Q1 The journey of Automotive:

In 1828 the Hungarian inventor Anyos Jedlik invented an world's first Electric motor, and created a first small model car powered by his Electric motor

Scottish inventor Robert Anderson also invented a crude electric carriage between 1832 and 1839. In 1835 Professor Sibrandus Stratingh of Groningen, the Nether Lands and his assistant christopher Becker from Germany also created a small scale electric car, powered by non rechargeable primary cells.

The first known electric locomotive was built in 1837 in Scotland by chemist Robert Davidson of Aberdeen.

The invention of the improved battery technology in France in 1881, by Gaston plante

The first successful Electric vehicle was built in 1996 in US by William Morrison. The electric vehicle was designed as passenger carriage driven by Driver with 2 Passenger carrying Capacity.

In Beginning of 1900 Electric cars were even labelled as "Women Cars". At the turn of the century 40% of American cars were powered by Steam, 38% by electricity and 22% by Petrol. The Commercial electric vehicles were

Produced primarily in Europe.

In 1912 petrol powered cars became easier to drive due to the invention of charles kettering and hu electric starter. The electric cars began to lose their position in the car market at America in 1920. The EV was dominated by Gasoline Cars in between 1924 to 1960.

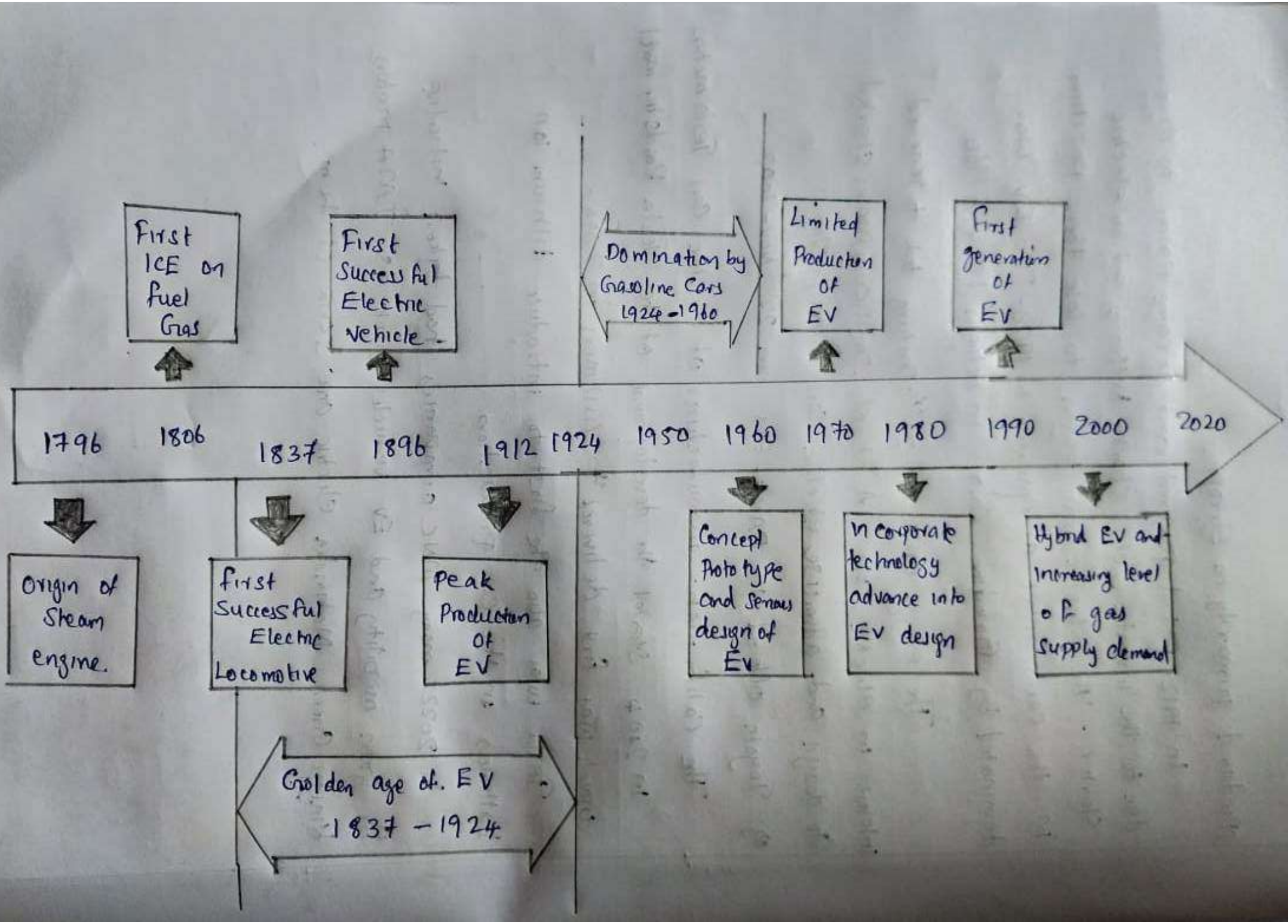
The energy crises in 21st Century led to renewed interest in electric cars. A lot of small companies started to design and advertise electric cars to the public.

eg: Toyota offered its RAV4-EVS in 22nd NOV-2002

The Californian manufacturer of electric cars Tesla motors in 2004 started the development of the Tesla Roadster model which was first delivered to customers in 2008.

Tesla was also the first to introduce lithium ion batteries in its car production.

In 2022 many MNC companies had taken initiative for green mobility and EV vehicles such as TATA motors, Kinetic Green, Mahindra electric are some of them.


First ICE on fuel Gas
First Successful Electric vehicle
Domination by Gasoline Cars 1924-1960
Limited Production of EV
First generation of EV
1796
1806
1837
1896
1912
1924
1950
1960
1970
1980
1990
2000
2020
Origin of Steam engine.
first Successful Electric Locomotive
Peak Production of EV
Concept Prototype and Serious design of EV
Incorporate technology advance into EV design
Hybrid EV and increasing level of gas supply demand
Golden age of EV 1837 - 1924

Q2 Explain & Draw the Layout of various type of EV's.

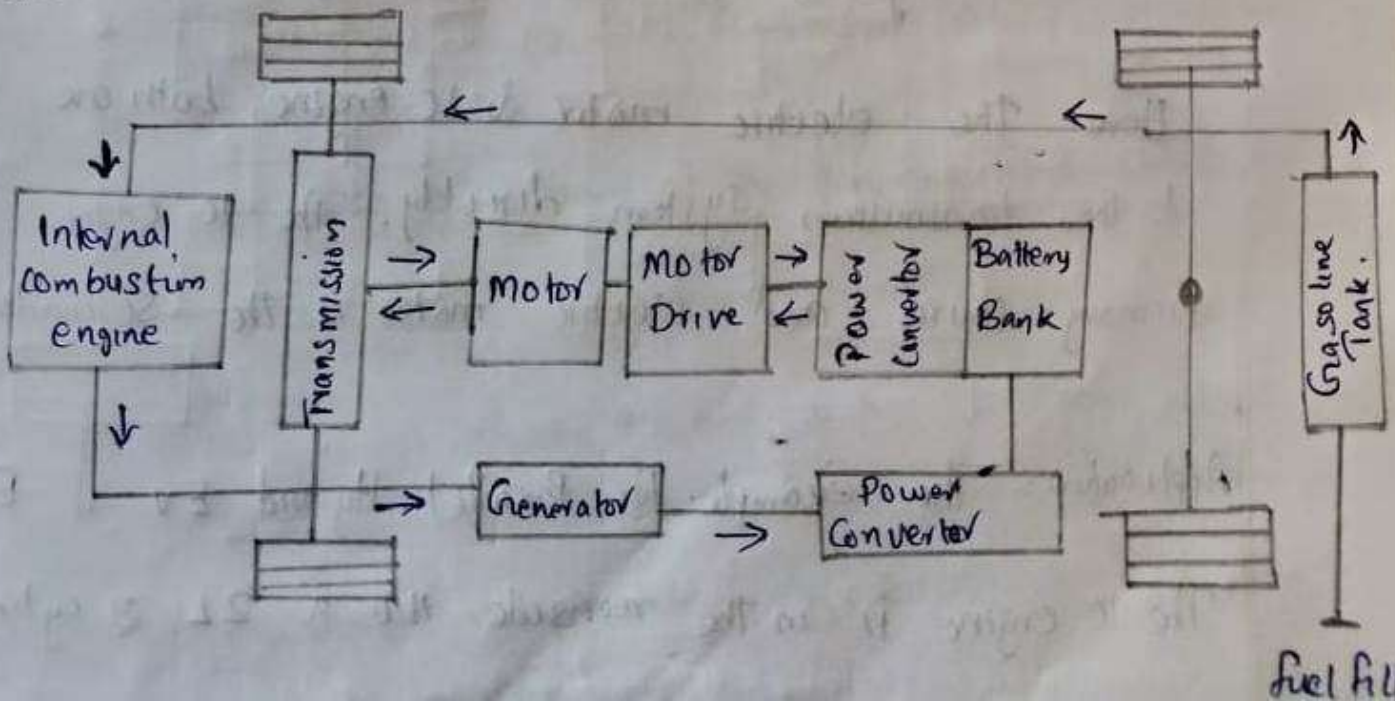
1, Series Hybrid Electric vehicle

In a Series HEV there is no direct connection between the IC engine & transmission system. Here the electric motor is the primary source and IC engine is the secondary source. Here the motor power is greater than the IC engine power. The battery pack is larger than the parallel HEV. The cost of Series HEV is very high, since it can see very less in globally.

Application :- The series HEV is mainly used in BMW i3

It is a 1.2L Two cylinder engine.

BMW i3 is equipped with range extention. mainly two models are available in market.



Advantages of Series HEV

1. Mechanical decoupling between the IC engine and driven wheels allows the IC engine operating at its very narrow optimal region.

2. Nearly ideal torque-speed characteristics of electric motor make multi-gear transmission unnecessary.

Disadvantages of the Series HEV

1. The energy is converted twice (mechanical to electrical and then to mechanical) and thus reduces the overall efficiency.

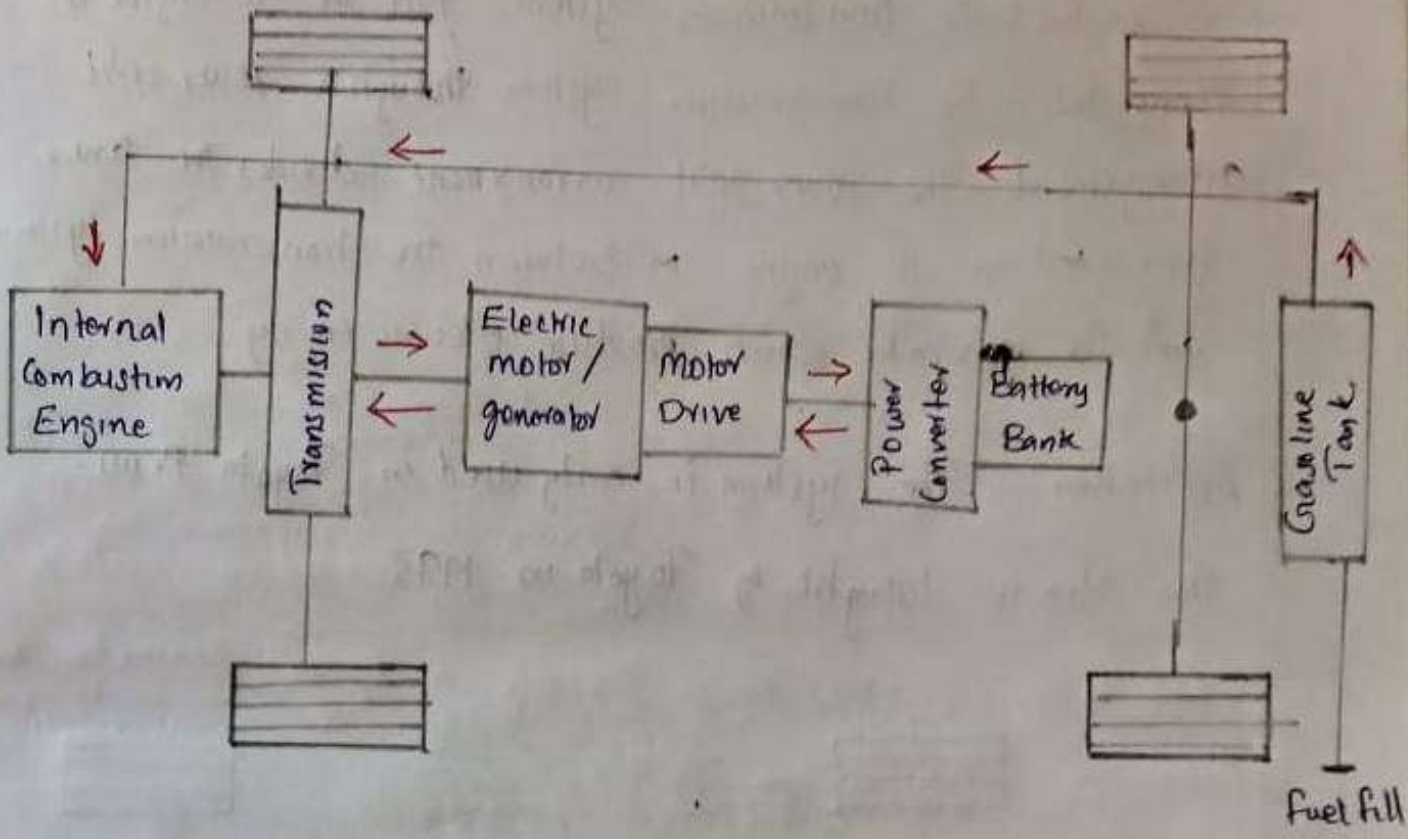
2. Two electric machines are needed and a big traction motor is required because it is the only torque source of the driven wheels.

2. Parallel Hybrid Electric vehicle

Here the electric motor & IC engine both are connected to the transmission system directly. The IC engine is the primary source and electric motor is the secondary source

Application:- The example for Parallel Hybrid EV is BMW i8. The IC engine is in the rear side it is a 2L 3 cylinder inline engine. The electric motor is at the front

The milage is around 40-45. During braking BMW i8 recuperates energy by regenerative braking system.



Advantages of Parallel HEV

1, Both engine and electric motor directly supply torque to the driven wheels and no energy form conversion occurs hence energy loss is less

2, Compactness due to no need of the generator and smaller traction motor.

Disadvantages of Parallel HEV.

1. Mechanical coupling between the engines and the driven wheels, thus the engine operating points cannot be fixed in a narrow speed region

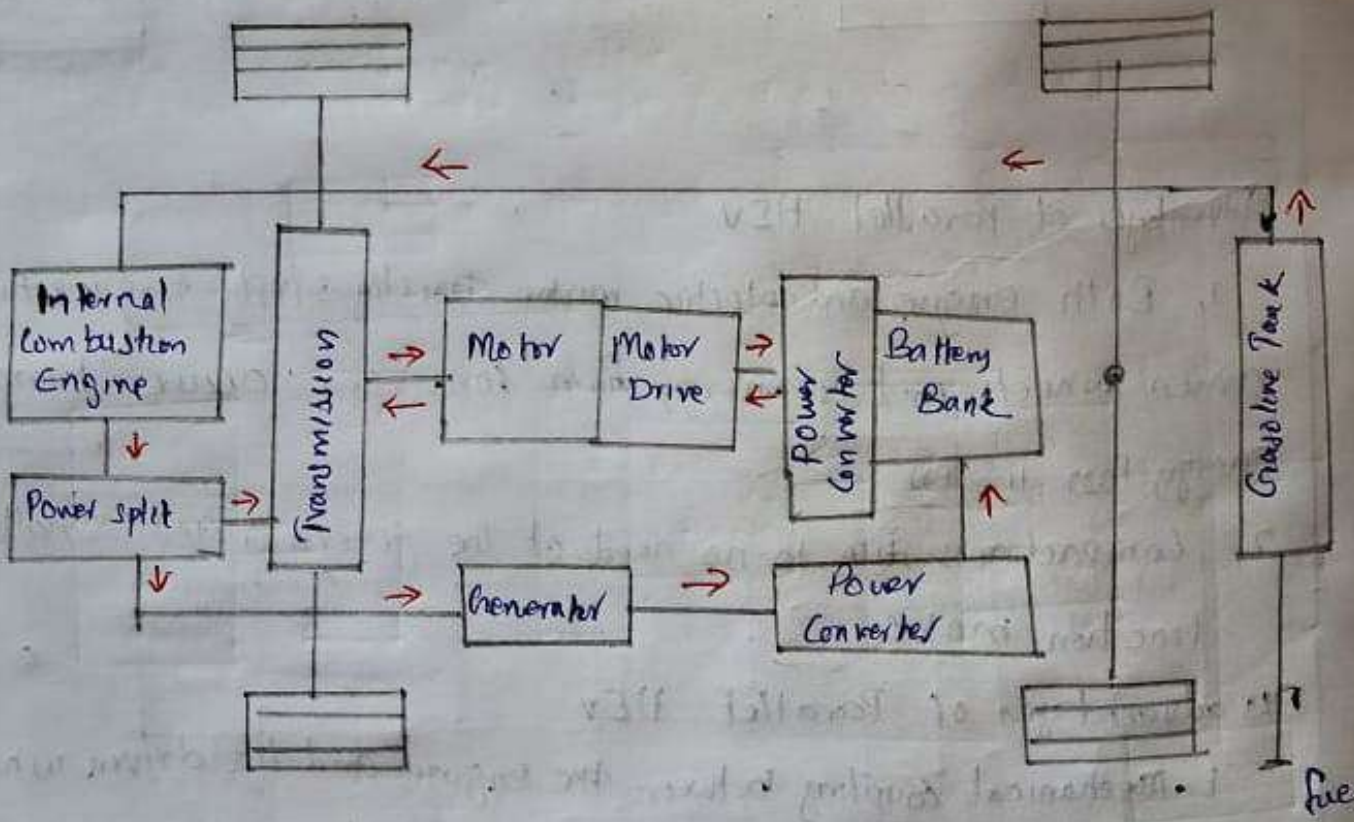
2. The mechanical configuration and the control strategy are complex compared to series hybrid drive train.

3. Series Parallel Hybrid Electric vehicle

In a Series Parallel Hybrid EV system the motor is directly connected to the transmission system. But the IC engine is connected to the transmission system through a power split arrangement. The power split arrangement divides the power generated in IC engine in between the transmission system and the generator which produce electric energy.

Application: The system is only used in Toyota Prius.

This idea is brought by Toyota in 1995.



* The Series Parallel Hybrid vehicle have feature of both Series and Parallel hybrid * Many different modes of driving are possible under IC engine dominant Hybrid

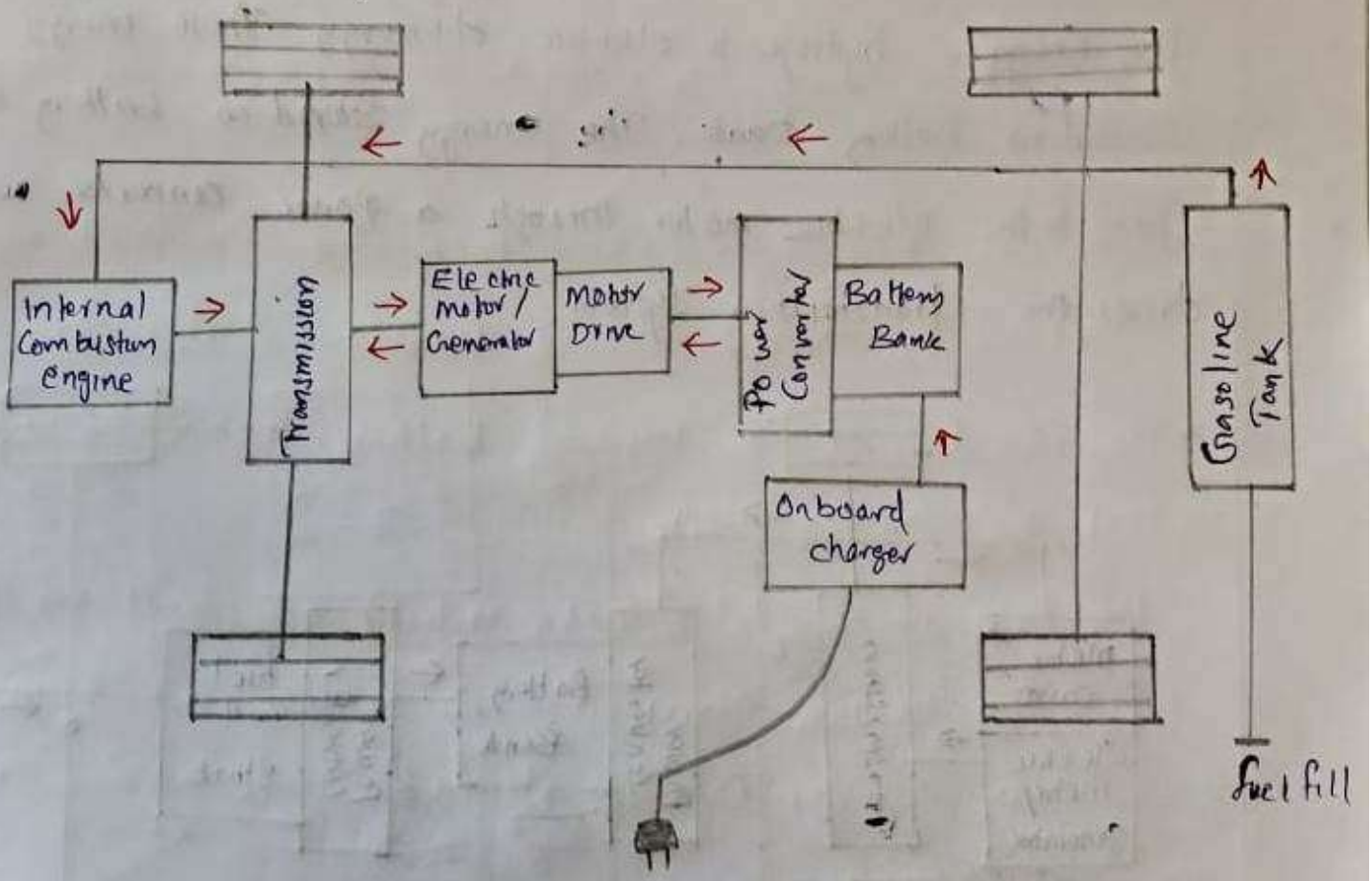
vehicle and under motor dominant drive mode.

4. Plug in Hybrid (PHEV).

in PHEV we have an option of attaching a charger from wall socket, we can charge the battery bank from outside source.

Application :-

~~Hyundai Ioniq uses the PHEV system, also~~ BMW i8 uses the PHEV system ~~also~~



Advantages :-

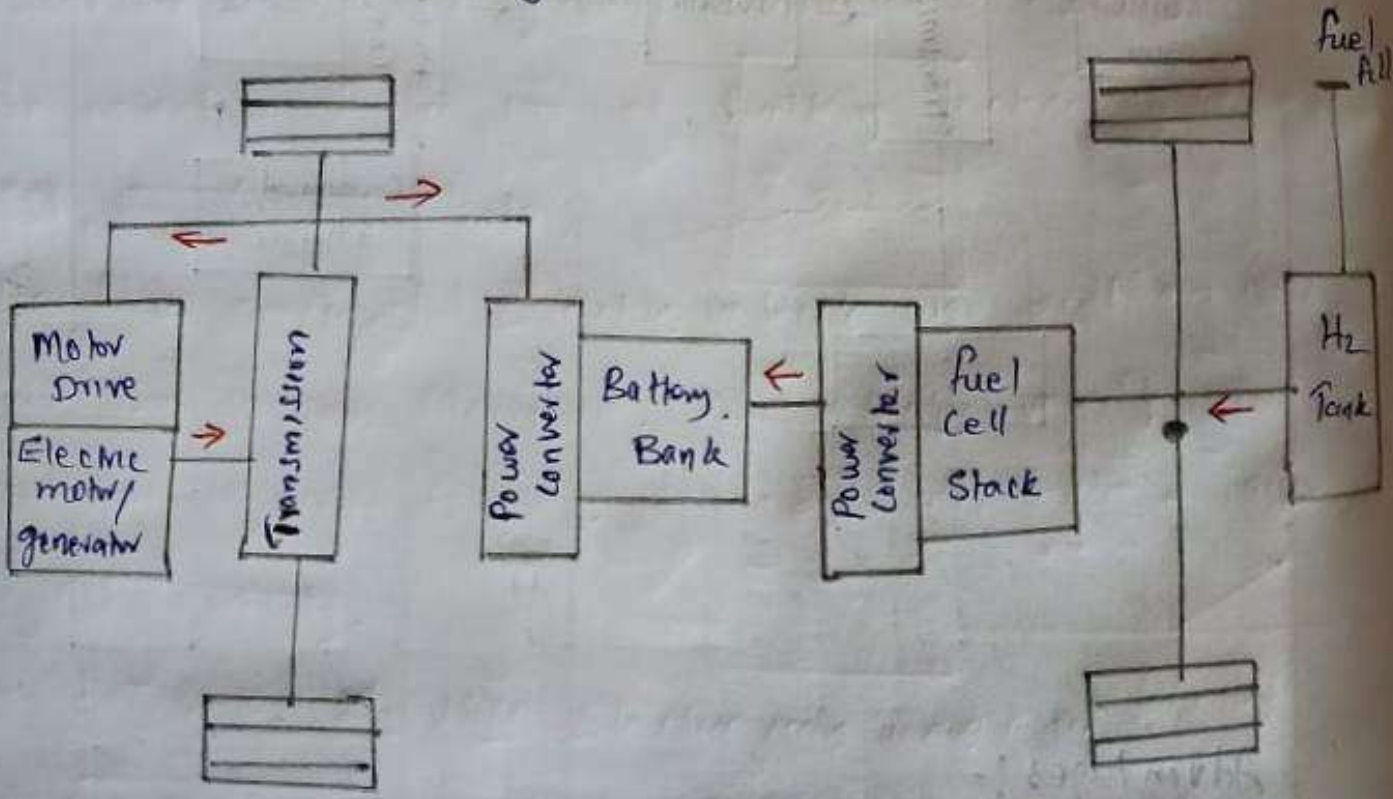
1. Zero emission when driving on batteries
2. fuel efficient in traffic
3. easy to drive
4. cheap to run if doing regular 10/15 mile commutes

Disadvantages:

1. relatively expensive & complex to maintain
2. fuel economy not very good on motorway journeys
3. battery life concerns.

5. Fuel cell EV

In a fuel cell EV system we can't seer any IC engine here the primary power source is Hydrogen gas. Fuel cell converts the energy in hydrogen to electric energy. These energy stored in battery bank. The energy stored in battery bank given to the electric motor through a power converter which drives the transmission system.



Advantages :-

~~less fuel cost~~

1. Hydrogen fuel cost → less emission than any other system
2. less weight due to absence of IC engine

disadvantages :-

1. Difficulty to handle hydrogen fuel it is really explosive
2. Space in the sense of battery is large.
3. The cost of fuel as hydrogen is very costly.

Application :- Hyundai Nexo uses fuel system.

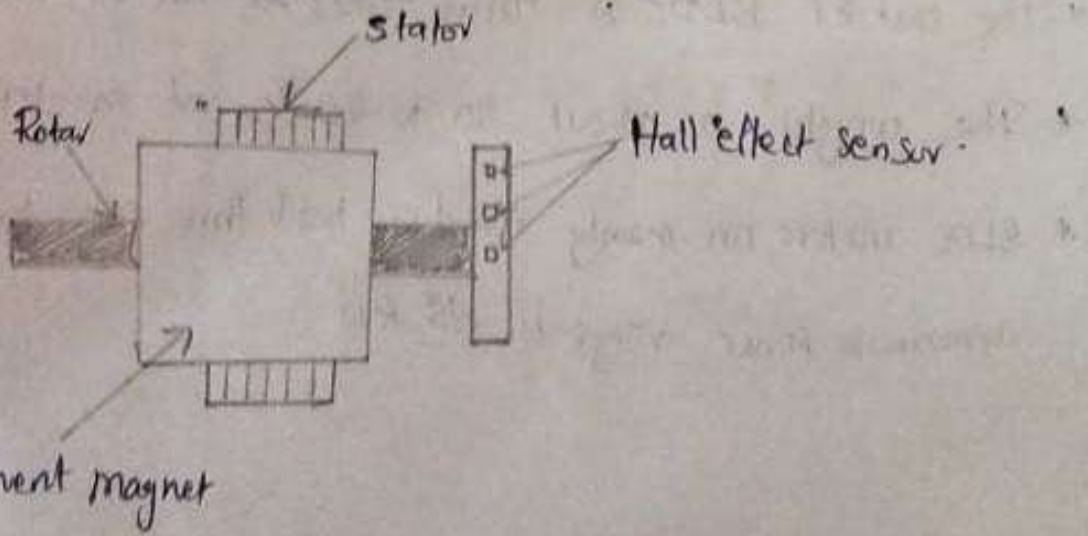
Q3. Explain with diagram the construction & working principle of Brushless motor BLDC ?

Ans:- Brushless DC motors also known as electronically commutated motors. (ECMs, EC motors). Primary efficiency is a most important feature of BLDC motors. Because the motor is the sole bearer of the magnets and it doesn't require any power. ie no connections, no commutator and no brushes. In place of these the motor employs control circuitry. To detect where the motor is at certain time, BLDC motors employ along with controllers rotary encoders or a Hall sensor.

Construction of Brushless DC motor.

In this motor, the permanent magnets attach to the rotor. The current carrying conductors or armature windings are located on the stator. They use electrical communications to convert electrical energy into mechanical energy.

In BLDC the magnetic field generated by the stator and the rotor revolve at the same frequency.



Working Principle of Brushless DC motor

Brushless DC motor works on the principle similar to that of a Brushed DC motor. 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 the BLDC motor the current carrying conductor is stationary and the permanent motor is moving. Whenever the stator coil get a supply from 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.

* The efficiency range of a BLDC motor is ~~was~~ between 95 - 35 %
* The cost of BLDC is three times as that of an Induction motor
* The weight is about 30 to 40 % of an induction motor
* BLDC motors are mainly used in two & three wheelers & the approximate power range is 15 KW.