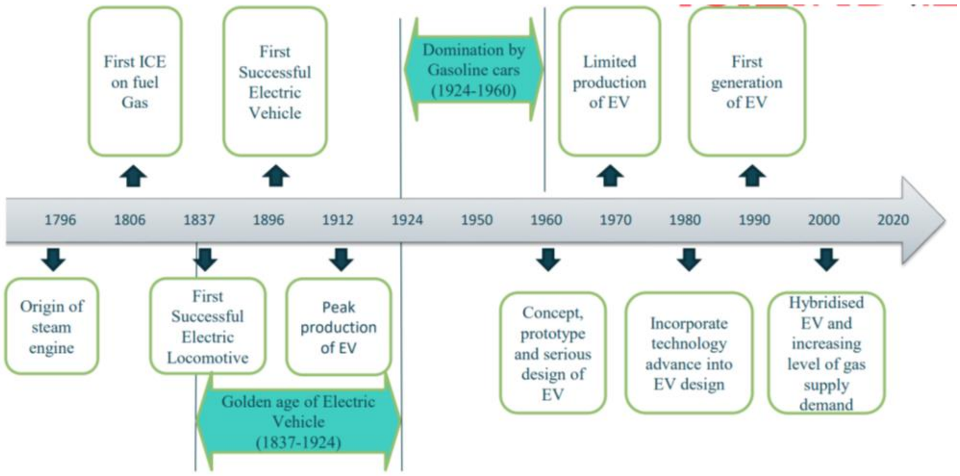
ASSIGNMENT 1

1. Flow Chart for the history of automotive



Development of the automobile started in 1672 with the invention of the first steam-powered vehicle, which led to the creation of the first steam-powered automobile capable of human transportation, built by Nicolas-Joseph Cugnot in 1769.Inventors began to branch out at the start of the 19th century, creating the de Rivas engine, one of the first internal combustion engines, and an early electric motor. Samuel Brown later tested the first industrially applied internal combustion engine in 1826. Development was hindered in the mid-19th century by a backlash against large vehicles, yet progress continued on some internal combustion engines. The engine evolved as engineers created two- and four-cycle combustion engines and began using gasoline as fuel. Production vehicles began appearing in 1887, when Carl Benz developed a gasoline-powered automobile and made several identical copies. Recent automobile production is marked by the Ford Model T, created by the Ford Motor Company in 1908, which became the first automobile to be mass-produced on a moving assembly line.

<u>Invention of Electric Motor</u>

In 1835 the two Dutchmen Sibrandus Stratingh and Christopher Becker built an electric motor that powered a small model car. This is the first known practical application of an electric motor. In February 1837 the first patent for an electric motor was granted to the US-American Thomas Davenport. The years 1885 until 1889 saw the invention of the three-phase electric power system which is the basis for modern electrical power transmission and advanced electric motors. A single inventor for the three-phase power system cannot be named. There are several more or less well-known names who were all deeply involved in the inventions (Bradley, Dolivo-Dobrowolsky, Ferraris, Haselwander, Tesla and Wenström).Today, the three-phase synchronous motor is used mostly in highly dynamic applications (for example in robots) and in electric cars. It was developed first by Friedrich August Haselwander in 1887.The highly successful three-phase cage induction motor was built first by Michael Dolivo-Dobrowolsky in 1889. Today, this is the most frequently produced machine in the power range of 1 kW and above.

Golden Era of EV

During the early 1900s, there was a golden age of electric cars, when they made up more than one-third of car sales in the U.S. In the early 20th century, people traded in their horses for more advanced vehicles that improved transportation and allowed the country to grow and thrive.

- 1906 “One Hundred Mile” Frichtle

In Cleveland, Ohio, Oliver Frichtle claimed his battery-powered car could make it 100 miles before needing a charge. Once he proved it on a road trip, the car became popular amongst elite women who liked the extra room within the vehicle.

- 1912 Detroit Electric

Detroit Electric was making 13,000 electric cars annually by 1912. This was a production record for this time, and it was clear that Detroit Electric was a frontrunner in the industry.

- 1910 Baker Victoria

Baker Electric Motor Vehicle Company set a record in 1910 by driving the farthest distance on a single charge. The trip was just over 200 miles, and the Victoria traveled at a speed of 12 miles per hour. Today, one of these cars is owned by Jay Leno.

Domination of Electric Vehicle by Gasoline Cars

Cars during this time were powered by one of three methods: steam, gasoline or electricity. Gasoline-powered vehicles had internal combustion engines (ICE). They were often tedious to start, especially on a cold morning. It would sometimes take 45 minutes for a car to warm up. Additionally, they required a hand crank to start, which took some physical strength to turn. They were noisy, smelled strange and vibrated while driving. Steam-powered cars, of which there were many, featured an external combustion process that yielded a powerful car, but those cars were slow to get started and less efficient than ICE vehicles once they got going. Even so, there was stiff competition between traditional and electric vehicles. Both had their advantages and disadvantages—it was challenging to know which type of vehicle would reign supreme at that point when dozens of small car companies competed for attention.However, as time passed, it was clear that ICE cars became a more appealing option—drivers could travel farther distances without worrying about recharging their low-capacity batteries. Henry Ford, in spite of his interest in building an electric car that prefigured the later, successful Model T. Once Ford shifted gears to the Model T and other competitors stepped up, the electric car (and the steam car for other, but related reasons) was left behind.

Coming of New Era in EV

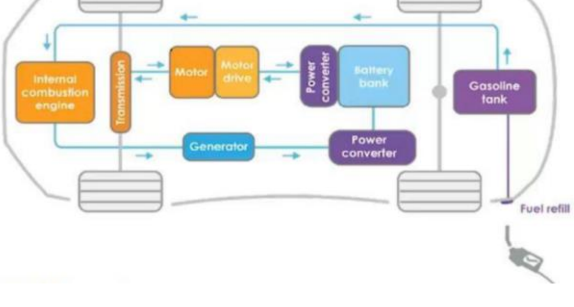
Factors such as growing demand for low emission commuting and governments supporting long range, zero emission vehicles through subsidies & tax rebates have compelled the manufacturers to provide electric vehicles around the world. This has led to a growing demand for electric vehicles in the market. Countries around the world have set up targets for emission reductions according to their own capacity. Increasing investments by governments across the globe to develop EV charging stations and Hydrogen fuelling stations along with incentives offered to buyers will create opportunities for OEMs to expand their revenue stream and geographical presence. The EV sector across Asia Pacific is projected to experience steady growth owing to the high demand for lower cost efficient and low-emission vehicles, while the North American and European market are fast growing markets due to the government initiatives and growing high-performance Passenger vehicle segment. However, relatively less number of EV charging stations and hydrogen fuel stations, higher costs involved in initial investments, and performance constraints could hamper the growth of global electric vehicle market.

Introduction to Hybrid Electric Vehicles

A hybrid electric vehicle (HEV) is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system (hybrid vehicle drivetrain). The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance. There is a variety of HEV types and the degree to which each function as an electric vehicle (EV) also varies. The most common form of HEV is the hybrid electric car, although hybrid electric trucks (pickups and tractors), buses, boats and aircraft also exist. Modern HEVs make use of efficiency-improving technologies such as regenerative brakes which convert the vehicle's kinetic energy to electric energy, which is stored in a battery or super capacitor. Some varieties of HEV use an internal combustion engine to turn an electrical generator, which either recharges the vehicle's batteries or directly powers its electric drive motors; this combination is known as a motor–generator. Many HEVs reduce idle emissions by shutting down the engine at idle and restarting it when needed; this is known as a start-stop system. A hybrid-electric produces lower tailpipe emissions than a comparably sized gasoline car since the hybrid's gasoline engine is usually smaller than that of a gasoline-powered vehicle. If the engine is not used to drive the car directly, it can be geared to run at maximum efficiency, further improving fuel economy. Ferdinand Porsche developed the Lohner-Porsche in 1901. But hybrid electric vehicles did not become widely available until the release of the Toyota Prius in Japan in 1997, followed by the Honda Insight in 1999. Initially, hybrid seemed unnecessary due to the low cost of gasoline. Worldwide increases in the price of petroleum caused many automakers to release hybrids in the late 2000s; they are now perceived as a core segment of the automotive market of the future. As of April 2020, over 17 million hybrid electric vehicles have been sold worldwide since their inception in 1997.Japan has the world's largest hybrid electric vehicle fleet with 7.5 million hybrids registered as of March 2018.

2. HYBRID ELECTRIC VEHICLE

a) Series Hybrid Electric Vehicle



Series drivetrains are the simplest hybrid configuration. In a series hybrid, the electric motor is the only means of providing power to the wheels. The motor receives electric power from either the battery pack or from a generator run by a gasoline engine. A computer determines how much of the power comes from the battery or the engine/generator. Both the engine/generator and the use of regenerative braking recharge the battery pack.

Advantages:-

• 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:-

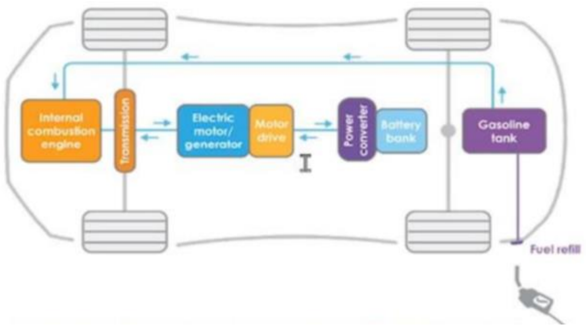
• The energy is converted twice (mechanical to electrical and then to mechanical) and this reduces the overall efficiency.

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

Applications:-

BMW i3

b) Parallel Hybrid Electric Vehicle



In vehicles with parallel hybrid drivetrains, the engine and electric motor work in tandem to generate the power that drives the wheels. Parallel hybrids tend to use a smaller battery pack than series drivetrains, relying on regenerative braking to keep it recharged. When power demands are low, parallel hybrids also utilize the motor as a generator for supplemental recharging, much like an alternator in conventional cars.

Advantages:-

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

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

Disadvantages:-

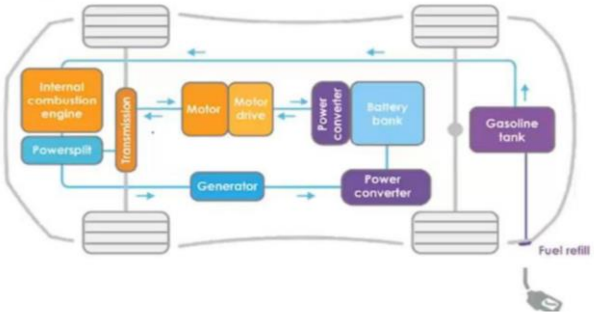
• Mechanical coupling between the engines and the driven wheels, thus the engine operating points cannot be fixed in a narrow speed region.

• The mechanical configuration and the control strategy are complex compared to series hybrid drivetrain.

Application:-

Mercedes-Benz S400 BlueHYBRID

c) Series-Parallel Hybrid Vehicle



Series/parallel drivetrains merge the advantages and complications of the parallel and series drivetrains. By combining the two designs, the engine can both drive the wheels directly (as in the parallel drivetrain), and be effectively disconnected, with only the electric motor providing power (as in the series drivetrain). The Toyota Prius helped make series/parallel drivetrains a popular design. With gas-only and electric-only options, the engine operates at near optimum efficiency more often. At lower speeds it operates more as a series vehicle, while at high speeds, where the series drivetrain is less efficient, the engine takes over and energy loss is minimized.

Advantages:-

- Zero emission when driving in batteries.
- Fuel efficient in traffic
- Easy to drive

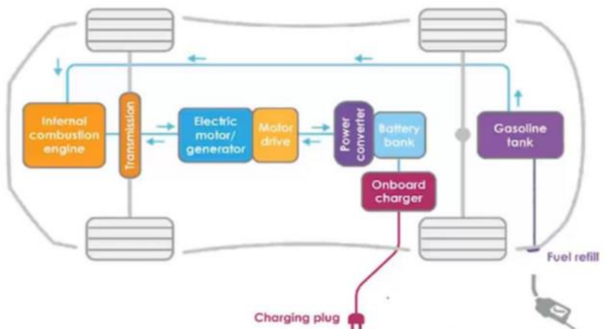
Disadvantages:-

- Expensive
- Fuel economy not good
- Battery life concerns

Application:-

Honda Insight, Honda Civic Hybrid

d) Plug-in Hybrid



A plug-in hybrid electric vehicle (PHEV) uses a battery to power an electric motor and uses another. The battery pack in a PHEV is generally larger than in a standard hybrid electric vehicle. The larger battery pack allows the vehicle to operate predominantly on electricity during short trips. For longer trips, a PHEV can draw liquid fuel from its on-board tank to provide a driving range similar to that of a conventional vehicle. An on-board computer decides when to use which fuel according to which mode allows the vehicle to operate most efficiently. The battery can be charged by plugging into an electric power source, through regenerative braking, and by the internal combustion engine. In regenerative braking, kinetic energy normally lost during braking is captured and stored in the battery fuel, such as gasoline or diesel, to power an internal combustion engine.

Advantages:-

• zero emission when driving on batteries

• Fuel efficient in traffic

• Easy to drive

• Cheap to run if doing regular 10/15 mile commutes.

Disadvantages:-

• relatively expensive & complex to maintain

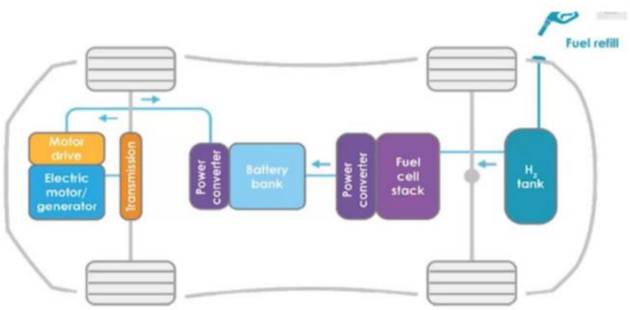
• Fuel economy not very good on motorway journeys

• Battery life concerns

Application:-

Mitsubishi Outlander PHEV

e) Fuel-Cell EV



FCEVs use a propulsion system similar to that of electric vehicles, where energy stored as hydrogen is converted to electricity by the fuel cell. Unlike conventional internal combustion engine vehicles, these vehicles produce no harmful tailpipe emissions. Other benefits include increasing U.S. energy resiliency through diversity and strengthening the economy. FCEVs are fuelled with pure hydrogen gas stored in a tank on the vehicle. Similar to conventional internal combustion engine vehicles, they can fuel in less than 4 minutes and have a driving range over 300 miles.

Advantages:-

- High Energy Density Improves Productivity

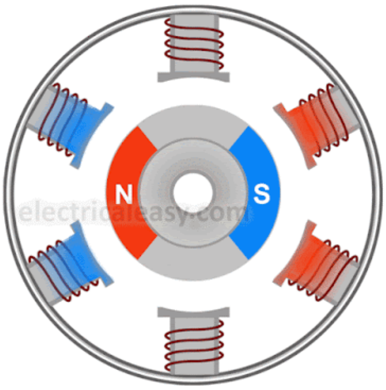
Disadvantages:-

- The Use of Fossil Fuels in Hydrogen Production.
- Hydrogen Storage and Transportation.
- Fuel Cell Efficiency.

Application:-

Hyundai ix35 FCEV

3. Brushless DC Motor



Construction of A BLDC Motor

A commutator-brushes arrangement helps in achieving unidirectional torque in a typical dc motor. Obviously, commutator and brush arrangement is eliminated in a brushless dc motor. Here, an integrated inverter/switching circuit is used to achieve unidirectional torque. That is why these motors are, sometimes, also referred as 'electronically commutated motors'.Just like any other electric motor, a BLDC motor also consists of two main parts a stator and a rotor. Permanent magnets are mounted on the rotor of a BLDC motor, and the stator is wound for a specific number of poles. Also, a control circuit is connected to the stator winding. Most of the times, the inverter/control circuit or controller is integrated into the stator assembly. This is the basic constructional difference between a brushless motor and a typical dc motor.A typical controller provides a three-phase frequency-controlled supply to the stator winding. The supply is controlled by logical control circuits and energizes specific stator poles at a specific point of time. This can be understood from the below animations about working of BLDC motors.

Working

Principle – Lorentz force law which states that whenever a current carrying conductor is placed in a magnetic field it experiences a force.

Stator windings of a BLDC motor are connected to a control circuit (an integrated switching circuit or inverter circuit). The control circuit energizes proper winding at the proper time, in a pattern which rotates around the stator. Permanent magnets on the rotor try to align with the energized electromagnets of the stator, and as soon as it aligns, the next electromagnets are energized. Thus, the rotor keeps running.