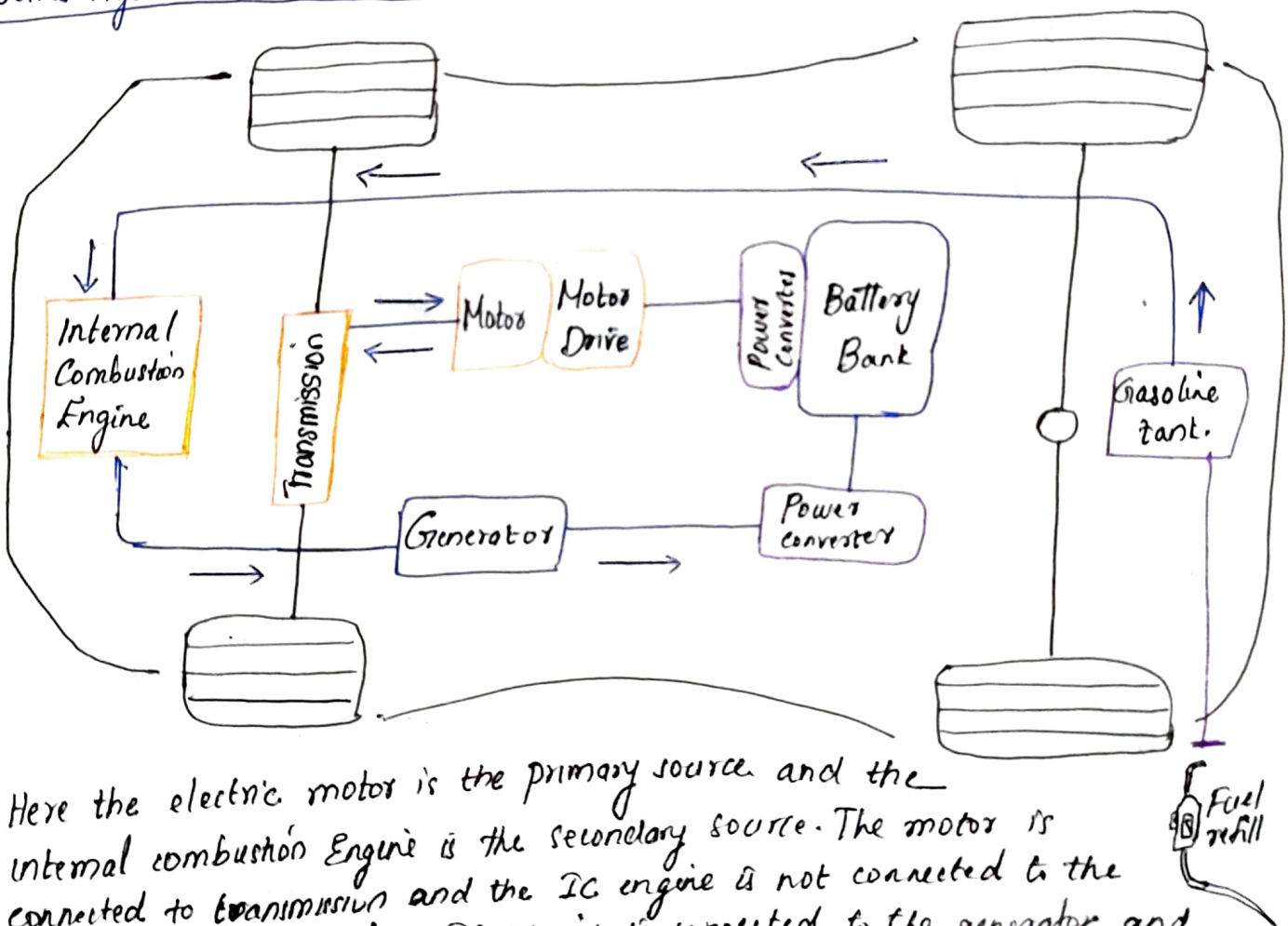
ASSIGNMENT-1

Submitted on : 02:10:2022

Q.2 Explain and draw the layout of following Hybrid Electric Vehicles with their two Advantages, Disadvantages & Industrial Application in automotive segment ?

(a) Series Hybrid Electric Vehicles
(b) Parallel Hybrid Electric Vehicles
(c) Series-Parallel Hybrid Vehicle
(d) Plug-in Hybrid Electric Vehicle
(e) Fuel cell Electric Vehicle

Ans:2) (a) Series Hybrid Electric Vehicles :



Here the electric motor is the primary source and the internal combustion Engine is the secondary source. The motor is connected to transmission and the IC engine is not connected to the transmission, because, here IC engine is connected to the generator and it will charge the battery pack and the battery pack will in turn charge the motor and finally the motor will drive the vehicle.

Since motor is the primary source, it will be of higher power than that of the IC engine.

There are mainly 4 cases

Case : 1 Normal Driving

- IC engine
- Motor

Case : 2 : Light load

- IC engine
- Motor

Case 3: During Braking

- IC engine
- Motor

Case 4: Vehicle at Stop

- IC engine
- Motor

Advantages of Series hybrid Vehicle:

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

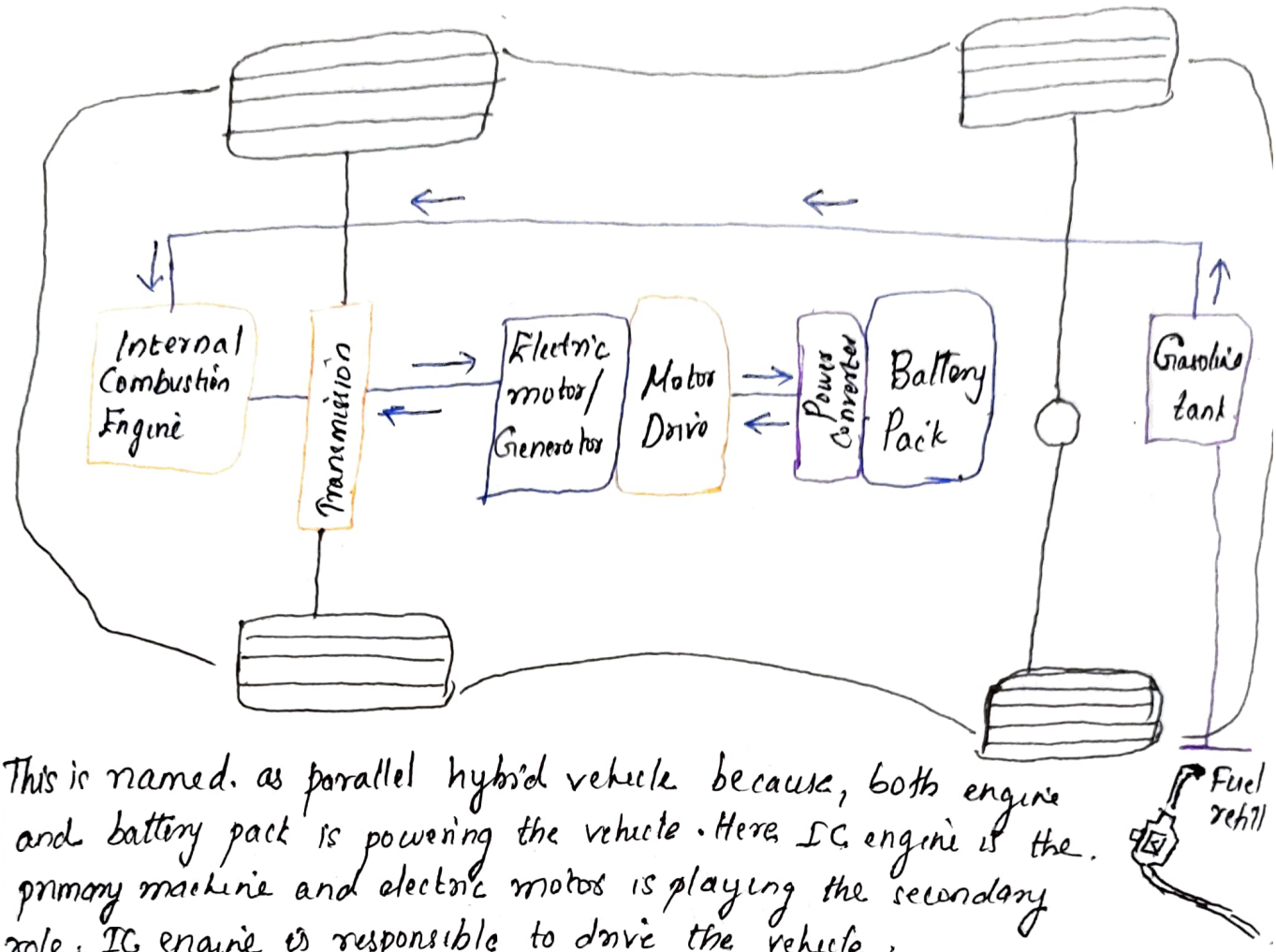
Disadvantages of Series hybrid Vehicle:

- The energy is converted twice (mechanical to electrical and then to mechanical) and this reduces the overall efficiency.
- Two electric machines are needed and a big traction motor is required because it is the only torque source of the driven wheels.

Industrial Application in Automobile Segment:

Well known automotive Series hybrid models include the variant of the BMW i3 that is equipped with a range extender. Another example of a series hybrid automobile is a Fisker Karma. The Chevrolet Volt is almost a series hybrid, but also includes a mechanical link from the engine to wheels above 70mph.

(b) Parallel Hybrid Electric Vehicles:



This is named as parallel hybrid vehicle because, both engine and battery pack is powering the vehicle. Here IC engine is the primary machine and electric motor is playing the secondary role. IC engine is responsible to drive the vehicle.

Case:1 IC engine drive:

We are running IC engine, the motor will not be rotating

Case: 2 : Electric drive:

Here, we are running the electric pack, the motor will be running, and IC engine is OFF. Motor will be driving the vehicle

case: 3 Hybrid mode:

Both the IC engine and motor will drive the vehicle together.

Case 4: Battery is low

IC engine will be running the vehicle as well as charging the battery. This can be done in many ways, like the electric motor is made to act as generator to recharge the battery pack or IC engine could be attached to a seperate generator to recharge the battery pack. This choice is upto the manufacturer

Case: 5: Renegenerative Braking

IC engine will be OFF and the motor will be acting as generator and it will recharge the battery pack.

Advantages of hybrid electric vehicle in parallel.

- Both engine and electric motor supply torques to the driven wheels and no energy from conversion occurs, hence energy loss is less.
- Compactness due to no need of the generator and smaller traction motor.

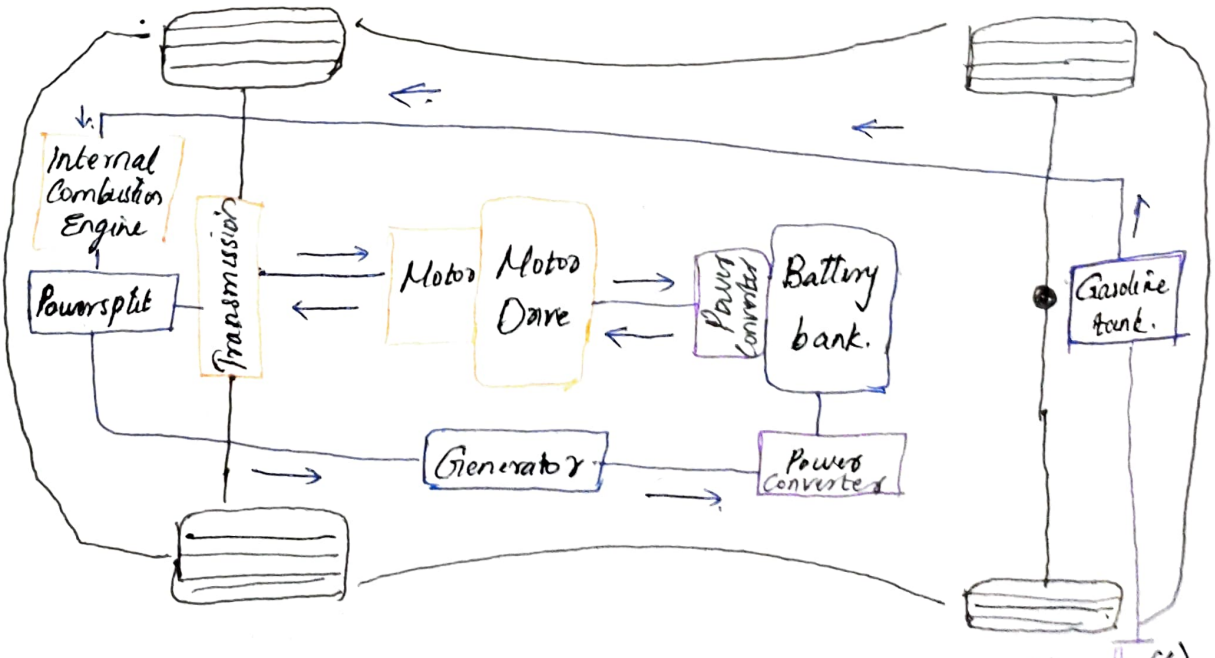
Disadvantages of Parallel hybrid Vehicle:

- 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 drivetrain.

Industrial Applications in Automobile Segment:

Examples of cars using mild parallel hybrid configurations are the Honda Insight, Honda Civic Hybrid and the Mercedes-Benz S400 Blue HYBRID. One of the best known hybrid cars has been the Toyota Prius. This is an example of a vehicle that uses a power-split or series-parallel hybrid configuration.

(c) Series-Parallel Hybrid Vehicle:



This has the features of both series and parallel hybrid. Many different modes of driving are possible under ICE dominant hybrid vehicle and under Motor dominant drive mode: We have motor, which is directly connected to the transmission, but the engine is connected to a device known as powersplit. Powersplit will split the power between the generator and the transmission. When the battery is low and we want to recharge the battery pack, the powersplit will direct the power to the generator. Also, if we dont want to recharge the battery, but you want to drive the engine instead, so we can shift to transmission, and if we want both, the power output from the engine will be divided between the transmission and the generator as per the load.

Advantages of Series-Parallel hybrid Vehicle

- reduced traction motor size
- no need for a generator
- elimination of efficiency losses in multiple power conversion processes between the electric machines and the battery.

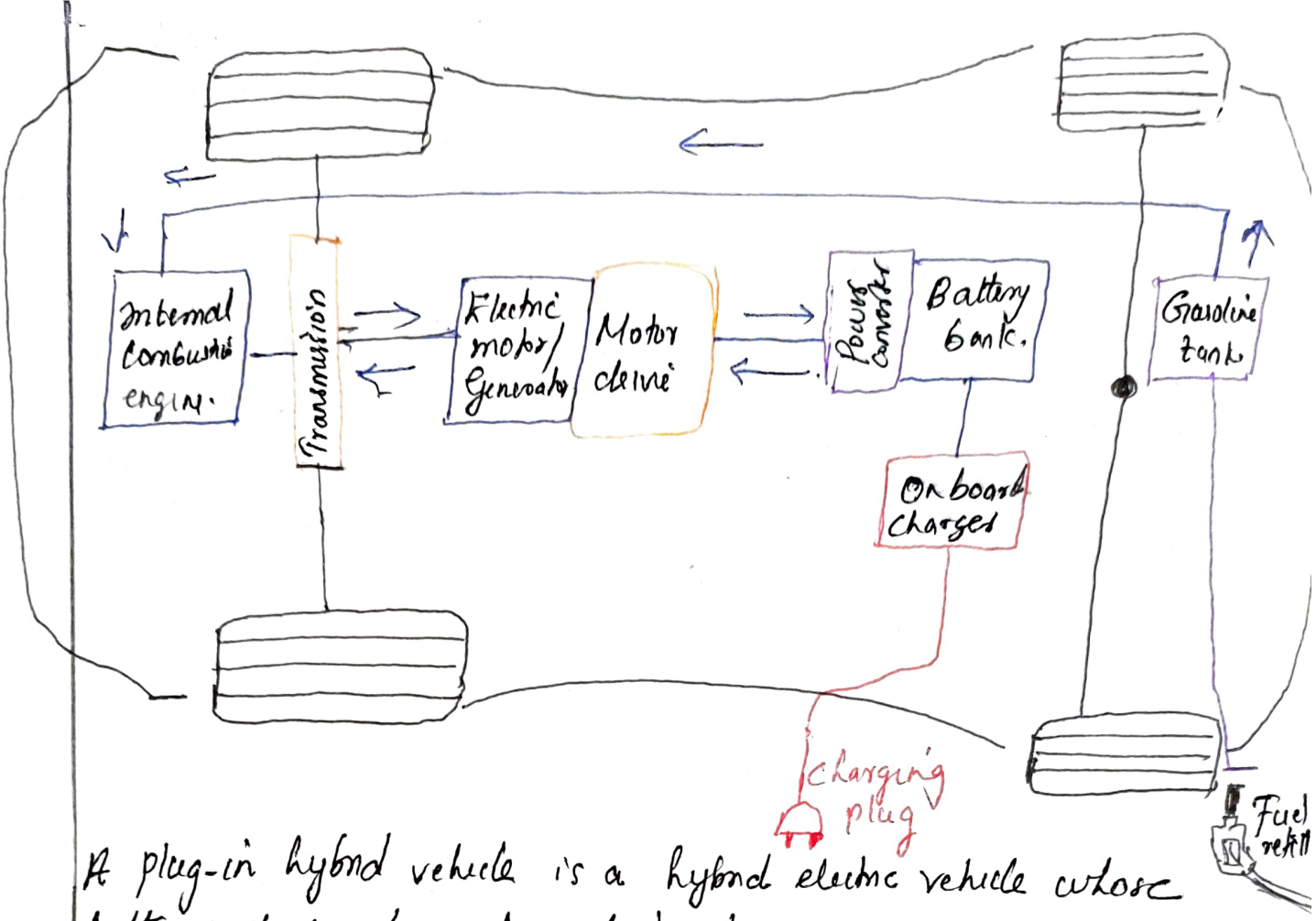
Disadvantages of Series-Parallel hybrid Vehicle

- The larger battery and motor makes the series-parallel hybrid system very expensive
- Control complexity.
- Complex drive train configuration.

Industrial Application in Automobile segment:

- Nissan experimented
- Fiat experimented
- Toyota Prius.

(d) Plug-in hybrid Electric vehicle (PHEV)



A plug-in hybrid vehicle is a hybrid electric vehicle whose battery pack can be recharged by plugging a chargable cable into an external electric power source, in addition to internally by its on-board internal combustion engine-powered generator.

Advantages of plug-in hybrid vehicle:

- Zero emission when driving on batteries
- Fuel efficient in traffic.
- easy to drive
- cheap to run if doing regular 10/15 miles commutes.

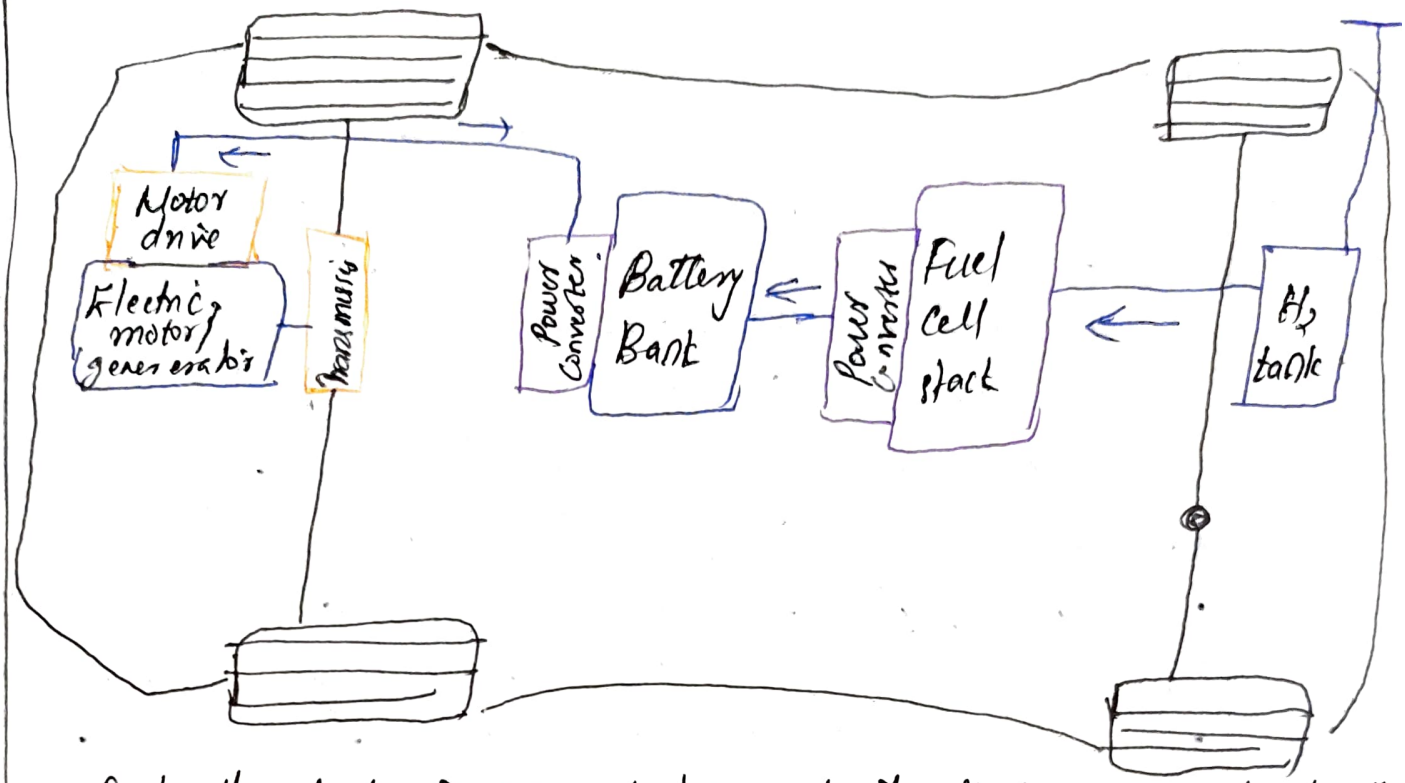
Disadvantages of Plug-in hybrid vehicles

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

Industrial Application of Plug-in hybrid vehicles

- Honda Clarity . Toyota RAV4 . Ford Escape .
- Chrysler Pacifica . Hyundai Sonata Te . Kia Niro

(e) Fuel cell Electric Vehicle :



A fuel cell vehicle is an electric vehicle that uses a fuel cell, sometimes in combination with a small battery or super capacitor, to power its onboard electric motor. Fuel cells in vehicles generate electricity generally using oxygen from the air and compressed hydrogen.

Advantages of fuel cell Electric Vehicles

- Zero-emission power
- Robust Reliability
- Improved efficiency
- Scalable.
- Lower operational cost

Disadvantages of fuel cell Electric Vehicles

- Hydrogen storage and transportation
- Cost of Raw materials
- Regulatory Issues
- Highly flammable

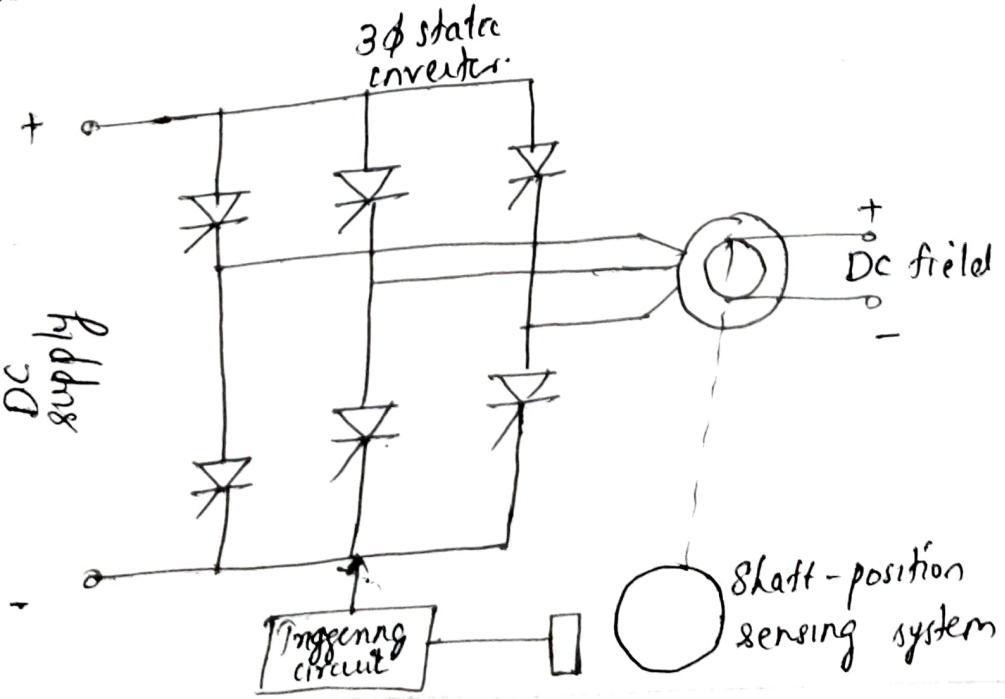
Industrial Application in Automobile Segment

- Hyundai NEXO ..

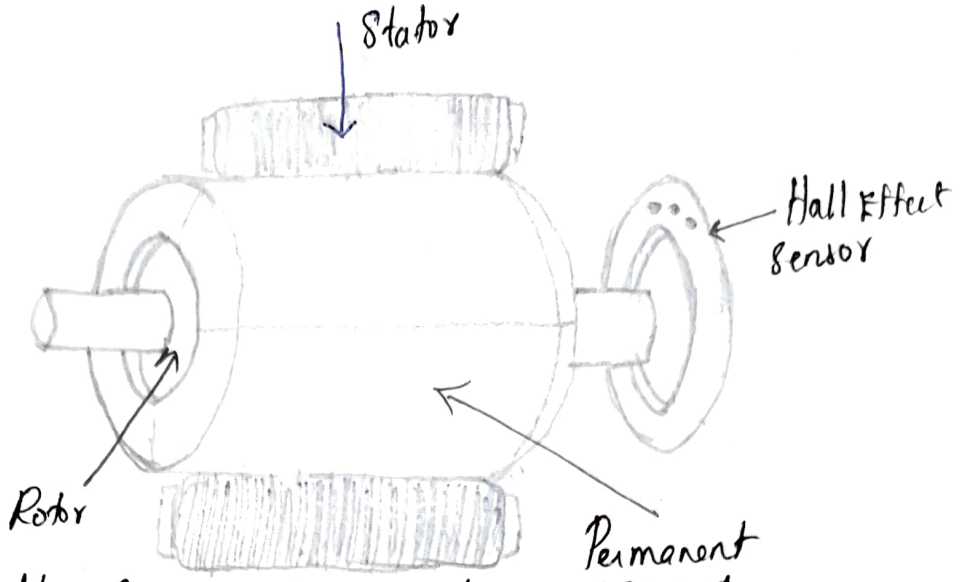
Q.3 Explain with Diagram the Construction & Working principle Brushless motor BLDC.

Ans(3) A DC motor can be thought of as an ac synchronous m/c the field is stationary and the armature with its multiphas winding is rotating. The armature receives ac supply from source through brushes and commutator. The brushes and co constitutes an inverter sensitive to the shaft position. In a s way, a synchronous motor may be considered to operate as dc motor. In a synchronous m/c, the field is rotating, whe the armature is stationary, but it could be supplied by an controlled by shaft-position sensing signals. The static invert the shaft position sensitive controller can very well be regar as an electronic commutator serving the same function as the mechanical commutator.

The brushless DC motor are generally more exp for the same kW rating than conventional motors but. certain advantages too, such as little or no maintenanc longer operating life, no risk of explosion or possibility radiation due to arcing, higher efficiency, rapid re etc... These motors are capable of operation submerged combustible gases and may be even hermetically sea They provide a fairly linear output torque v/s input curve which lends itself to serve the applications.



Construction of Brushless DC motor



In this motor the permanent magnet attached to the rotor. The current carrying conductors or armature windings are located on the stator. They use electrical commutation to convert electrical energy into mechanical energy. Brushless motor does not have any current carrying commutators. The field inside a brushless motor is switched through an amplifier which is triggered by the commutating device like an optical encoder.

Working principle of BLDC motor

BLDC motor works on the principle similar to that of 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 BLDC motor, the current carrying conductor is stationary and permanent magnet is moving. When the stator coils get supply from the source, it becomes electromagnet and starts producing uniform field in the air gap. Though the source of supply is DC, switching makes to generate an AC voltage w/f with trapezoidal shape. Due to the force of interaction b/w electromagnet stator and PM rotor, the rotor continues to rotate. With the switching of windings as high and low signals, corresponding winding energized as N and S poles. The PM rotor with N and S poles align with stator poles which causes motor to rotate.

Advantages of BLDC motor

- Less overall maintence due to absence of brushes
- Reduced size with far superior thermal characteristics
- Higher speed range and lower electric noise generation
- It has no mechanical commutator and associated problem.
- High efficiency and high output power to size ratio, due to the use of PM rotor.

Disadvantages of BLDC motor

- These motors are costly
- Electronic controllers are required to control this motor which is expensive
- Requires complex drive circuitory.
- Need of additional sensors.

Applications

- Electric vehicles, hybrid vehicles and electric bicycles,
- Computer hard drives and DVD-CD players.
- Used in two-wheelers like ATHER 450X, Pure EV entrance neo, Chetak Electric.

Q-1 Explain the journey of automotive with the help of flow chart from the begining of 18th century to 21st century and give brief description on the following milestones in the automotive journey.

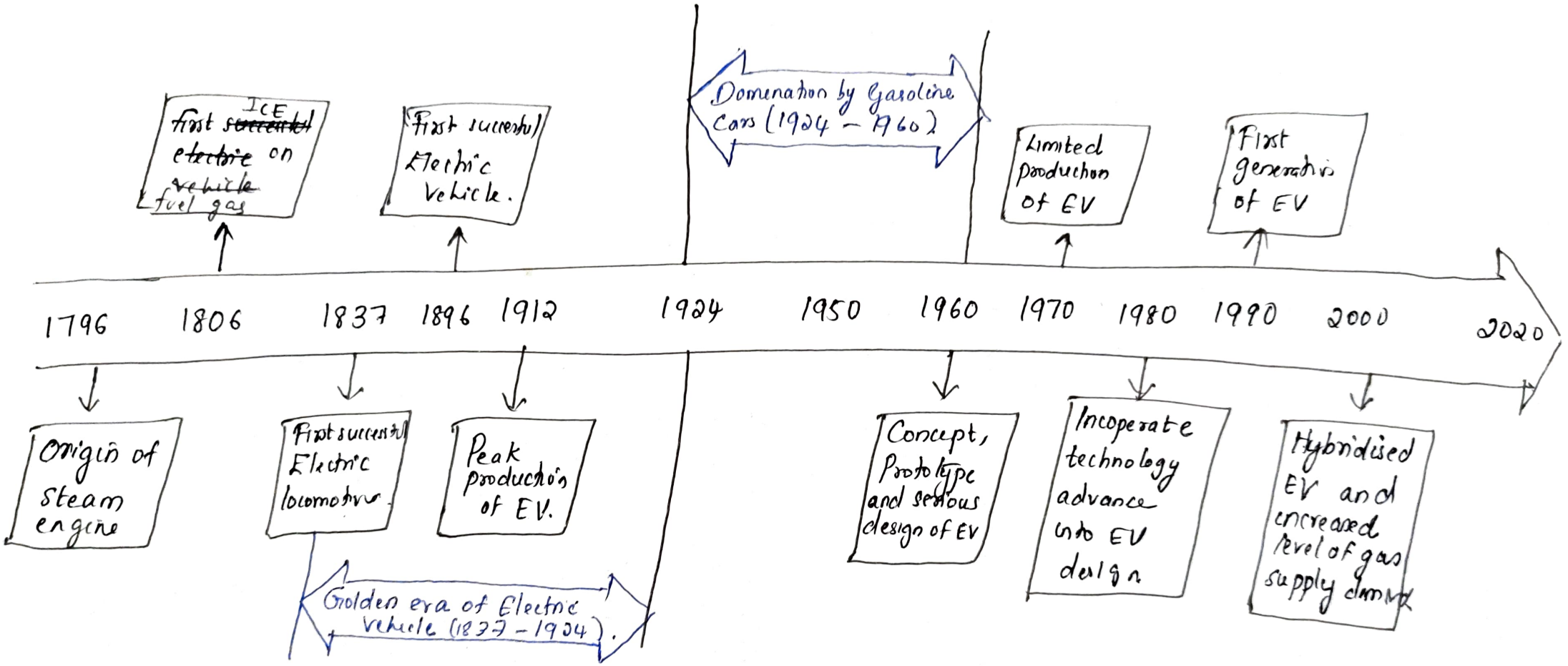
(a) Invention of Electric motor

(b) Golden era of EV

(c) Domination of EV by gasoline Car

(d) Comming of new era in EV

(e) Introducing HEV.



Flow chart of the journey of Automotive from the beginning of 18th Century to 21st Century.

- 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 Netherlands 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 D'avidion of Aberdeen
- The invention of the improved battery technology in France 1881, Gaston Plante
- The first succesful EV was built in 1896 in US by William Morrison
- The EV was designed as passenger carriage driven by driver with two passenger carrying capacity
- In the begining of 1900, electric cars were even labelled as Women's cars.
- At the turn of the century, 40% of American's cars were powered by steam, 38% by electricity and 22% by petrol.
- Commercial EV's were produced primarily in Europe.
- In 1912, petrol powered cars became easier to drive due to the invention of Charles Kettering and his electric starter.
- Electric cars began to loose their position in the car market in America in 1920's.
- EV was dominated by gasoline cars in 1924 - 1960.
- The energy crisis in 21st century lead to renewed interest in electric cars.
- A lot of small companies started to design and advertise

electric cars to the public.

- Toyota offered its RAV4 – EVS in year 22nd Nov 2002
- Californian manufacturer of electric cars TESLA Motors ch 2004 started the development of TESLA ROADSTER model which was first delivered to the customer in 2008.
- TESLA was also the first to introduce Li-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 such of them

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