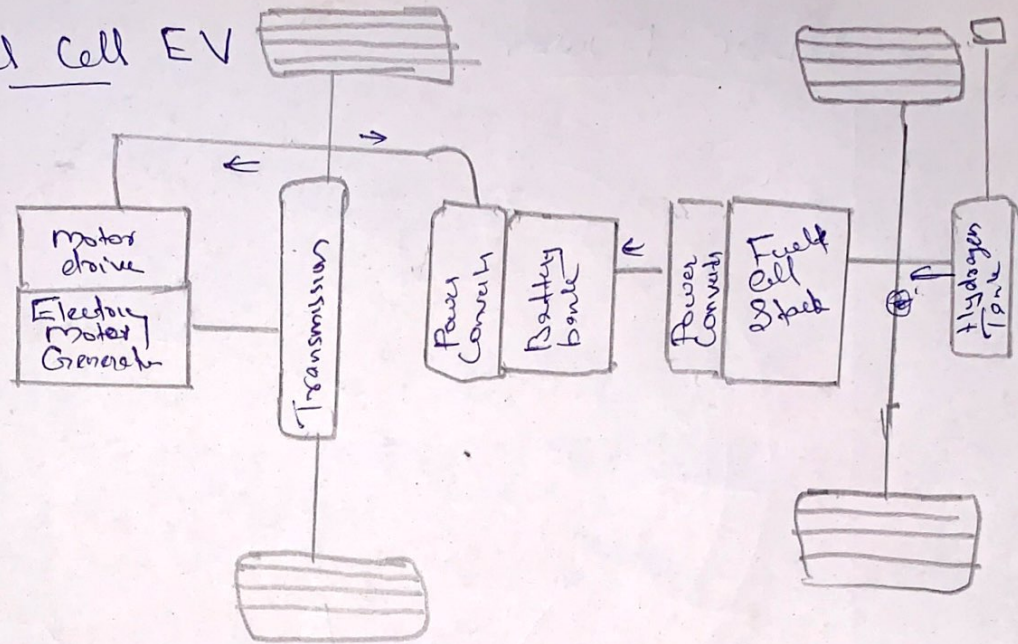
Disadvantage

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

Application

- Have a large all-electric range than traditional hybrid
- Easy to drive

2). Fuel Cell EV



Here the FCEV is same as series hybrid. Instead of engine we use fuel cell to recharge the battery pack. Fuel Cell Stack generate electricity and recharge battery pack. and then the battery pack power the motor.

Advantage

- Low pollutant or zero emission
- The byproduct is water.

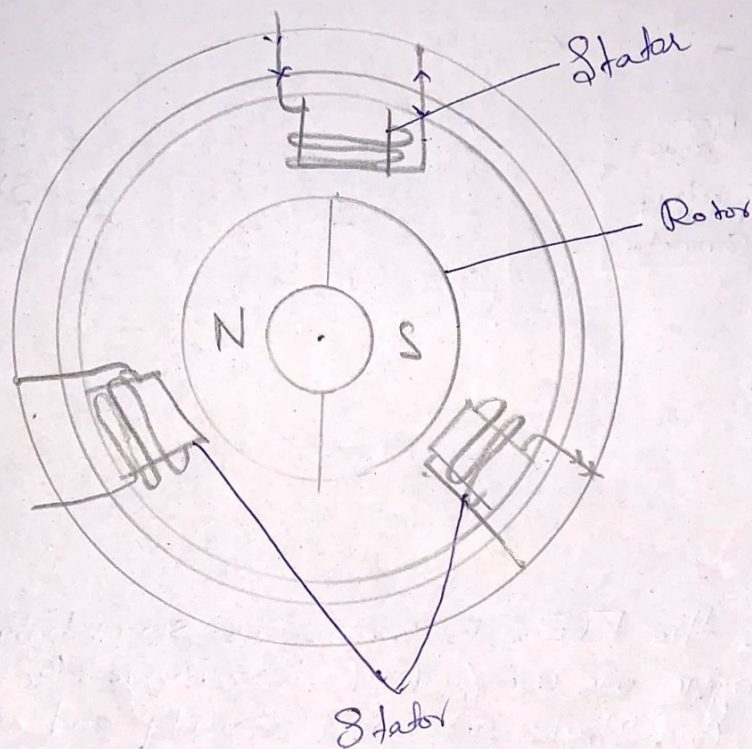
Disadvantage

- Difficult to handle hydrogen fuel.
- More space is needed for components.

Applications

- Uses fuel cell that generate elects

3. BLDC Motor



Construction

In BLDC motor, the permanent magnets attach to the rotor. The current-carrying conductors or armature windings are located on the stator. A BLDC motor is a type of synchronous motor in the sense that magnetic field generated by the rotor revolve at the same frequency.

Working Principle

BLDC works by 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 the BLDC motor, the current carrying conductor is stationary and the permanent magnet is moving. When the stator coils get a supply, it become electromagnet and starts producing the uniform field in the air gap. Though the source of supply is DC. Due to the force of interaction between electromagnet stator and permanent rotor, the rotor continues to ~~rotate~~ rotate. With the switching of winding as High and Low signals, corresponding winding energized as North and South pole. The permanent magnet rotate with North and South pole aligns with stator poles to rotate.