DIPLOMA BOARD EXAMINATION – APRIL 2024

ANSWER KEY FOR THE QUESTION CODE – 449

SUBJECT CODE / NAME: 4020620 – E-VEHICLE TECHNOLOGY AND POLICY

BRANCH: EEE,MECH,ECE SEMESTER: 4 MAXIMUM MARKS: 100

N.B 1. Answer all the questions under Part -A. Each question carries 3 marks. (10x3=30)

2. Answer all questions either (a) or (b) in Part-B. Each question carries 14 marks.

PART-A

1.What is front wheel drive? (3 MARKS)

FWD means that the power from the engine is delivered to the front wheels of the vehicle. In FWD, the front wheels are pulling the car.

2.Write about HEV. (3 MARKS)

A vehicle that has two or more energy sources and energy converters is called a hybrid vehicle. A hybrid vehicle with an electrical power train is called an HEV. The block diagram of hybrid electric vehicle.

3.Write about speed ratio. (3 MARKS)

At the low - speed region (less than the base speed as marked in figure), the motor has a constant torque. In the high-speed region (higher than the base speed), the motor has a constant power. This characteristics is represented by speed ratio given as

Speed ratio = x= Maximum speed of the vehicle/ Base speed of the vehicle

4.Mention any three applications of BLDC motor. (3 MARKS)

- 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.

5.What is battery management system? (3 MARKS)

BMS is designed to monitor the parameter associated with the battery pack and its individual cell. It applies the collected data to eliminate the risk and optimize the battery performance.

6.What is the impact of EV on power grid? (3 MARKS)

POSITIVE IMPACT

- Facilitating smart grid
- V2G(vehicle to grid)
- Integration of RES

NEGATIVE IMPACT

- Voltage instability
- Increased peak demand
- Harmonics
- Voltage sag
- Power loss
- Overloading of transformers

7.What are the advantages of EV Eco system? (3 MARKS)

The EV (Electric Vehicle) ecosystem offers several advantages, including

- Reduced greenhouse gas emissions,
- Lower fuel costs,
- Quieter operation, and
- Potentially lower maintenance costs due to fewer moving parts in electric vehicles compared to traditional internal combustion engine vehicles.
- Additionally, EVs contribute to energy independence by reducing reliance on fossil fuels and can benefit from renewable energy sources, further reducing environmental impact.

8.Write about key performance indicator. (3 MARKS)

Key Performance Indicator is a measurable value that demonstrates progress towards intended result. KPIs can be a useful tool to enable cities measure their progress.

9.What is the impact of the policy measures in the area of electric cars and two wheelers? (3 MARKS)

Electric Car: In Tamil Nadu (TN) nearly 25 lakh personal cars have been registered. By providing charging network and giving economic concession the Tamil Nadu government encourages users to buy Electric vehicle.

Electric Two-Wheeler: Nearly 85% of vehicle population is two-wheeler. When these vehicles are turned into EV then, it requires low battery capacity to propel the vehicle. Therefore, there is no need for dedicated charging stations for two wheelers, it can be done with the existing infrastructure in our house / office. By giving economic concession the TN government encourages the users to shift their interest to buy Electric vehicle.

10.Write about the initiatives of the charging Infrastructure. (3 MARKS)

(Any Three Points)

- The state will invest setting up charging stations with the support of TANGEDCO and private owners. The Tamil Nadu Generation and Distribution corporation Limited (TNGEDCO) is an electrical power generation and distribution public sector undertaking owned by Government of Tamil Nadu.
- The Government will develop schemes with appropriate subsidy to enable private operators to set up public charging stations.
- The charging stations will be provided in commercial buildings such as hotels, shopping malls, cinema halls, apartments etc.
- The Government will take effort to set up 3*3 Grid charging stations in Chennai, Coimbatore, Trichy, Salem and Tirunelveli.
- On charging station will be set up at 25Km intervals on both sides of NHAI and state highways. (NAI - National Highways Authority of India)
- Charging points will be provided in the Government office parking lots and other places based on requirements.
- TANGEDCO will invest in setting up both slow and fast charging networks in government buildings and other public places.
- TANGEDCO will setup the charging infrastructure on its own or through private sectors.
- EV charging service providers can also setup their own renewable energy generating stations.
- The tariff applicable for domestic consumption shall be applicable for private charging station at home (LT Tariff - 1A).
- Private charging can be done in common supply with the LT Tariff V.

- Tariff for the supply of electricity to public charging stations (PCS) will be determined by TNERC, which is not more than 15% above the average cost of supply. (TNERC - Tamil Nadu Electricity Regulatory Commission)
- Supply of Renewable energy will be ensured on preferential basis. Zero connection cost for EV charging stations.

PART-B

11.(a)Explain any two-drivetrain system in a conventional vehicle.

Note: All the types of drivetrain system are given. **(14 MARKS)**

(i)Front Wheel Drive (FWD) (Diagram-3marks &Theory-4marks)

FWD means that the power from the engine is delivered to the front wheels of the vehicle. In FWD, the front wheels are pulling the car. The drivetrain of FWD is shown in figure.

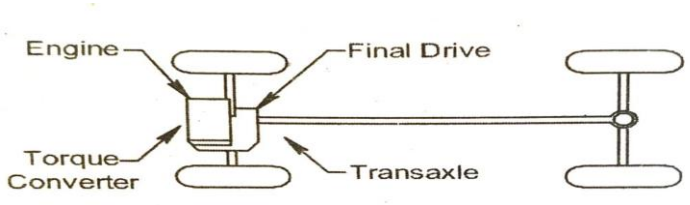


Figure: FRONT WHEEL DRIVE

Parts of FWD drivetrain

The drive train of front wheel drive consists of

- Transaxle
- Transmission
- Differential
- Final drive
- CV joints
- Drive shaft (Half shaft)
- Driven wheel

Working

The engine generates power and then transfers it to the clutch or torque converter. It is then forward the power to a transaxle. A transaxle is a single mechanical device which combines the functions of a vehicle transmission and differential into one integrated assembly. The differential transfers the torque to the driven wheels through half shafts and CV joints. Finally, the vehicle begins to move.

Advantages

- Cheap compared to RWD.
- Better fuel economy.
- High Engine cooling.
- Good road grip.
- Good control over the vehicle.
- There is no need of separate propeller shaft.

Disadvantages

- High maintenance cost.
- Increase the turning circle of a front wheel.

(ii) Rear wheel drive (RWD) (Diagram-3marks &Theory-4marks)

RWD means that the power from the engine is delivered to the rear wheels and the rear wheel is push the car forward. The front wheels do not receive any power. The drivetrain of RWD is shown.

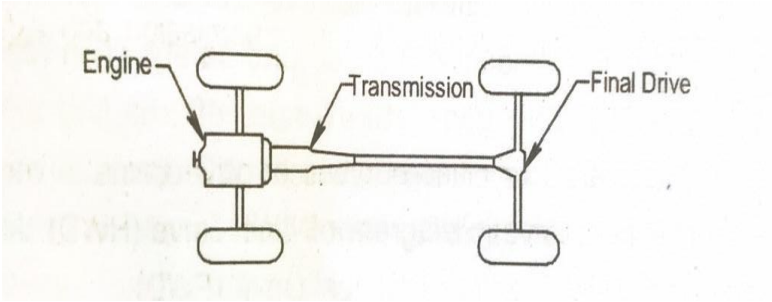


Figure: REAR WHEEL DRIVE

Parts of RWD Drivetrain

The drive train of rear wheel drive consists of

- Transmission
- Propeller shaft
- U joints
- Final drive
- Differential
- Drive shaft

- Driven wheel

Working

The engine generates power and then transfers it to the clutch or torque converter. It is then forward the power to a transmission which is connected to a propeller shaft through universal joints. The U joints provide both power transmission and flexibility to the shafts if they were to undergo an external force .The end of the propeller shaft is connected to a Final drive through another U joint After final reduction in speed it is connected to the differential. The differential transfers the torque to the driven wheels. Finally the vehicle begins to move.

Advantages

• It creates a better balance of weight.

• Lower maintenance.

• Engine cooling is good.

• It is easy to connect the components with the engine.

• It is easy to control the vehicle.

Disadvantages

•It does not perform well in poor weather conditions such as rain or snow.

• It limits the space for storage and passengers.

(iii)Four Wheel Drive (4WD) (Diagram-3marks &Theory-4marks)

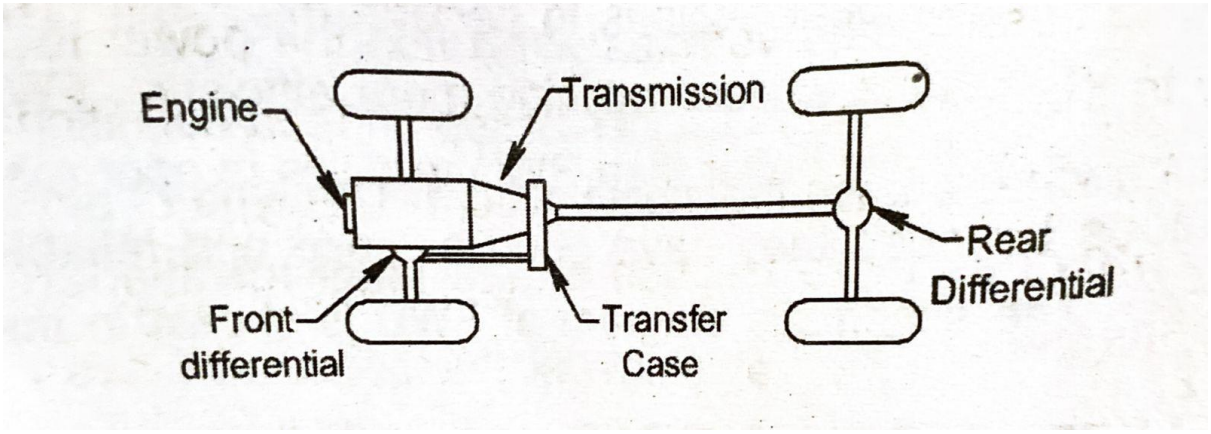


Figure: FOUR WHEEL DRIVE

Four-wheel drive means the power from the engine is delivered to all 4 wheels, all of the time when 4X4 is engaged.it has an option to operate in an RWD format to conserve fuel. It has both a front and rear differential on the front and rear axles that allows the left and right wheels to move at different speeds when making a turn. This prevents the wheel skit that would occur with all four wheels moving.

Advantages

- Pulling power is more.
- It provides power to take on any terrain or weather condition.

Disadvantages

- Initial cost is high.
- Maintenance is high.
- Complicated design.
- Create more noise and vibration.

(iv)All-Wheel Drive (AWD) **(Diagram-3marks &Theory-4 marks)**

A drivetrain that employs a front, rear and centre differential to provide power to all four wheels of a vehicle is called all-wheel drive system. It is also called full time AWD. The drive train of all wheel drive is shown in figure.

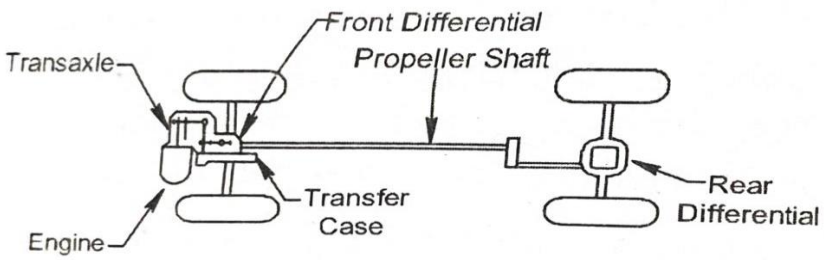


Figure: ALL WHEEL DRIVE

Parts of AWD Drivetrain

- Transmission (Gearbox)
- Transfer case (Centre Differential)
- Differential
- Front differential
- Rear differential
- Propeller shaft o Front

- Rear
- Final Drive
- CV joints
- Drive shaft (Half shaft)
- Driven wheel

Working

- The engine generates power and then transfers it to the clutch or torque converter. It is then forward the power to a transmission (Gearbox) which is attached to a transfer case.
- The transfer case splits the power from the engine equally to both rear and front axle through front and rear differentials. The transfer case is connected to front and rear differentials through front and rear propeller shaft. The differential (Both front and rear) transfers the torque to the driven wheels through half shafts and CV joints. Finally the vehicle begins to move.

Advantages

- Maximum grip on a variety of surfaces. AWD system adjusts to the road conditions by sending more or less power to the wheels.

Disadvantages

- Fuel consumption is more.
- Higher cost.

11 (b) Explain PHEV with block diagram. State its advantages and disadvantages. (14 MARKS)

(Diagram-7marks &Theory-7marks)

Plug-in Hybrid Electric Vehicle (PHEV)

The PHEV uses both an ICE and an electrical power train, like a HEV, but the difference between them is that the PHEV can be directly connected to the electrical grid for charging the batteries. It uses electric propulsion as the main driving force. So these vehicles require a bigger battery capacity than HEVs. There are different modes of operation in PHEV some of them are

- Battery alone mode

  Only battery provides the power.

- .Engine alone mode:

  Only ICE engine propels the vehicle.

- Combined mode

  Both the ICE and battery provide the required power.

- Power split mode :

  The ICE power is split to drive the vehicle and charge the battery.

The block diagram of plug-in Hybrid Electric Vehicle is shown in figure.

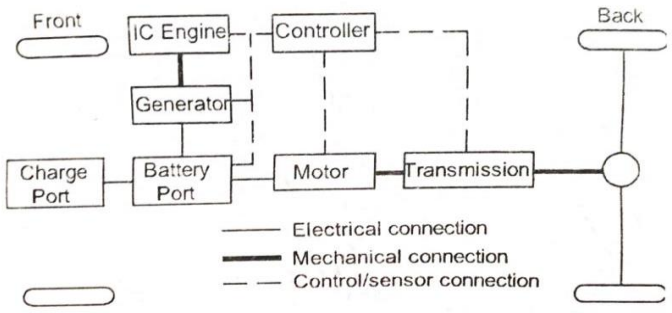


Figure: Block diagram of Plug-in hybrid Electric Vehicle

Working

- Energy from ICE Engine is transferred to Torque coupler through clutch 1 and transmission assembly.
- Energy from the battery pack is regulated by DC-DC converter and it is converted into AC by an inverter. The inverter will drive the electric motor. The torque produced by the motor is transferred to the torque coupler through clutch2 and transmission assembly.
- The Torque coupler either delivers the rotational torque produced from ICE / battery alone to wheels or it may combine the torque produced from energy source 1 82 (ICE & battery pack) and deliver the same to the wheels through differential.
- PHEVs start in 'Battery alone mode', and runs on electricity. When the batteries are low in charge, it calls on the ICE to charge up the battery pack. The ICE is used here to extend the range of the vehicle.
- Plug-in HEV has an internal charging unit that helps to charge the battery by directly connecting them to the electrical grid and they also have the facility to utilize regenerative braking.

Advantages of PHEV

- PHEV consumes less fuel and emits less toxic gasses to the atmosphere.
- Cheaper than ICE cars.

Disadvantages of PHEV

- Plug-in hybrid batteries' cost is more compared to normal hybrid batteries.
- Recharging takes time.
- Mileage gets reduced due to additional weight (High capacity batteries).

12.(a)Explain the configurations of Electric Vehicle. (14 MARKS)

(Diagram-7marks &Theory-7marks)

In an EV, there is only one moving part, the motor. It can be controlled by different control arrangements and techniques. The motor can be powered from different energy sources. ICE and electric motor can also work together. Due to this flexibility different configurations are emerged and it is adopted according to the type of vehicle. The block diagram of general electric vehicle configuration is shown in figure.

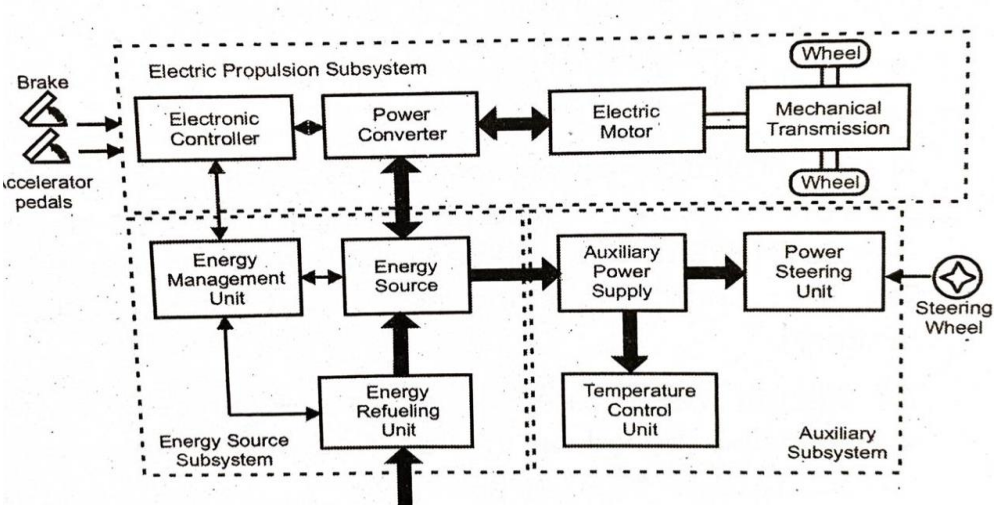


Figure: Block diagram of Electric Vehicle configuration

Construction

EV consisting of three major subsystems.

1. Electric propulsion

a. Electronic controller

b. Power converter

c. Electric motor

d. Mechanical transmission

e. Driving wheels

2. Energy source

a. Energy source

b. Energy management unit

c. Energy refueling unit

3. Auxiliary

a. Power steering unit

b. Temperature control unit

c. Auxiliary power supply

Operation

- The electronic controller receives input from the brake and accelerator pedals. Based on the inputs, it sends control signals to energy management unit to regulate the power flow between the electric motor and energy source (battery).
- As electric motors are connected mechanically to the transmission, based on the received power the electric motor drive the wheels of the engine.
- The backward power flow is due to regenerative braking o the EV and this regenerative energy can be stored in the energy source.
- The energy management unit cooperates with the electronic controller to control regenerative braking and its energy recovery. It also works with the energy refueling unit to control refueling and to monitor usability of the energy source

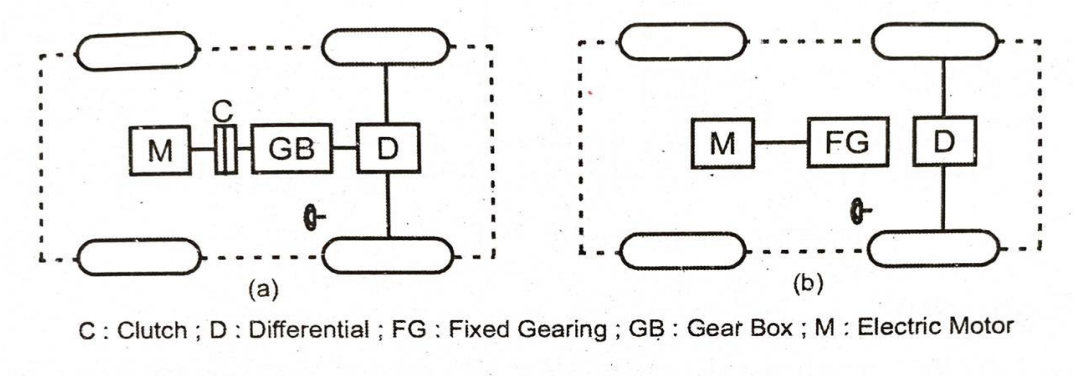


Figure (a)

- In this configuration ICE is replaced by an electric motor.
- It consists of an electric motor, a clutch, a gearbox, and a differential.
- According to the gear chosen by the driver, the torque generated by the electric motor is transferred to the wheels through differential.

- At low gears the wheels have high torque and low speed.
- At high gears the wheels have low torque and high speed.
- The differential is a mechanical device which enables the wheels to be driven at different speeds when the vehicle is making a turn.

Figure (b)

In this configuration the gearbox is replaced with fixed gearing, so the clutch is removed. Therefore, the weight and size of the mechanical transmission are greatly reduced.

It consists of electrical motor, fixed gearing and differential.

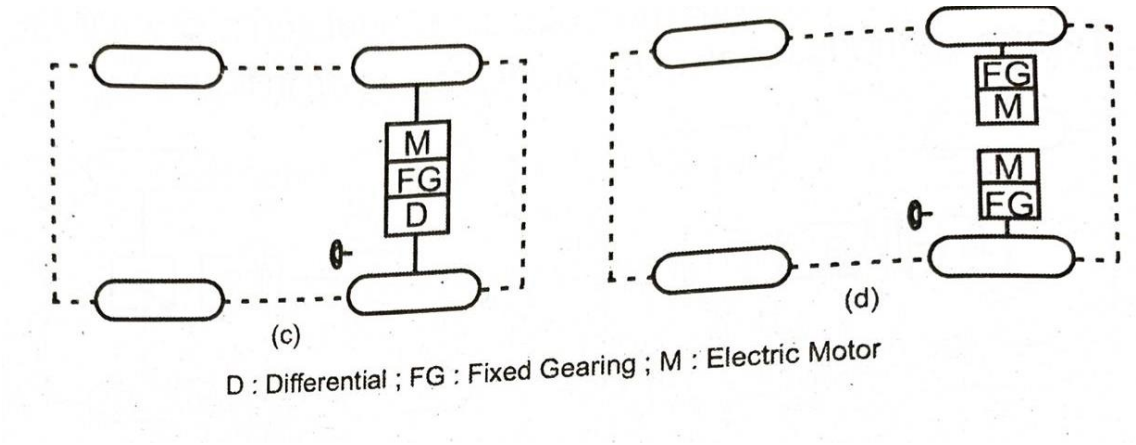


Figure (c)

- In this configuration the electric motor, fixed gearing, and differential are integrated into a single assembly, to drive the front wheels.
- Modern Electric vehicle adopted this design.

Figure (d)

•Here the differential action of EV can be electronically provided by two electric motors operating at different speed.

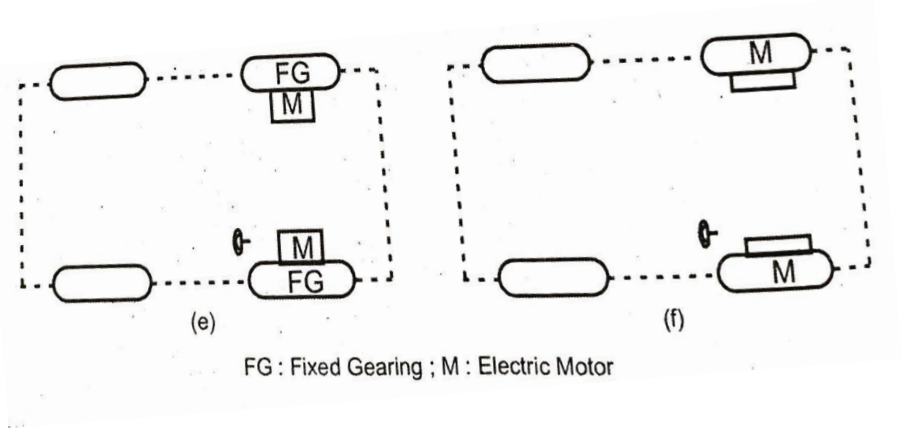


Figure (e)

- It is modified configuration of figure(d), either the fixed gearing arrangement placed within the wheels
- In this configuration the electric motor can be placed inside the wheel. This is called in wheel drive.
- Fixed planetary gearing is employed to reduce the motor speed to the desired wheel speed.

Figure (f)

- The mechanical gear system is removed by mounting a low speed motor on the wheel rim. Thus, speed control of the electric motor is equivalent to the control of the wheel speed and, hence, the vehicle speed.

12(b)Explain about hub motor drive with neat sketch. (14 MARKS)

(Diagram-7marks &Theory-7marks)

A hub motor is an electrical motor coupled to the wheels of a vehicle. It is commonly used in electric bicycle. The most commonly used hub motor is brushless DC motor (BLDC) motor**.**

Hub Motor Drive System

- The operation is similar to that of BLDC motor where the rotor rotation is linked with the vehicle wheel. The hub motor consists of stator and rotor.
- Here the rotor is made of permanent magnet and the stator is the stationary part which wound with coils. The stator winding is electronically commutated by a hub motor drive circuit.
- By controlling the repulsion / attraction between permanent magnet (rotor) and the electromagnet (stator) continuous rotation is achieved.

The general block diagram of hub motor drive system is shown in figure. It consists of

- Battery
- 3 phase inverters
- Controller
- BLDC hub motor
- Hall sensors

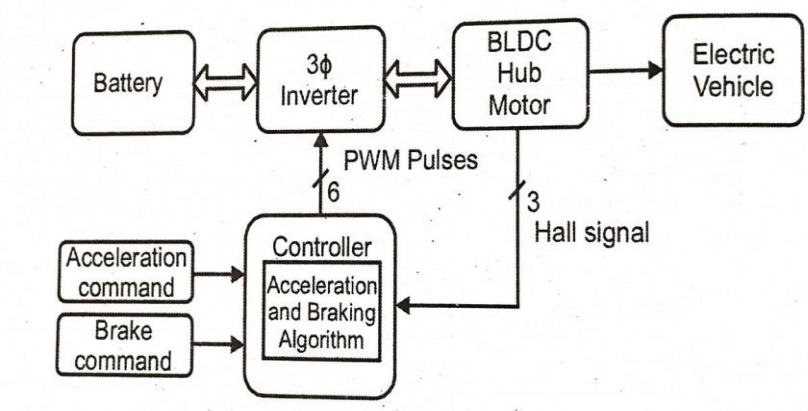


Fig. Hub motor drive system

Operation

- To rotate the hub motor continuously the stator of the motor should be energized in sequence. The instantaneous rotor position is required in order to determine which winding will be energized.
- Rotor position of hub motor is sensed using Hall sensors embedded into the stator. The controller processes this information along with Acceleration and braking command from the user and generate control signals inform of PWM pulses (Pulse Width Modulation).
- The PM pulse alters the switching of the 3-phase inverter so that the stator windings are energized in the expected order. Battery supplies necessary power to the inverter and control circuit.

Advantages

- It requires little or no maintenance.
- Hub motors are mechanically less complex. (No need of traditional clutches, gearboxes and transmission shafts).
- Hub motors are fairly reliable.

Disadvantages

- Efficiency is too low.
- Hub motors are heavy in weight.
- Expensive.

Applications

- Used in Electric vehicle like
    - E-bike
    - E- bicycle

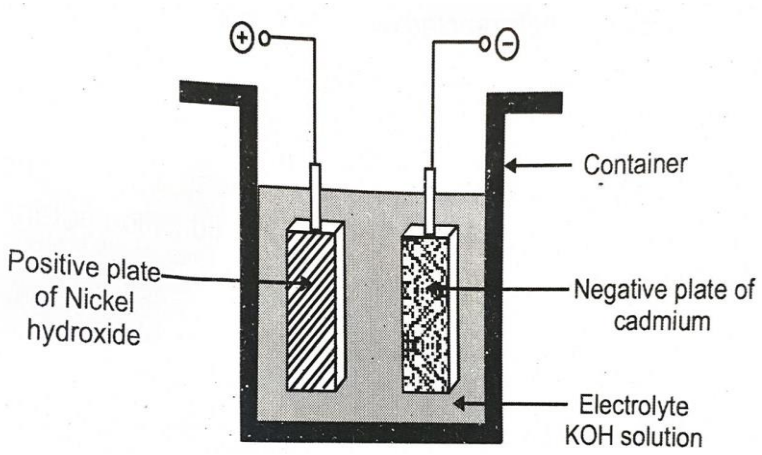
13.(a)Explain the construction and working of Nickel Cadmium battery.

(14 MARKS)

(Explanation & Diagram=10 Marks, Equation=4 marks)

Nickel - Cadmium battery is a rechargeable battery with Nickel Hydroxide as positive electrode and Cadmium as negative electrode and Potassium Hydroxide as electrolyte.

The construction of a Nickel - Cadmium battery is almost exactly same as that of Nickel - Iron cell, except that a nickel - cadmium cell contains one more positive plate as opposite to that of one more negative plate in nickel - iron battery. The construction is shown in figure.



Active Materials of Ni - Cd Battery

1. Nickel Hydroxide Ni (OH) acts as the positive plate.

2. The spongy Cadmium (Cd) acts as the negative plate.

3. The electrolyte it is made up of Potassium Hydroxide (KOH)

solution with specific gravity of 1.2.

Working

Chemical Reaction of Nickel - Cadmium Cell

During Discharging

During discharge, the potassium hydroxide breaks into positive ions and OH negative ions. The K ions move towards positive plate and the OH ions move towards the negative plate.

At the anode

$2\ Ni(OH)_3 + 2\ K \rightarrow 2\ Ni(OH)_2 + 2\ KOH$

At the cathode

$Cd + 2\ 0H \rightarrow Cd\ (OH)_2$

During Charging

When the battery is connected with the charger the opposite process of discharging takes place.

At the anode

$2\ Ni\ (OH)_2 + 2\ OH \rightarrow 2\ Ni\ (OH)_3$

At the cathode

$Cd\ (OH)_2 + 2\ K \rightarrow Cd + 2\ KOH$

Advantages

- Long life.
- Can discharge fully without being damaged.
- Recyclable.

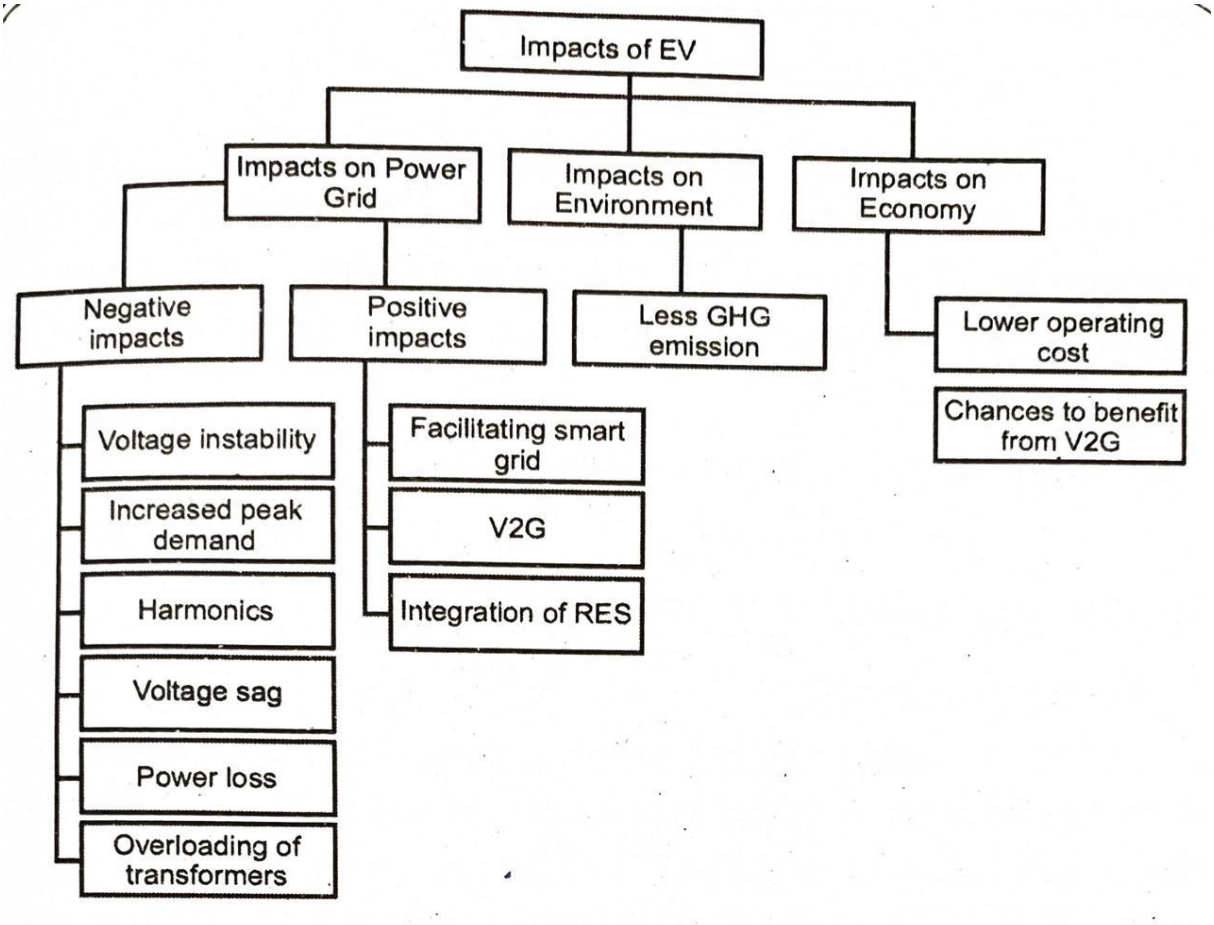
Disadvantages

- Cadmium can cause pollution.
- High cost.

Applications

- Used in emergency lighting system
- Used in calculators, digital cameras
- Used in cordless appliances
- Used in laptops
- Used in portable communication equipment’s

13 (b)Explain the various impacts of EV. (14 MARKS)



Itis broadly grouped into three major categories

1. Impact on power grid

2. Impact on environment

3. Impact on economy

Impacts on Power Grid

EVs are considered to be high power loads and they affect the power distribution system directly. Mostly it affects the distribution transformers, cables and fuses. Let us consider a EV battery with capacity 24 KWh. It represents the battery supports 24000 watts load running for 1 hour.

or

The battery supports 1000 watts load running for 24 hours.

or

The battery supports 500 watts load running for 48 hours

If the battery is charged with a 3.3 KW charger connected in 220 V, 15 A system, it can raise the current demand by 17 to 25%. If the charging is done during the peak hours it directly impacts the power grid. There are two types of impact on power grid.

- Negative impact *(The explanation for Any two topic under this section is enough)*
- Positive impact (*The explanation for Any two topic under this section is enough)*

Negative Impacts

1. Voltage Instability

EV loads have nonlinear characteristics that are different from the general industrial or domestic loads. It draws large quantities of power in a short time period. When large number of EV batteries are charged on same time then the current demand in the grid increases. This leads to voltage instability.

It can be avoided by adopting intelligent control system that damps the oscillations caused by charging and discharging of EV batteries (Vehicle to grid). Ex. Fuzzy logic controller.

2. Harmonics

Harmonics are created by electronic equipment like EV charger with nonlinear loads. The EV charger draws current abruptly creating short pulses. This short pulse create distorted current waveforms and it flow back into other parts of the power system known as harmonic distortion. Harmonic distortion reduces power quality and causes stress in the power system equipment like cables and fuses. The amount of harmonic in a system can be expressed by Total current harmonic distortion

The present grid structure is capable of withstanding 25% of EV penetration if slow charging method is used. In case of rapid charging the withstanding capacity of cable comes down to 15%. The harmonics can be eliminated by applying pulse width modulation in the EV charger.

3. Voltage Sag

A voltage sag or voltage dip is a short duration reduction in rms voltage which can be caused by overload or at the beginning of charging EV batteries.

Voltage sag can be avoided by adopting controlled charging method.

4. Power Loss

This power loss increases when the EV batteries are

Charged in off peak hours. Therefore, un coordinated charging increases the amount of loss. Power loss can be avoided by adopting coordinated charging method.

5. Overloading of Transformer

EV charging directly affects the distribution transformers. The extra heat generated by EV loads can lead to increased aging rate of the transformers. The lifetime of transformer is estimated based on rate of EV penetration, starting time of charging and ambient temperature. It is observed from the study that in the existing grid structure transformers can withstand 10% EV penetration without getting any decrease in lifetime.

Positive Impacts

1. Smart grid

In the smart grid system, intelligent communication and decision making is incorporated with the grid architecture.

Smart grid system supports coordinated charging. The interaction of Vs and smart grid can facilitate opportunities for Electric vehicle to transfer the stored power to the grid (V2G).

2. Vehicle to Grid (V2G)

Vehicle to grid is a method where the EV can provide power to the grid. In this system, the vehicles act as loads when they are drawing energy, and then it can become dynamic energy storages by feeding back the energy to the grid when EV is idle.

Vehicles using this scheme can simply be plugged in anytime to the grid. The smart grid system will choose a suitable time and charge the EV.

3. Integration of Renewable Energy Sources

EV owners can use Renewable Energy Sources to generate power locally to charge their EVs. Example: Solar panels placed on the parking lot roofs can charge the EV parked underneath.

Impacts on Environment

EV reduces the Greenhouse Gas (GHG) emission.

Conventional internal combustion engine (ICE) vehicles burn fuels directly and thus produce harmful gases; including carbon dioxide and carbon monoxide. Though HEVs have IC engines, their emissions are less than the conventional vehicles. EVs also produce far less noise, which can highly reduce sound pollution, mostly in urban areas.

Impact on Economy

The operating cost of EV is less compared to conventional IC engines because the efficiency of EV if higher (70%) compared to the efficiency of IC engines (60 to 70%).

V2G allows the owner of the vehicle to obtain a financial benefit from their vehicles by providing service to the grid (ie) When the EV is in ideal state, it can transfer the stored energy to the grid so that it will be used during peak hours. The vehicle can be charged later by a standalone solar PV system.

14.(a)Explain about the FAME -I guidelines in India. (14 MARKS)

FAME is a demand side incentive scheme under the NEMMP, with a focus on technology development, infrastructure creation and boosting demand through subsidies and pilot projects.

- Implemented since April 2015, extended till 31 March 2019.
- It has an approved outlay of INR 750 million.
- Incentives under the scheme are provided in the form of discounts.
- The discount amount is about one - third of the difference between the price of an EV and a comparable petrol vehicle.
- Approximately 60% of these funds are allocated towards demand incentives.

Coverage of the Scheme

- Cities and towns included under the scheme - smart cites, metropolitan cities of Delhi, Mumbai, Kolkata, Chennai Bengaluru, Hyderabad, Ahmedabad, North eastern and cities with more than 1 million population
- (1 million = 10 lakhs)
- Covers all vehicle segments i.e. two, three and four wheelers, cars, LCVs, buses etc. The incentives for different vehicle segments are
- Implementation of the FAME scheme has led to 77000 tons of CO_2 emission reduction and 31 million liters of fuel savings.

Incentives for Smart Cities

The Government of India has announced that it will provide financial support of up to 1.05 billion (1 billion = 100 crores) of Indian rupees as grant funding to Smart Cities for the purchase of EVs for mass public transport for implementing pilot projects under the FAME program. Only cities with populations greater than 1 million can avail this funding.

Key Areas of EV Funding

- The funding support is available only on the composite deployment of electric buses (with a maximum of 100 per city), electric four - wheeler (4 - W) passenger cars and electric three wheelers (3 - W).

- The government will also provide financial support towards setting up of charging infrastructure in the selected cities with an upper ceiling of 150 million per city.
- Department of Heavy industries will receive only a consolidated proposal from the city. The cities will be responsible for the coordination among city and state level stakeholders.

14(b)(i) Explain EV eco system in Tamil Nadu. (7 MARKS)

The electric mobility ecosystem includes

• Government: Formulates the guiding policies and regulations.

• OEMs and suppliers: They design and manufacture vehicles.

• Power and electricity suppliers: They are responsible for electricity generation, transmission and distribution.

• City - level bodies: Support setting up of charging infrastructure by energy operators / charging solution providers.

- End consumers: The end user can be a public, commercial vehicle operator, owners of personal vehicle.

The state that has good EV mobility eco system has the advantage of rapid adoption of technology. The following are the advantages of EV ecosystem for Tamil Nadu.

Government

Tamil Nadu government orders implementation of the 'Tamil Nadu Electric Vehicle Policy 2019'.The first EV SUV made in India was manufactured in Tamil Nadu by Hyundai. The Government of Tamil Nadu supported this project with a very innovative model of financial incentives and facilitations through MOU (Memorandum of Understanding) signed with Hyundai during the Global Investors Meet, 2019.

OEMs and Suppliers

Chennai is home to major automobile manufacturing companies in India, such as Hyundai, Ford, Nissan, TVS, Mahindra, and Daimler etc. It has a huge scope for up gradation and expansion for producing Electric Vehicles within the existing manufacturing facilities. The state has many technical institutions that provide a pool of skilled workforce for the industry.

Power and Electricity Suppliers

Tamil Nadu is one of the power surplus states with two nuclear plants and many thermal and hydro - electrical power stations in the State offering a steady source of electricity required for the EV ecosystem.

In particular, the State has one of the highest installed Capacity for renewable energy such as wind energy and solar energy. This offers a reduction in overall pollution in addition to reduction in local air pollution.

City - Level Bodies

Supports setting up of charging infrastructure by energy operators / charging solution providers by giving incentives. It was discussed in detail in unit V under demand side incentives.

End Consumers

The end user can be a public, commercial vehicle operator, owners of personal vehicle.

14 (b)(ii) Explain Global impacts on electric mobility. (7 MARKS)

- The electric vehicles are better for environment. They emit fewer greenhouse gases and air pollutants than petrol or diesel vehicles.
- Emissions are having a serious impact on the climate and environment. More and more CO, is entering the atmosphere, with the result that the earth is becoming warmer and warmer.
- According to the survey by the Intergovernmental panel on climate change (IPCC) traffic is responsible for 24 percent of all CO, emissions worldwide.
- Electric vehicles do not emit any CO, when driven. The CO, emission is done by gasoline and diesel vehicles. The Electric vehicles are CO, neutral in the full sense of the world only if the batteries and the electricity to power them are produced using renewable energies. Low emission vehicles have better air quality.
- Therefore, they have a positive effect on people's health. The number of people living in cities will grow. The UNO's world urbanization prospects report concludes that almost 70 percent of the world's population will live in urban regions by 2050.
- Combustion engines uses fossil fuels like oil, from which gasoline and diesel are produced. These are finite resources. How long these sources will last is an important point. According to the study "Statistical Review of World Energy 2017", the world's currently known oil reserves will last almost 50 years given current level of consumption. To enable alternative forms of powertrain to become established, many countries offer incentives to by E vehicles.

15.(a)Explain about the requirements of E-vehicle policy 2019. (14 MARKS)

The Government of Tamil Nadu will focus on policy interventions intended to encourage EV manufacturing as were as EV marketing in the state. Incentives and concessions will be offered by the Government of Tamil Nadu for promoting investments in Electric Vehicle manufacturing. EV battery manufacturing or assembly, EV charging infrastructure manufacturing and Equipment manufacturing enterprises. The state's approach to each class of vehicles will be as follows

a) Electric cars and two wheelers

Nearly 25 lakhs personal cars have been registered in Tamil Nadu so for nearly 85% of vehicle population is two-wheeler. There is a great potential for cars and two wheelers in the EV segment. The battery charging requirements for two-wheeler segment is relatively low. It, enables fast charging through. standard charging infrastructure. The conversion to EV will be encouraged through fiscal concessions and creation of charging networks.

b) Electric vehicle in shared mobility

Within a span of 10 years the state will promote conversion of all Auto Rickshaws in six major cities of Chennai, Coimbatore, Trichy, Madurai, Salem and Tirunelveli to Electric vehicles. This will be extended to other cities and towns in a gradual manner. Similarly, the state will support conversion of all taxies to EVs within a span of ten years.

c) Electric vehicle in public transport

Around 21,000 public transport buses are operated by State Transport Undertakings (STUs) in the state. STUS will strive to replace 5% of buses as EV every year and around 1000 EV buses may be introduced every year.

Buses are expected to be charged at the Bus Depots using 3 phase electric connection. In addition, small top up charging can be done en-route station or bus terminals. One slow-charging unit for every electric bus and one fast charging station for every 10 electric buses shall be provided.

Private operators of buses will also be encouraged to transition to EV buses.

d) Electric vehicle in educational institutions

There are nearly 32,000 buses, mini buses and vans run by educational institutions such as schools and colleges in the state. These institutional vehicles will be encouraged to transition all their vehicles to EVs gradually.

e) Electric vehicles in goods carrier

Small commercial vehicles used for delivering light loads will be encouraged to convert EVs. E-commerce and delivery companies in Tamil Nadu will be encouraged to transition their vehicles to EVs gradually. Due to the current battery capacity constraints, goods transport lorries may require longer to transition to EVs, as the technology evolves.

15 (b)(i) Explain Re cycling eco system for batteries and EV's. (7 MARKS)

- The Government will encourage the reuse of EV batteries that have reached the end of life by setting up recycling business.
- It is done by collaboration with battery and EV manufacturers that focus on. "Urban Mining" of rare materials that can be get from the used battery. These recycled rare materials can be used to manufacture new batteries.
- Charging Station Operators will be encouraged to operate as end - of - life battery recycling agencies by collecting batteries that reached end of life from vehicle owners.
- The Government of Tamil Nadu will invite battery recycling business to establish their presence in Tamil Nadu.
- Appropriate protocols and investment subsidies for setting up such a business shall be notified by the Government of Tamil Nad after consultation with stakeholders (Battery users & Manufactures):
- Original Equipment Manufactures should take responsibility of recycling of old batteries and its components.

15 (b)(ii) Explain capacity building and charging structure of EV. (7 MARKS)

Capacity building

- Tamil Nadu has good young demographic and skilled manpower in all trades. It is critical to support any industrial operations. The state will identify the nature and level of skills required by the EV industry to develop and execute various training program on EV design, development and manufacturing through various channels.
- Higher education department will develop the curriculum in Engineering and Polytechnic colleges in EEE, Mechanical and Automobile courses to suit the EV industry requirements. Similarly, IT curriculum will also be updated accordingly.
- Tamil Nadu Skill Development Corporation (TNSDC) will provide short term skill development programs to the existing technical persons working in EV industries. Short term courses will be conducted in selected Engineering Colleges and Technical institutes in collaboration with TNSDC. These courses will be designed in consultation with EV industry.

Charging Structure

A high-level committee shall be formed to monitor the implementation of E-vehicle with Chief secretary, Government of Tamil Nadu as the Chairman with the below mentioned committee members.

- Additional Chief secretary, Home department
- Principal secretary, Transport department
- Principal secretary, Finance department
- Principal secretary, Energy department
- Principal secretary, Industries department
- Principal secretary, MA&WS (Municipal Administration and Water Supply) department
- Chairman, TANGEDCO
- MD & CEO, Tamil Nadu Industrial Guidance Bureau
- Up to five experts from various fields pertaining to E-Vehicles manufacture, battery charging etc.

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