



Questionnaires with Answers on the Advanced Technology of Automotive Engine: Bangladesh Perspective

Samsul Islam¹, Mohammad Zoynal Abedin^{1, *}, Md. Abdul Hannan Miah¹, Zahid Ahsan¹, Arif Md. Shahed Iqbal², Mustafizur Rahman³, Md. Mir Shakib Ahmed¹, Md. Aminul Islam¹, Md. Osman Gani⁴, Mohammad Abdul Hye⁵

¹Department of Mechanical Engineering, Dhaka University of Engineering and Technology, Gazipur, Bangladesh

²Department of Mechanical Engineering, International University of Business Agriculture and Technology, Dhaka, Bangladesh

³Department of Automotive Engineering, Coventry University, Coventry, United Kingdom

⁴Department of Physics, Jahangirnagar University, Dhaka, Bangladesh

⁵Department of Mechanical Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

Email address:

samsulbd@duet.ac.bd (Samsul Islam), abedin.mzoynal@duet.ac.bd (Mohammad Zoynal Abedin), hannan@duet.ac.bd (Md. Abdul Hannan Miah), 15203047@student.duet.ac.bd (Zahid Ahsan), iqbal.shahed@iubat.edu (Arif Md. Shahed Iqbal), mustafizmr@gmail.com (Mustafizur Rahman), mirsakib@hotmail.com (Md. Mir Shakib Ahmed), mechengraminul@gmail.com (Md. Aminul Islam), osmankanon@gmail.com (Md. Osman Gani), hye_duet@yahoo.com (Mohammad Abdul Hye)

*Corresponding author

To cite this article:

Samsul Islam, Mohammad Zoynal Abedin, Md. Abdul Hannan Miah, Zahid Ahsan, Arif Md. Shahed Iqbal, Mustafizur Rahman, Md. Mir Shakib Ahmed, Md. Aminul Islam, Md. Osman Gani, Mohammad Abdul Hye. Questionnaires with Answers on the Advanced Technology of Automotive Engine: Bangladesh Perspective. *American Journal of Mechanical and Industrial Engineering*. Vol. 8, No. 2, 2023, pp. 18-44. doi: 10.11648/j.ajmie.20230802.11

Received: April 10, 2023; **Accepted:** May 31, 2023; **Published:** June 20, 2023

Abstract: Bangladesh's automotive industry is the third biggest in South Asia. Bangladesh has several famous automobile factories which assemble Mitsubishi and Proton vehicles, Hino and Tata commercial vehicles. Motorcycles, auto rickshaws and the locally built Mishuk tricycle are fabricated in Bangladesh. The gross domestic product growth of Bangladesh has increased by 4 percent and the per capita income touched 2097 dollars in June 2021. This gradual growth fuels the demand for personal transport. In Bangladesh, imported vehicles have unusually high taxes and customs that start at 128 percent and reach as high as 700 percent depending on the engine capacity. Besides supplementary duty, one has to pay 25 percent customs duty, 3 percent regulatory duty, 5 percent trade vat, and 15 percent vat which increases the price of the imported car. Once personal transport was considered a luxury now is becoming more of a necessity for Bangladeshi and it really means that the automobile industry has a good future ahead. This compiled work will discuss advanced questionnaires with answers for technicians and service engineers in the automobile sector. The study is based on the automobile sector and it will definitely help to face the interview and other written exams related to this sector. At the same time, it will help to enrich the advanced knowledge of technicians and service engineers in their work field. In this paper, there are lots of schematic diagrams, detailed figures and pictures given for a better understanding of the basic topics and that is the fulfillment of this paper's aim.

Keywords: Advanced Technology, Automotive Engine, Fuel Cell, Hybrid and Electric Vehicle, Military Vehicle, Automobile Industry, Bangladesh Perspective

1. Introduction

Bangladesh's Automotive Industry has been growing

rapidly with the development of the country. Today, the automotive industry is marked as one of the major industrial sectors of Bangladesh. The sector is contributing to the economy of the country. With the increase in employment

rate, population, industrialization and establishments the demand for transportation has been increasing at a rapid rate. Due to economic development and the increased financial capability of individuals, the demand for cars, motorcycles and other vehicles are increasingly rising among individuals [1].

From the beginning, there was no automobile manufacturing plant in Bangladesh. But we have assembled the industry from the beginning. Pragoti Industries Ltd. is one of Bangladesh's oldest and biggest car assemblers. Since its start in 1966, the business has produced approximately 50,000 cars. Along with Pragoti other firms like Rangs Motors and PHP Motors stepped into the automobile assembly industry of Bangladesh. Besides, the automobile market has a huge dependency on imported vehicles. Due to the heavy import tax, brand-new cars are not the preferred one for Bangladeshis. Second-hand cars are known as reconditioning vehicles that dominate most of the automobile market. According to the BBS in 2020 Bangladesh imported 2,76,094 vehicles [2].

Passenger vehicles are most popular in the four-wheeler market. It grabs a 5.3 percent automobile market share. Among the passenger vehicles Sedan is commonly known as private cars grabs the 55 percent market share of the passenger vehicle market. According to the Bangladesh Road Transport Authority, 12,403 units of passenger vehicles were registered in 2020. 4911 SUVs and 2779 units of Multi-Purpose Vehicles (MPV) vehicles were registered in 2020.

Japanese imported reconditioned cars are most preferred in Bangladesh. In 2020, 82 percent of the passenger vehicles were imported from Japan. Though there were other options like China, Germany, India and Malaysia [3].

Bangladesh's commercial vehicle sector is reliant on Asian imports, particularly from India, Japan, and China. TATA, Ashok Leyland, and Eicher dominate the Bangladeshi truck market. Chinese manufacturers dominate the LCV & Pickup sector. Some Japanese and European trucks and construction equipment operate in Bangladesh, albeit in small numbers. The inter-city passenger bus market is dominated by Japanese and European manufacturers. The luxury ac bus market is dominated by Scania, Volvo, MAN, Mercedes-Benz, and Hyundai Universe. Hino and ISUZU are also present in this market. In the non-ac bus industry, Hino is the market leader and has the most shares. In the intra-city market, Indian manufacturers have taken the lead. TATA, Ashok Leyland, and Eicher dominate the intra-city market [4].

The automobile industry is dominated by two-wheelers of 82 percent. The two-wheeler market started to grow quickly in the fiscal year 2016-2017 when the government reduced tax on imported two-wheeler components by 25 percent to promote local production. Bajaj, TVS are the major players in the two-wheeler market but Runner, Mahindra, Yamaha, Suzuki are also contributing a major part in the industry [5].

Bangladesh has a huge potential in the automobile market. Huge investments are coming for the assembly industry.

Already many brands and local industries started to assemble motorcycles and four-wheelers in Bangladesh. However, the high tariff on imported cars restricts the overall growth of imported vehicles. If the concerned authority reduces the traffic on the automobile the market would experience exponential growth in the future.

2. Questionnaires with Answers on the Advanced Automotive Technology for Technicians and Service Engineers

2.1. Advanced Vehicles by Motive Fuel

2.1.1. What Are the Advanced Vehicles by Motive Fuel

Answer: The advanced vehicles by motive fuel are:

- 1) Fossil fuel-based Vehicle; Example: SI Engine, CI Engine, Gasoline Engine, Airplane Engine, Marine Engine.
- 2) Hybrid-based Vehicle; Example: Mild Hybrids, Full Hybrids, Plug-In Hybrids.
- 3) Electric-based Vehicle; Example: EV, General EV, Plug-In EV.

2.1.2. What Is a Fossil Fuel Car

Answer: Vehicles that are powered by fossil fuels, such as gasoline, diesel, kerosene, and fuel oil are set to be phased out.

2.1.3. What Is a Hybrid Vehicle

Answer: A hybrid vehicle is one that uses two or more distinct types of power, such as submarines that use diesel when surfaced and batteries when submerged. Other means to store energy include pressurized fluid in hydraulic hybrids.

2.1.4. What Are the Types of Hybrid Cars

Answer: There are three main types of hybrid vehicles: (1) Mild Hybrids; (2) Full Hybrids; (3) Plug-In Hybrids.

2.1.5. How Do Hybrid Electric Cars Work

Answer: Hybrid electric vehicles are powered by an internal combustion engine and one or more electric motors, which use energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine.

2.1.6. What Are the Advantages of a Hybrid Car

Answer: Eco-friendly: Since hybrids house an electric motor as well as a gasoline engine, they need less fossil fuel, resulting in fewer CO₂ emissions. On top of that, they have more efficient gas mileage than conventional cars.

Financial benefits: Many governments around the world have introduced tax credits and incentives for buyers and owners of hybrids. They are also exempt from environmental charges.

Higher resale value: As more and more people are getting tired of gasoline price fluctuations and care about our planet, they are becoming more willing to make the switch to hybrids. As a result, the resale value of such vehicles keeps

increasing.

Lighter cars: Hybrids are manufactured with lightweight materials, which allow vehicles to run on less energy. Their smaller-sized and lightly built engines also contribute to conserving energy.

Regenerative braking: Hybrids use a system called "regenerative braking" in which the battery recharges a little whenever the driver brakes. The mechanism allows the driver more time between manual recharges.

2.1.7. What Are the Disadvantages of a Hybrid Car

Answer: Less power: Hybrids combine both an electric motor and a gasoline engine, with their gasoline engine primarily operated as the power source. Therefore, neither the gasoline engine nor the electric motor works as strongly as they do in conventional gasoline or electric cars. But Hybrids work just fine for normal drivers who usually drive around the city.

Pricey to buy: The initial cost of hybrids is more expensive than conventional vehicles in most cases.

Higher running costs: Due to their engine and continuous development in technology, it may not be easy to find a mechanic with the required expertise. And they would likely charge a little more for maintenance and repairs. Moreover, the highest running cost occurs when replacing the battery.

Poor handling: Hybrids have more machinery than conventional cars, which adds extra weight and reduces fuel efficiency. So, hybrid car manufacturers have had to make smaller engines and batteries to cut down on weight. But this results in reduced power for the vehicle and support in the body and suspension.

Electrocution risk: The batteries in hybrids contain a high voltage, which can increase the risk of the passengers and rescuers being electrocuted in the event of an accident.

2.1.8. How Long Does a Hybrid Battery Last

Answer: Most hybrid batteries should take drivers about 100,000 miles. With excellent maintenance, some owners are able to push this number to 200,000. Warranties typically extend to about the 100,000-mile mark, so manufacturers do expect this to be the upper limit on battery life.

2.1.9. How Much Is a Hybrid Battery Cost

Answer: Hybrid car batteries can range from approx. one lac to eight lac taka and the final price depends on the make and model of the car. For example, a quote for a hybrid battery for a Toyota Prius can run around four lac taka, while a quote for a hybrid battery for a Ford Escape can be closer to nine lac taka.

2.1.10. What Is the Most Common Problem with Hybrid Cars

Answer: One of the typical hybrid car issues is problems with the evaporative emissions system. Usually, problems occur in the form of system failure or leaks. If valves or lines fail, it should be replacing the system, but scheduling regular hybrid car maintenance can prevent this issue.

2.2. Electric and Hybrid Vehicles

2.2.1. What Is Meant by Electric Vehicles

Answer: An EV is defined as a vehicle that can be powered by an electric motor that draws electricity from a battery and is capable of being charged from an external source.

2.2.2. What Are the Types of Electric Vehicles

Answer: There are four types of electric vehicles available: (1) Battery Electric Vehicle (BEV); (2) Hybrid Electric Vehicle (HEV); (3) Plug-in Hybrid Electric Vehicle (PHEV); (4) Fuel Cell Electric Vehicle (FCEV).

2.2.3. What Is a Battery Electric Vehicle (BEV) and How Does It Work

Answer: Battery Electric Vehicle (BEV): BEVs are fully powered by electricity. These are more efficient compared to hybrid and plug-in hybrids. BEVs are also known as All-Electric Vehicles (AEV). Electric Vehicles using BEV technology run entirely on a battery-powered electric drivetrain. The power for the electric motor is converted from the DC Battery to AC. The electricity used to drive the vehicle is stored in a large battery pack which can be charged by plugging it into the electricity grid. The charged battery pack then provides power to one or more electric motors to run the electric car.

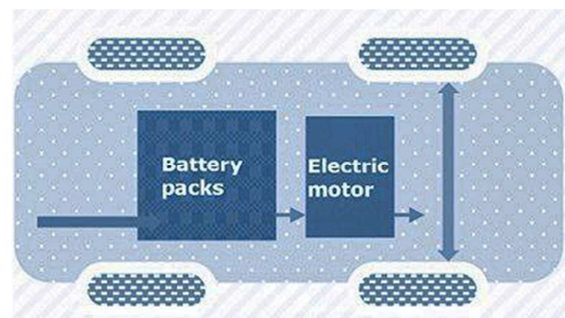


Figure 1. Battery Electric Vehicle (BEV) [6].

Main Components of BEV: Electric motor, Inverter, Battery, Control Module, Drive train.

Examples of BEV: MG ZS, TATA Nexon, TATA Tigor, Mahindra E20 plus, Hyundai Kona and Mahindra Verito.

2.2.4. What Is a Hybrid Electric Vehicle (HEV) and How Does It Work

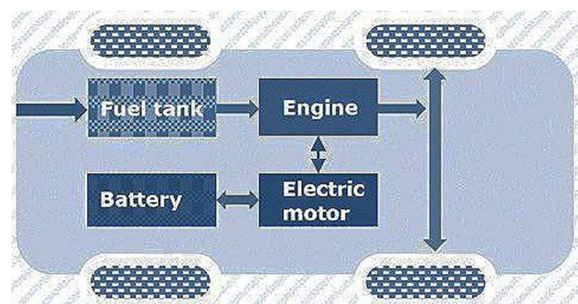


Figure 2. Hybrid Electric Vehicle (HEV) [6].

Answer: Hybrid Electric Vehicle (HEV): HEVs are also known as series hybrid or parallel hybrids. The vehicle uses both the internal combustion (usually petrol) engine and the battery-powered motor powertrain. The petrol engine is used both to drive and charge when the battery is empty.

These vehicles are not as efficient as fully electric or plug-in hybrid vehicles. Main Components of HEV: Engine, Electric motor, Battery pack with controller and inverter, Fuel tank, Control module.

Examples of HEV: Engine, Electric motor, Battery pack with controller and inverter, Fuel tank, Control module.

2.2.5. What Is a Plug-in Hybrid Electric Vehicle (PHEV) and How Does It Work

Answer: Plug-in Hybrid Electric Vehicle (PHEV): The PHEVs are also known as series hybrids. They have both engine and a motor. Uses both an internal combustion engine and a battery charged from an external socket (they have a plug). This means the vehicle's battery can be charged with electricity rather than the engine. PHEVs are more efficient than HEVs but less efficient than BEVs. PHEVs can run in at least 2 modes:

- 1) All-electric Mode, in which the motor and battery provide all the car's energy.
- 2) Hybrid Mode, in which both electricity and petrol/diesel are employed.

Main Components of PHEV: Electric motor, Engine, Inverter, Battery, Fuel tank, Control module, Battery Charger (if onboard model).

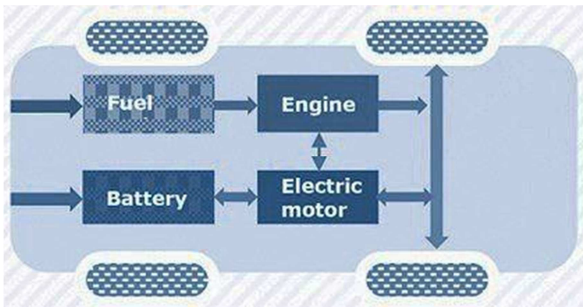


Figure 3. Plug-in Hybrid Electric Vehicle (PHEV) [6].

Examples of PHEVs: Porsche Cayenne S E-Hybrid, BMW 330e, Porsche Panamera S E-hybrid, Chevy Volt, Chrysler Pacifica, Ford C-Max Energi, Mercedes C350e, Mercedes

S550e, Mercedes GLE550e, Mini Cooper SE Countryman, Ford Fusion Energi, Audi A3 E-Tron, BMW i8, BMW X5 xdrive40e, Fiat 500e, Hyundai Sonata, Kia Optima, Volvo XC90 T8.

2.2.6. What Is a Plug-in Fuel Cell Electric Vehicle (FCEV) and How Does It Work

Answer: Fuel Cell Electric Vehicle (FCEV): FCEVs are also known as Zero-Emission Vehicles. They employ "fuel cell technology" to generate the electricity required to run the vehicle. The chemical energy of the fuel is converted directly into electric energy. For example, a hydrogen FCEV.

Main Components of FCEV: Electric motor, Fuel-cell stack, Hydrogen storage tank, battery with converter and controller.

Examples of FCEVs: Toyota Mirai, Riversimple Rasa, Hyundai Tucson FCEV, Honda Clarity Fuel Cell and Hyundai Nexo.

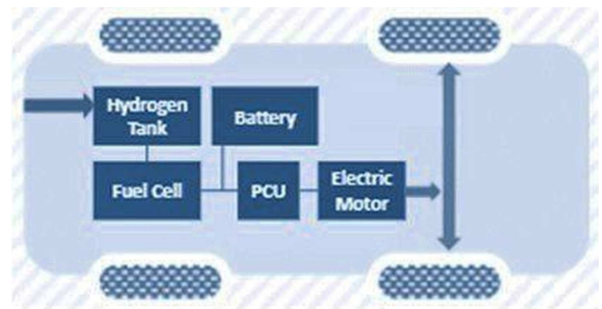


Figure 4. Fuel Cell Electric Vehicle (FCEV) [6].

2.2.7. Is a Hybrid Car Better than Petrol Car

Answer: Combining fuel with electricity, they produce lower emissions than standard petrol vehicles. Fewer fuel costs; combining an electric engine with fuel means that hybrid cars offer better gas mileage. That means they require less fuel to cover longer distances, which means cars will be spending less on fuel top-ups.

2.2.8. What Is Powertrain and Its Types

Answer: A powertrain is an assembly of every component that thrusts into motion. It includes the engine, transmission, driveshaft, axles, and differential. The different types of powertrains were available and powertrains are the main cause of comfortable for a driver in different driving road conditions.

Table 1. The Different Types of Powertrains Available and the Driving Conditions are Best Suited for a Driver.

Powertrains	The Driving Conditions They are Best Suited for
Diesel	Consider if driving mostly involves: long-distance journeys, rural driving, motorway driving, long commutes and towing.
Petrol	Consider if driving mostly involves: short to medium-distance journeys, or rural driving.
BEVs	Consider if driving mostly involves: town/ city driving, short to medium journeys, school runs/ shopping. BEVs typically offer an 80-250 miles driving range and are cheap to run when charged at home.
PHEVs	Consider if driving mostly involves: town/city driving, commuting, short to medium journeys, school runs/shopping. Plug-in hybrids are capable of zero-emission driving, typically between 20-30 miles, and can run on petrol or diesel for longer trips.
HEVs	Consider if driving mostly involves: town/ city driving, short to medium journeys, school runs/shopping. Hybrid Electric Vehicles (HEVs) are capable of zero-emission driving, but typically over less range than a PHEV. They use electric power generated during braking to improve fuel economy and run on petrol or diesel for longer trips.
MHEVs	Consider if driving mostly involves: town/city driving, commuting, short, medium, long journeys, school runs/ shopping. MHEVs, sometimes known as hybrid assist vehicles, have a petrol or diesel internal combustion engine equipped with an electric motor that can allow the engine to be turned off as the car is coasting or braking.

Powertrains	The Driving Conditions They are Best Suited for
FCEVs	Consider if driving mostly involves: town/ city driving, short to medium journeys, and school runs. FCEVs are zero-emission electric vehicles, which use hydrogen fuel cells to generate power. Hydrogen stored in an on-board fuel tank is combined with oxygen in the fuel cell and the only outputs are electricity, heat and water.

2.2.9. What Are the Different Types of Electric Vehicle Powertrain Technologies

Answer: There are three main types of BEVs or Battery Electric Vehicles, PHEVs or Plug-In Hybrid Electric Vehicles, and HEVs, or Hybrid Electric Vehicles.

Battery electric vehicles (BEVs): BEVs are powered solely by batteries. They use an electric motor to turn the wheels and produce zero emissions. Since April 2020, zero emission Evs (BEVs) are zero-rated standard road tax (VED) for both the first year and all subsequent years. Examples: Tesla

Model 3, Mini Electric, Nissan Leaf.

Battery Electric Vehicle + Range Extender (BEV + Rex): BEV + Rex is laid out exactly like a BEV with the addition of a small gasoline generator to charge the battery when needed. Unlike the HEV configuration, however, this generator does not switch on automatically and the generator and attached tank capacities are very limited. Moreover, the generator is not capable of moving the wheels: its sole function is to charge a depleted battery.

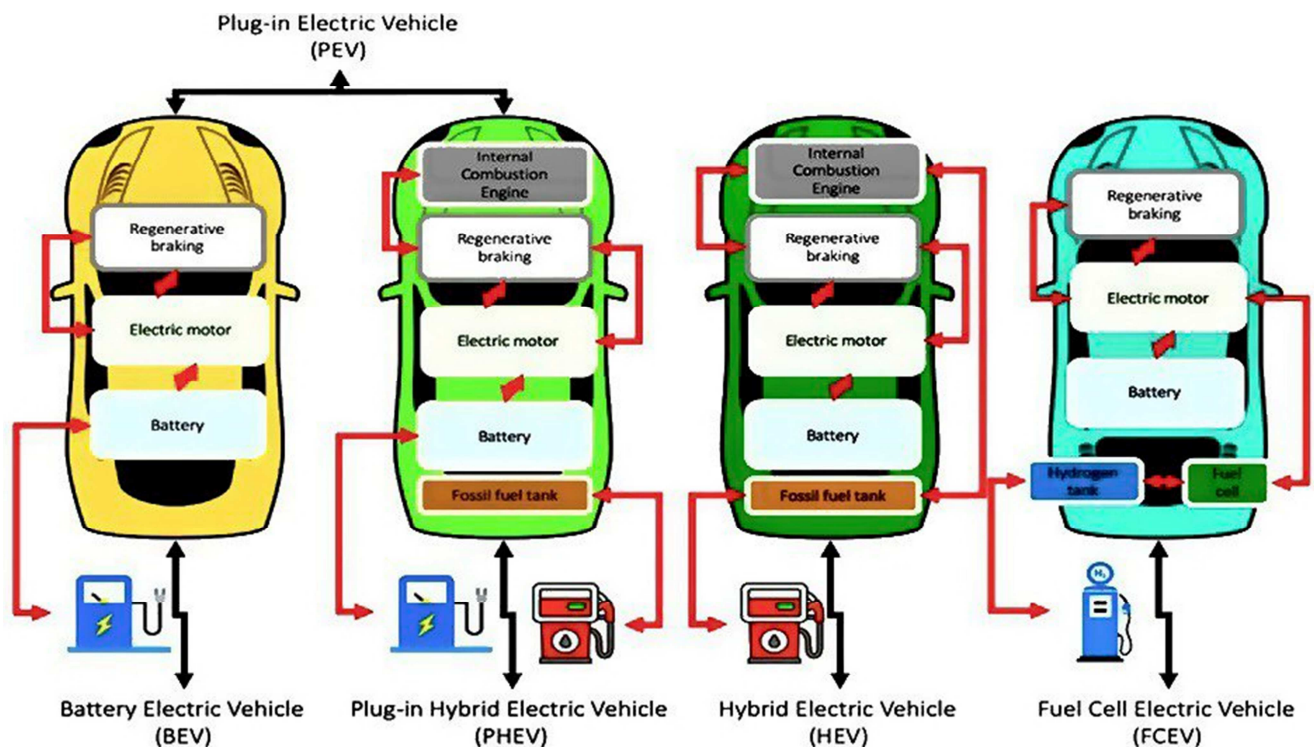


Figure 5. Different types of powertrain technologies for electric vehicles [7].

Plug-In Hybrid Electric Vehicles (PHEVs): PHEVs are capable of zero-emission driving, typically between 20-30 miles, and can run on petrol or diesel for longer trips. As the name suggests, they need to be plugged into an electricity supply in order to maximize their zero-emission capability. They have a reduced road tax (VED). Examples: Mitsubishi Outlander, Volkswagen Golf GTE, Toyota Prius Plug-in.

Hybrid Electric Vehicles (HEVs): HEVs are capable of zero-emission driving, but typically over less range than a PHEV. They use electric power generated during braking to improve fuel economy and run on petrol or diesel for longer trips. They have a lower road tax (VED). Examples: Toyota Yaris Hybrid, Lexus RX450h, Ford Mondeo Hybrid.

Mild Hybrid Electric Vehicles (MHEVs): MHEVs,

sometimes known as hybrid assist vehicles, have a petrol or diesel internal combustion engine equipped with an electric motor that can allow the engine to be turned off as the car is coasting or braking. The motor can also be used to provide assistance to the engine, reducing fuel consumption and CO₂ emissions. MHEVs cannot be driven on electricity alone. Examples: Mercedes-Benz S 400, Range Rover Evoque, Suzuki Swift.

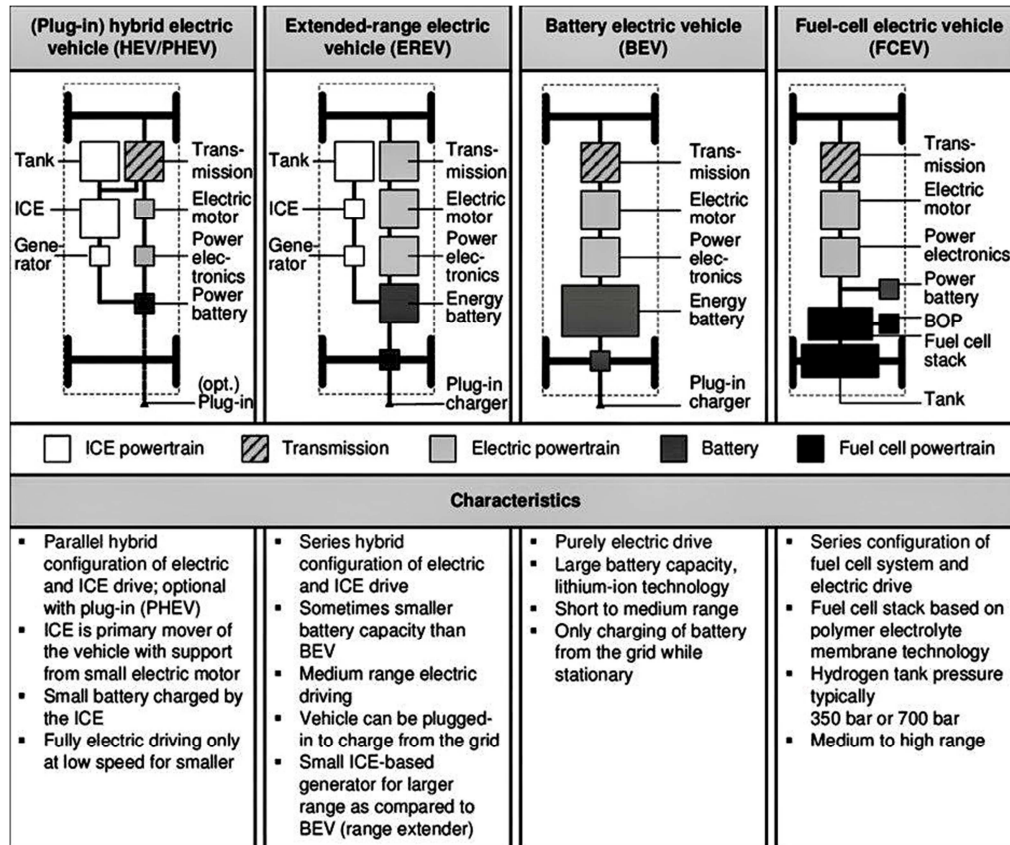
Fuel Cell Electric Vehicles (FCEVs): FCEVs are zero-emission electric vehicles, which use hydrogen fuel cells to generate power. Hydrogen stored in an on-board fuel tank is combined with oxygen in the fuel cell and the only outputs are electricity, heat and water. Examples: Toyota Mirai, Hyundai Nexo.

Table 2. Different Types of Powertrain Electric Vehicles Efficiency [8].

	BEV	BEV + REX	FCEV	PHEV	HEV
Example	Tesla Model S	BMW i3	Toyota Mirai	Mini Countryman Plug-In	Toyota Prius
Energy Efficiency	73%	73% to 20%	22%	60% to 17%	54% to 15%
Transmission	NO	NO	NO	YES	YES/ HSD
Gearshift	NO	NO	NO	YES	YES
Engine	AC induction/ Synchro	AC Synchronous	AC Synchronous	AC Synchronous	AC Synchronous
Emissions	-66% CO ₂	-66% to -8% CO ₂	-50% CO ₂	-58% to +2% CO ₂	-57% to +11% CO ₂

2.2.10. What Are the Different Types of Electric Vehicles and Write Down Their Characteristics

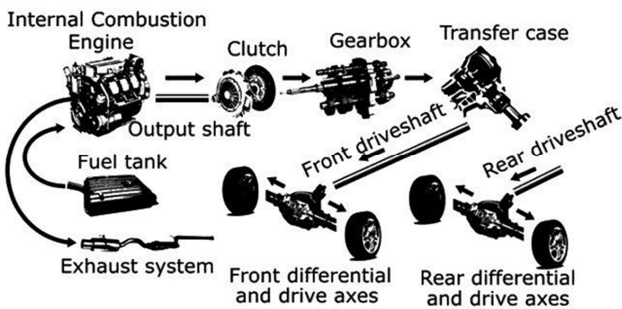
Answer: The different types of electric vehicles and their characteristics are illustrated below with their figure.

**Figure 6.** Different Types of Electric Vehicles and Their Characteristics [9].

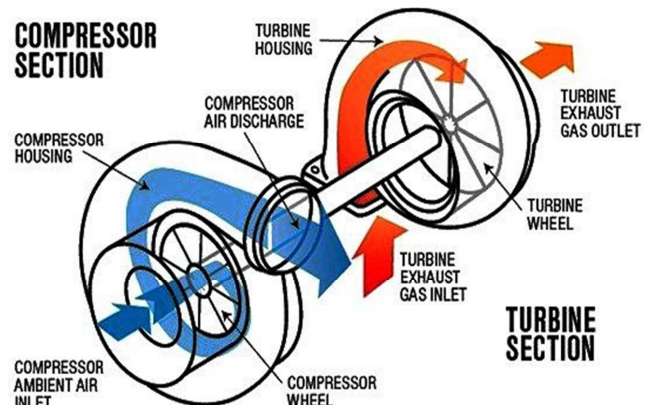
2.3. Drive Train with All-Wheel Drives

2.3.1. Show the Drive Train with All-wheel Drive

Answer: Conventional mobility with Internal Combustion Engines (ICE) and complex drivetrains as shown in Figure 7.

**Figure 7.** Internal Combustion Engine (ICE) Drivetrain with an All-Wheel Drive with Obvious Complexity [10].

2.3.2. What Is a Turbocharger and Its Types

**Figure 8.** Schematic Diagram and Working Principle of the Turbocharger [11, 12].

Answer: A turbocharger is a device fitted to a vehicle's engine that is designed to improve overall efficiency and increase performance. There are six types of turbochargers: (1) Single-Turbo; (2) Twin-Turbo; (3) Twin-Scroll Turbo; (4) Variable Geometry Turbo; (5) Variable Twin Scroll Turbo; (6) Electric Turbo.

2.3.3. What Is a Supercharger and Its Types

Answer: A supercharger is a mechanical or more recently, an electronic air compressor that is bolted onto the engine and is used to force more air into the combustion chamber.

There are four types of superchargers: (1) Roots Superchargers; (2) Twin-Screw Superchargers; (3) Centrifugal Superchargers; (4) Electric Superchargers.

2.3.4. What Is a Conventional Cooling System

Answer: Vehicle engine cooling systems have several functions. Excess heat removal from the engine helps to rapidly cool it, quickly reach operating temperature, maintain a constant engine operating temperature, and provide heat to the vehicle's passenger compartment (Figure 10).

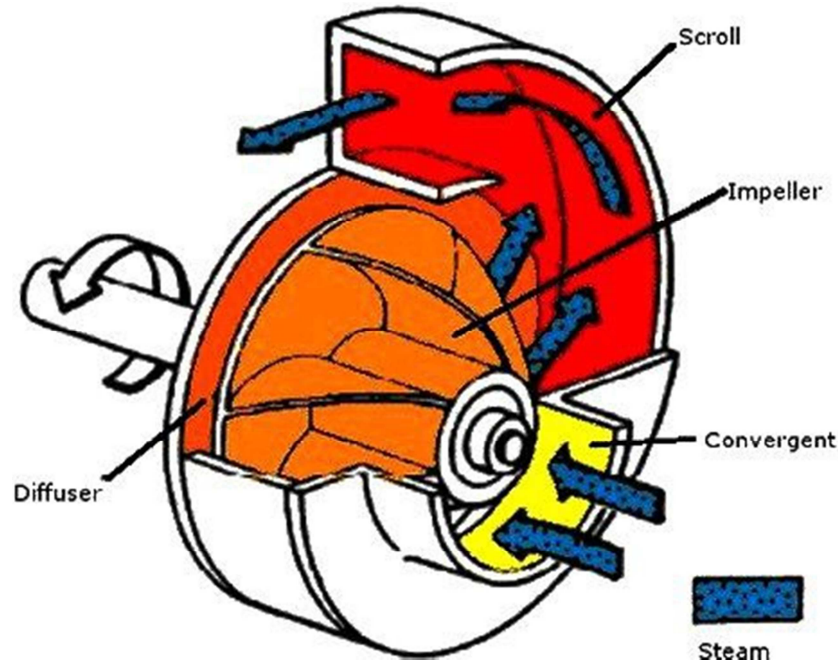


Figure 9. Centrifugal Supercharger (Electrical Supercharger) [13].

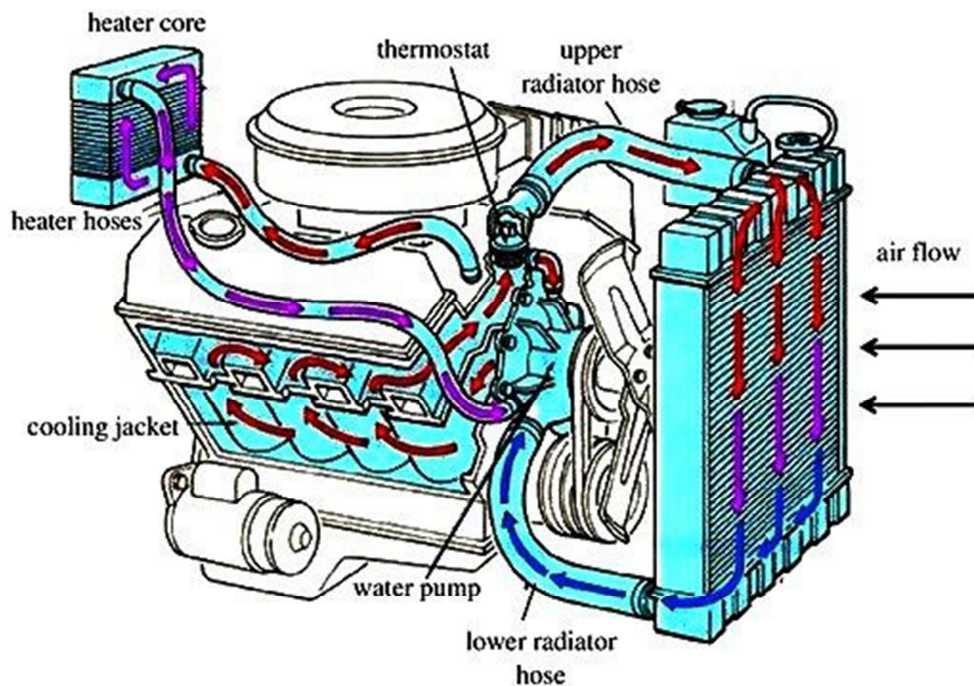


Figure 10. Schematic Diagram of a Conventional Cooling System [14].

2.3.5. What Is the Purpose of a Louvered Fin in a Radiator

Answer: Modern automobiles use radiators with multi-louvered fins with rectangular tubes. This increases the air-side heat transfer performance by more than 60% when compared with the traditional plate-fin heat exchangers. The louvered fins provide more surface area for heat transfer [15].

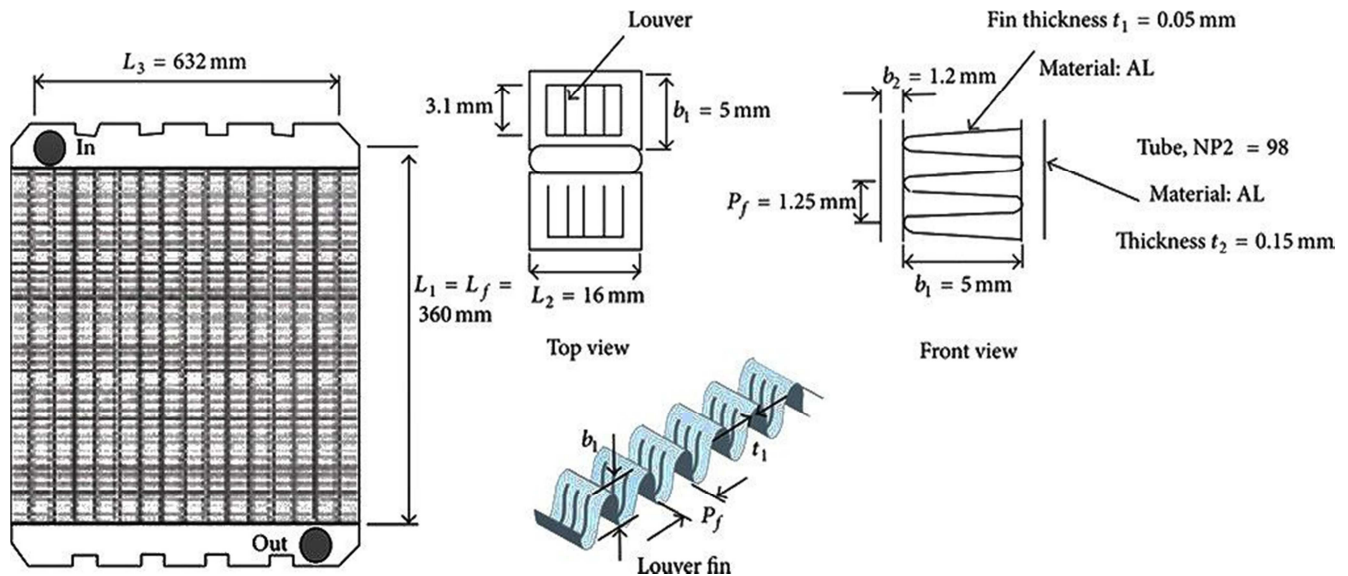


Figure 11. Schematic diagram of the louvered fin car radiator showing the dimensions and the number of tubes [16].

2.3.6. Describe the Different types of Drivetrains Used in Vehicles

Answer: There are several types of drivetrains used in vehicles, including:

Front-Wheel Drive (FWD): Power is delivered to the front wheels of the vehicle.

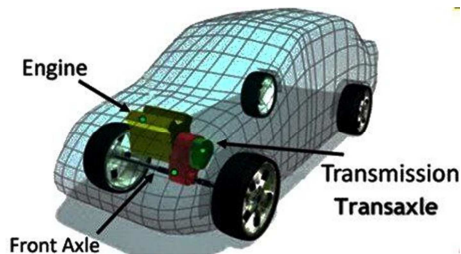


Figure 12. Front-Wheel Drive (FWD) [17].

Rear-Wheel Drive (RWD): Power is delivered to the rear wheels of the vehicle.

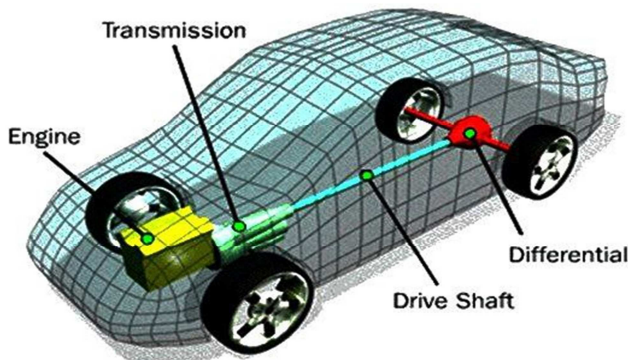


Figure 13. Rear-Wheel Drive (RWD) [17].

All-Wheel Drive (AWD): Power is delivered to all four wheels of the vehicle.

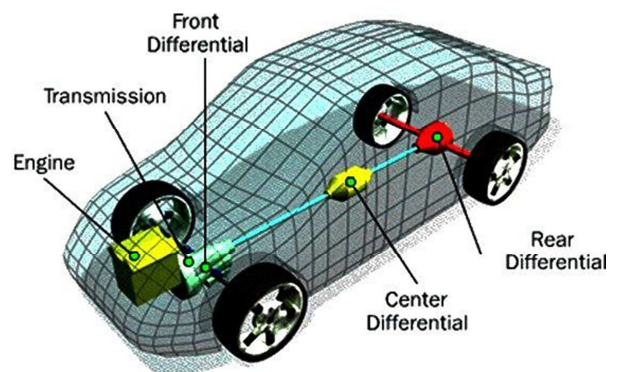


Figure 14. All-Wheel Drive (AWD) [17].

Four-Wheel Drive (FWD): Power is delivered to all four wheels of the vehicle, but with a stronger focus on off-road capabilities.

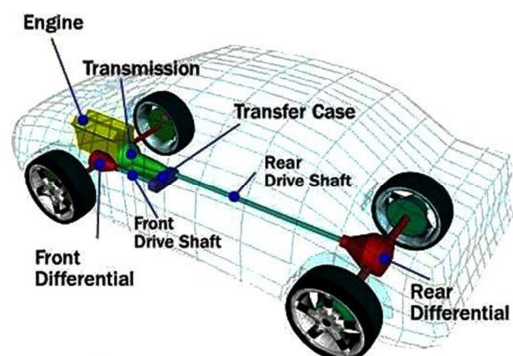


Figure 15. Four-Wheel Drive (FWD) [17].

2.4. Suspension System

2.4.1. What Is the Classification of the Suspension System

Answer: The suspension system is always derived in some mechanical way. Generally speaking, the designs of the suspension systems are classified into two main groups: (1) Dependent suspension system (solid axle); (2) Independent suspension system [18]. Each group can be functionally quite different and they are studied and discussed accordingly. Recently, both suspension systems can be found on ordinary vehicles and commercial vehicles [19].

2.4.2. What Are the Types of Independent Suspension System

Answer: There are different types of independent suspension systems: (1) MacPherson suspension system; (2) Double wishbone suspension system; (3) Multi-link suspension system and Trailing arm [20].

2.4.3. What Is Conventional Suspension

Answer: Conventional suspension with components in the display. Hub bearing deflection angle β is limited by braking pads inside the caliper and can be larger in comparison to when integrated inside an In-Wheel Motor (IWM).

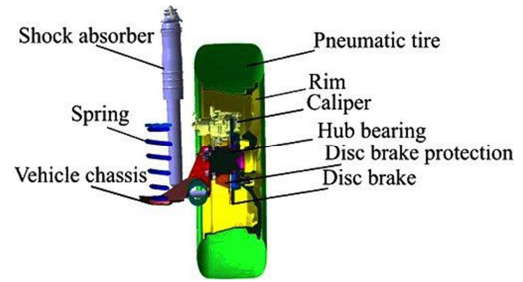


Figure 16. Conventional suspension with components in display [21].

2.4.4. Give Examples of Different Independent Suspension Constructions

Answer: Examples of different independent suspension constructions are shown in Figures 17 and 18 [22].

2.4.5. What Is the Front View and Side View of Dependent Suspension and Suspension Motion

Answer: The dependent suspension system is known as solid axle, when both wheels (left and right) are mounted on the same solid axle (Figure 19). In this case, any movement of any wheel will be transmitted to the opposite wheel causing them to camber together. Solid drive axles usually are used on the rear axle of many passenger cars, trucks and on the front axle in many four-wheel drive vehicles.

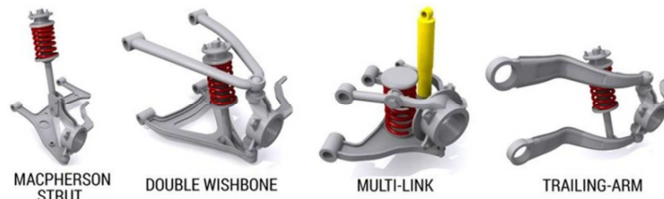


Figure 17. Examples of Different Independent Suspension Constructions [22].

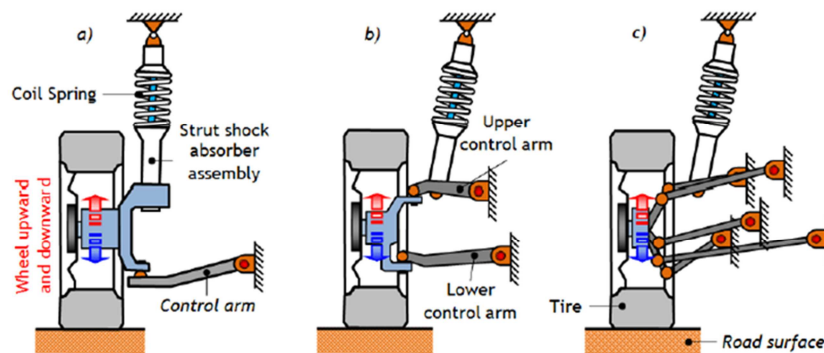


Figure 18. Different Types of Independent Suspension Systems; a) MacPherson strut, b) Double wishbone and c) Multi-Link Suspension System [23].

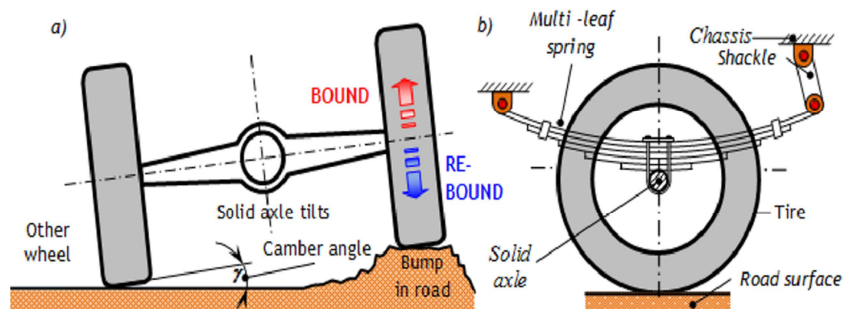


Figure 19. The Dependent Suspension System (solid axle); a) front view and b) Side View [23].

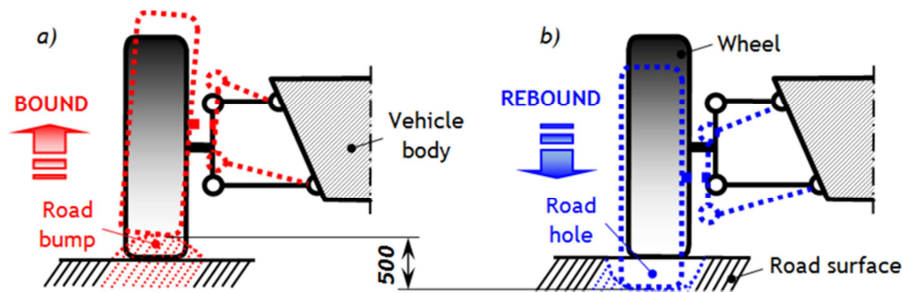


Figure 20. Suspension motions; a) upward and b) downward [22].

2.4.6. What Is Suspension Geometry

Answer: The suspension geometry is an important factor during the design process, which helps us to identify the vertical wheel motion and how is the position of the wheel in

such motion. The suspension geometry not only dictates the path of the wheel but also controls the forces that are transmitted between sprung and un-sprung mass [24].

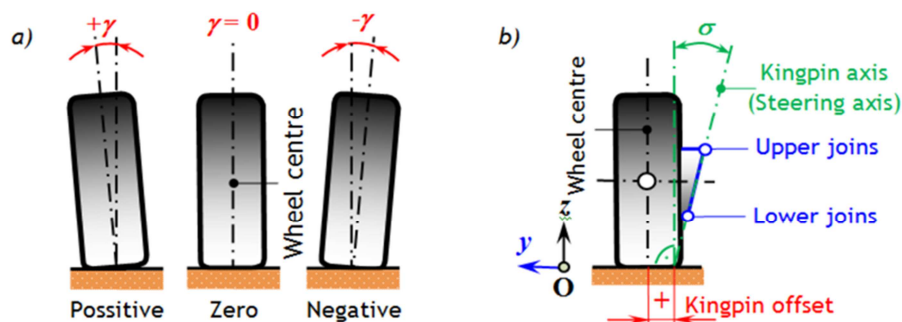


Figure 21. Suspension Geometry; a) Camber Angle (front view) and b) Kingpin Inclination Angle and Kingpin Offset (front view); Camber Angle (γ), Positive Camber ($+\gamma$), Negative Camber ($-\gamma$), Kingpin Inclination Angle σ [23].

2.4.7. What Is Truck Suspension System

Answer: Truck Suspension is the suspension system that allows relative between both a truck frame and wheels. The suspension system provides a number of tasks like

stabilization, cushioning, road holding, road handling and ride quality. Truck's Suspension consists of tires, springs, spring leafs, shock absorbers and linkages.

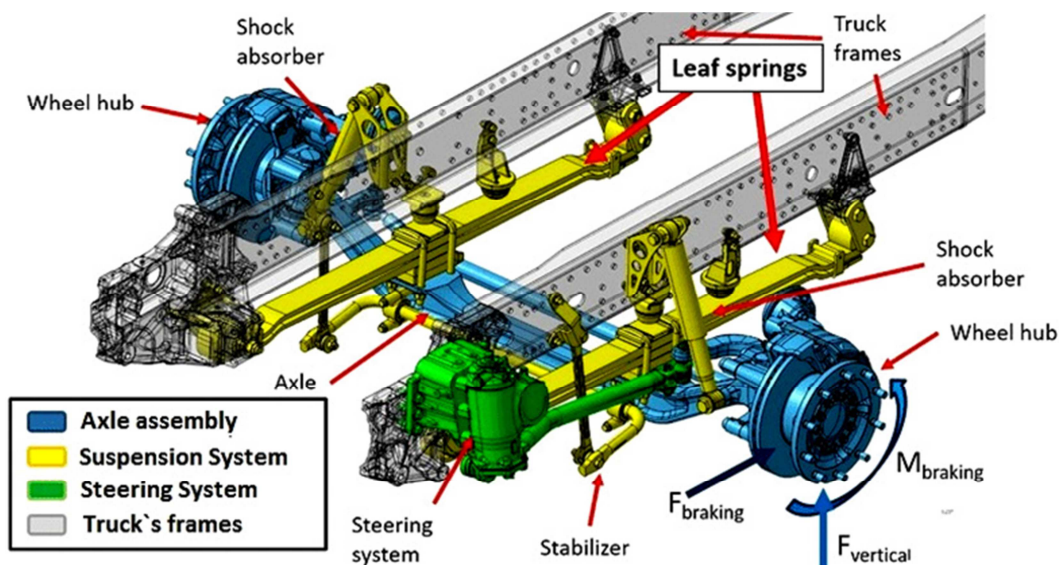


Figure 22. Truck suspension system [25].

2.4.8. What Are the Type of Truck Suspension System

Answer: (1) Leaf spring suspension: It is the form of

spring used for suspension in Trucks (can be referred to as a semi-elliptical spring).

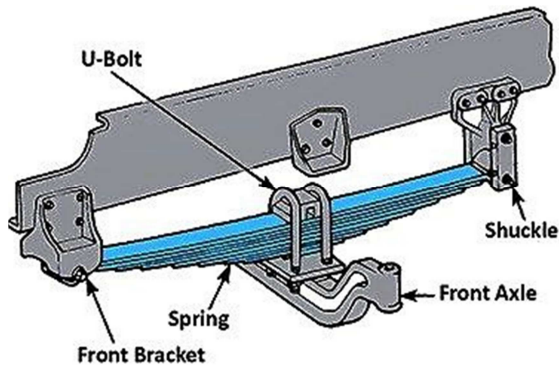


Figure 23. Leaf spring pack suspension [26].

(2) Torsion bar suspension: It is a type of suspension that uses a torsion bar as its main weight-bearing spring.

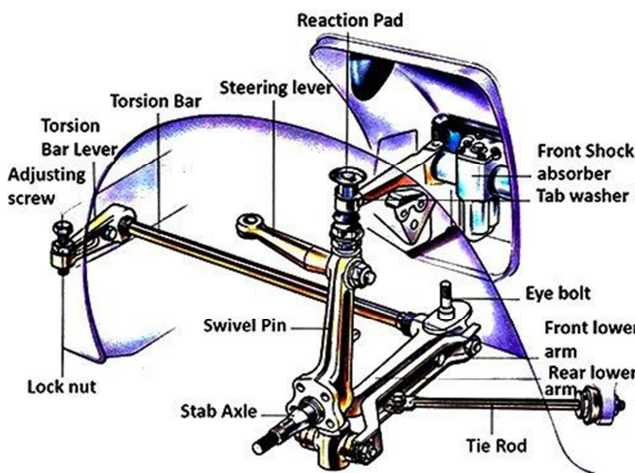


Figure 24. Torsion bar suspension [27].

(3) Equalizer beam suspension: It connects the suspension of two or more adjacent axles of a vehicle with more than two axles.

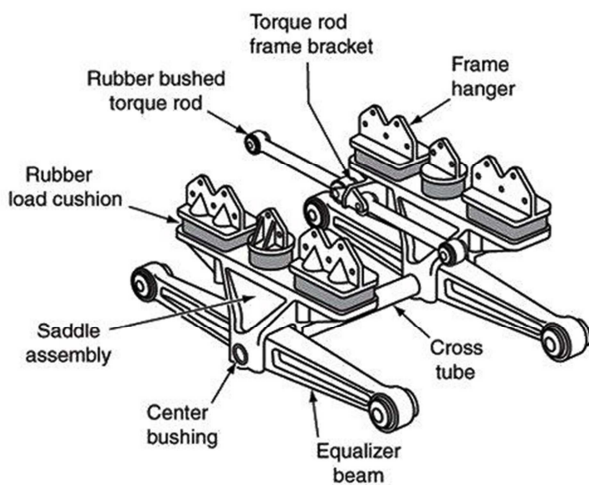


Figure 25. Equalizer beams with rubber cushions [28].

(4) Air spring suspension: It uses pressurized air, which raises the chassis from the axle by pressure. Up to 5000 lbs. of load-leveling capacity.



Figure 26. Air spring Suspension [29].

2.5. Camber, Caster, Braking System and Dashboard of Car

2.5.1. What Is Camber

Answer: Camber is either positive or negative and refers to the angle made by the wheel with respect to the vertical position of the vehicle. Positive Camber: When wheels are tilted outward, the vehicle has improved stability. Negative Camber: High-performance vehicles that require better cornering tend to use negative camber because it gives the driver more control in this regard.

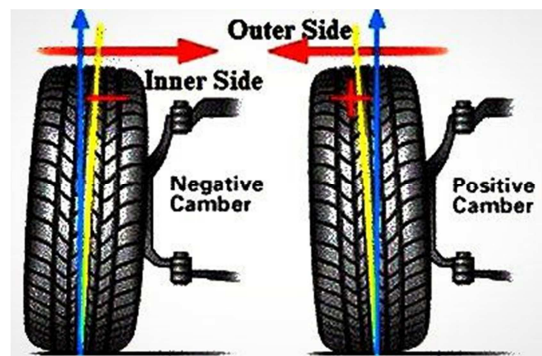


Figure 27. Positive and Negative Camber [30].

2.5.2. What Is Caster

Answer: Caster is the angle that identifies the forward or backward slope of a line that is drawn through the upper and lower steering pivot points. It does not affect tire wear, but the caster does have an influence on the directional control of the steering. Positive Caster: If the line slopes towards the rear of the vehicle, then positive caster. The downside to the positive caster. Negative Caster: If the line slopes towards the front of the vehicle, then the caster is negative. A negative caster will allow steering less around turns but may cause drift if driving straight forward (Figure 28).

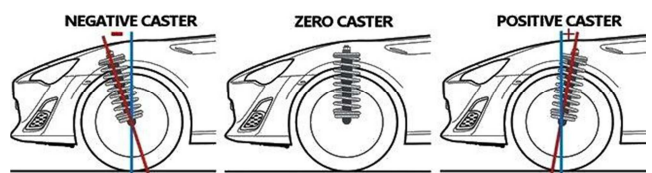


Figure 28. Positive and Negative Caster [31].

2.5.3. What Is Toe

Answer: Toe is a measurement that determines how much the front and/or rear wheels are turned in or out from a straight-ahead position. The amount of toe, whether it's toe-in

or toe-out, is expressed as the difference between the track widths as they are measured at the leading and trailing edges of the tires.

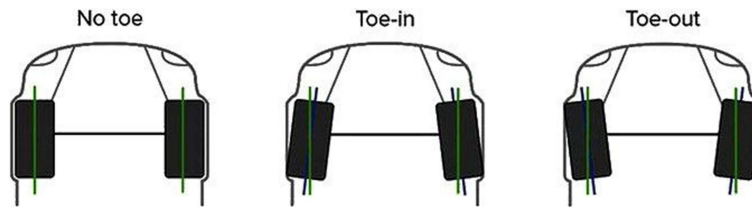


Figure 29. Toe in and Toe out [32].

2.5.4. ABS vs EBD vs BA vs AEB and How These Brakes Are Different from Others

Answer: ABS (Anti-lock Braking System): ABS prevents the wheels from locking up in the situation of hard braking under tricky conditions. It helps in stopping the car at a shorter distance under emergency braking. It prevents wheel lock-up, increases control over the vehicle, gives better braking performance in diverse conditions and reduces dramatically “skidding” effect.

Electronic Brakeforce Distribution (EBS): The main advantages of EBD system are: EBD enhances stability and reduces stopping distance, makes braking more predictable, improves traction on the road and maximizes braking

efficiency. EBD offers significant braking durability under any conditions and is not dependent on ABS to operate. The hardware of EBD comprises the following components which are: Wheel Speed sensors, load sensors, Brake force modulators /Valves and Electronic Control Unit (ECU).

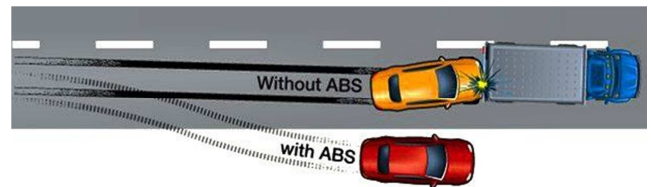


Figure 30. Anti-lock Braking System in the Situation of Tricky Conditions [33].

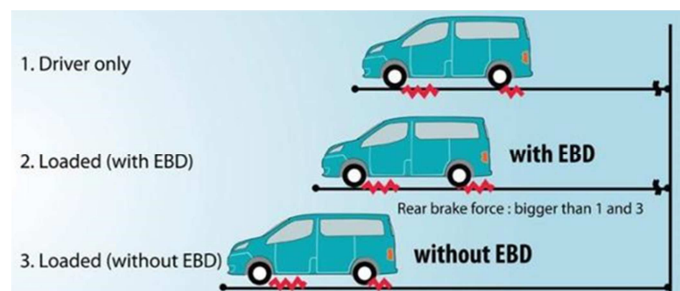


Figure 31. EBD Optimizes Rear Brake Force Depending on the Load [34].

Braking Assist (BA): Also known as Emergency Brake Assist (EBA) is another piece of car braking technology. As the name suggests is responsible to assist the driver in an emergency stop situation. It reduces stopping distance by up to 45%. It helps engage the brakes during an emergency situation.

Autonomous Emergency Braking (AEB): AEB stands for Autonomous emergency braking. They are designed to help

in applying brakes automatically. AEB warns the driver about a possible collision and applies the brakes automatically if he or she does not respond to the warning. AEB systems work well for rear-end collisions. This is because rear-end collisions are predictable and very common. Most accidents happen due to rear-end collisions. This feature should be included in all cars manufactured locally.

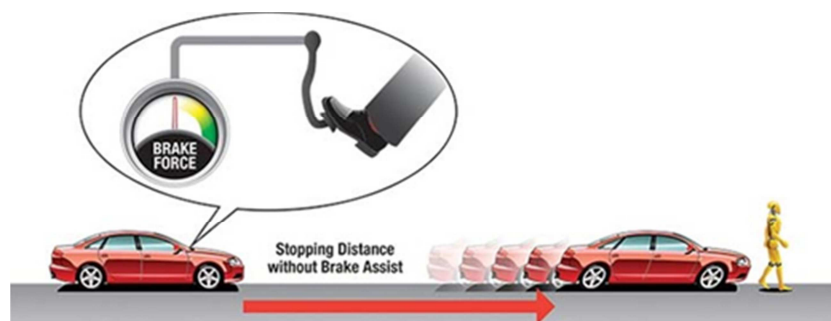




Figure 32. Braking Assist (BA) reduces stopping distance by up to 45% [35].

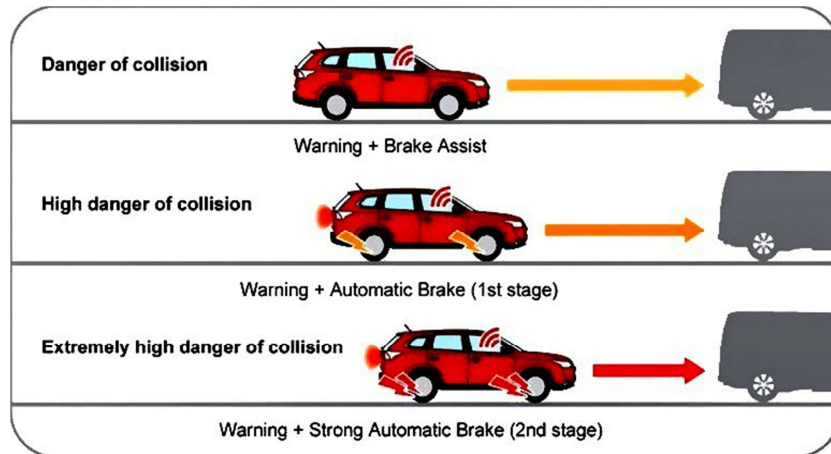


Figure 33. Autonomous Emergency Braking (AEB) Help in Applying Brakes Automatically [36].

2.5.5. What Does It Show on the Dashboard of a Car

Answer: Combination Meters and Gauges: The combination of meters and gauges consists of meters, gauges, warning lights, and indicator lights to show the information needed by the driver for safe driving.

Meters and Gauges:

The following meters and gauges indicate, through the movement of their needles, the pieces of information that change constantly:

- 1) Tachometer.
- 2) Speedometer.
- 3) Water temperature gauge.
- 4) Fuel gauge (w/ fuel level warning light).

Some models are also equipped with the following meter and gauge:

- 1) Oil pressure gauge.
- 2) Voltmeter.
- 3) Tachometer: Indicates the number of rotations of the engine per minute.
- 4) Speedometer: Indicates the current vehicle speed: km/h or mile/h. There is also an odometer and a trip meter that indicate the driven distance.
- 5) Tachometer: Indicates the number of rotations of the engine per minute.
- 6) Water temperature gauge: Indicates the temperature of the coolant water of the engine.
- 7) Oil pressure gauge: Indicates the circulation pressure of the engine oil.
- 8) Fuel gauge (w/ fuel level warning light): Indicates the

volume of remaining fuel.

- 9) Voltmeter: Indicates the voltage generated by the alternator.

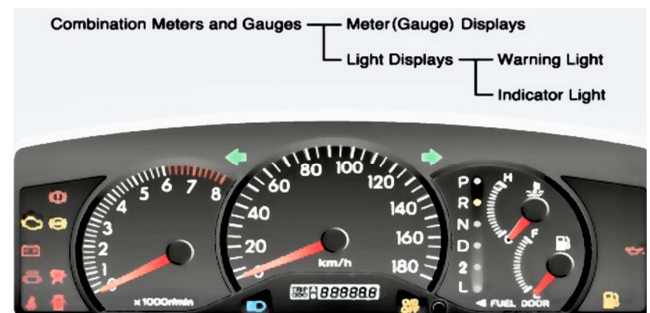


Figure 34. Dashboard of a Car [37].

Warning Lights:

These warning lights illuminate in the following situations: To alert the driver that a system has a malfunction or requires replenishment or replacement:

To ensure safe driving, red and orange bulbs are used, depending on the urgency or the priority of the information.

- 1) ABS warning light (ABS-equipped vehicles only)
- 2) Brake fluid level warning light
- 3) Multifunction indicator lamp
- 4) Discharge warning light
- 5) Seat belt warning light
- 6) Open door warning light
- 7) Airbag warning light (Airbag-equipped vehicles only)

- 8) Low fuel level warning light
- 9) Low oil pressure warning light
- 10) Fuel sedimentary warning light (Only for diesel vehicles)
- 11) Glow plug warning light (Only for diesel vehicles)

2.6. Smart Key and VIN Barcode of Vehicle

2.6.1. What Is a Smart Key for a Car

Answer: A smart key is a key designed for electronically accessing a corresponding vehicle. It was first developed by Siemens in 1995 and introduced by Mercedes-Benz under the name “Keyless-Go” in 1998.



Figure 35. A Smart Key of a Car [38].

2.6.2. What Does a Smart Key Do

Answer: Smart keys are part of a computerized system that uses and microchips to automatically unlock the doors and start the vehicle without the use of a key.

2.6.3. What Is a Vehicle Identification Number (VIN)

Answer: The car's vehicle identification number (VIN) is the identifying code for a SPECIFIC automobile. The VIN serves as the car's fingerprint, as no two vehicles in operation have the same VIN. A VIN is composed of 17 characters (digits and capital letters) that act as a unique identifier for the vehicle. A VIN displays the car's unique features,

specifications and manufacturer. The VIN can be used to track recalls, registrations, warranty claims, thefts and insurance coverage.

2.6.4. What Is a VIN Barcode

Answer: A VIN barcode is a unique code that is used in the automotive industry to identify individual motor vehicles. It is standardized by ISO 3779 and ISO 4030.

2.6.5. Where Does the VIN Barcode Locate on a Car

Answer: The car has the VIN bar code on the inside of the driver's door. Some cars also have the VIN on the driver's side dashboard.

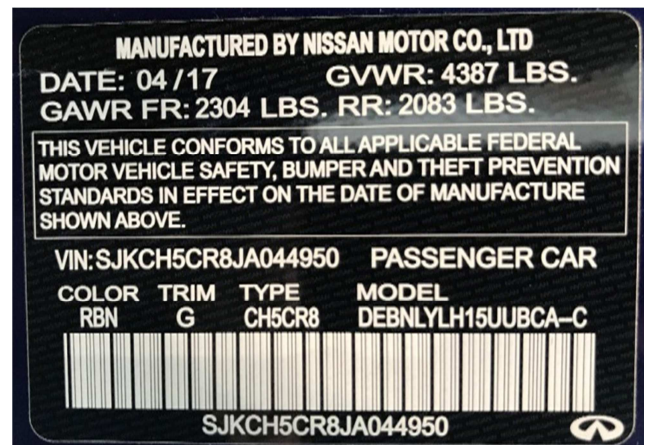


Figure 36. VIN Barcode [39].

2.6.6. What Do the Numbers and Letters in a VIN Mean

Answer: The following digits describe vehicle, including its make, model, trim level, the year it was built, details about its engine, its assembly plant, and its serial number. The breakdown below of the meaning behind each segment of the Vehicle Identification Number (VIN):

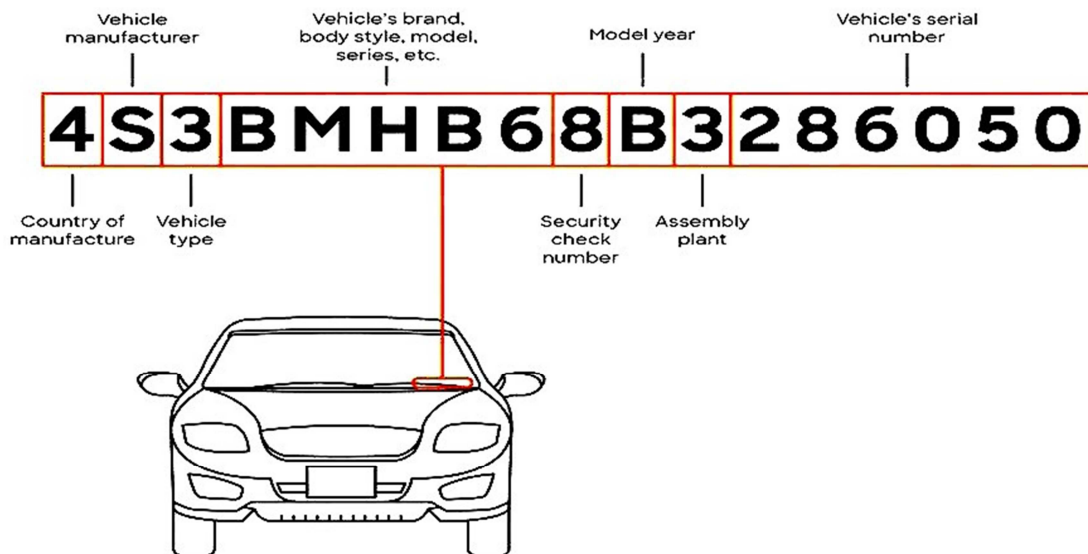


Figure 37. Diagram Explaining the Words/numbers Mean on the Vehicle Identification Number (VIN) [40].

Here are what all the parts of the VIN number mean, in order of appearance:

- 1) The first digit, which is 4 in our sample VIN, tells the car's country of manufacture.
- 2) The second digit, S in the sample VIN, is the car's manufacturer.
- 3) The third digit in the VIN, 3, tells the car's vehicle type.
- 4) That's followed by a series of five digits, BMHB6 in our sample VIN, that tell a car's brand, body style, model, series, etc.
- 5) The next digit, 8 in our sample VIN, is its security check number.
- 6) That's followed by the letter B, which tells a car's model year.
- 7) The eleventh digit of the VIN, 3, tells the car's assembly plant.
- 8) The last six digits of our sample VIN, 286050, make up the car's serial number.

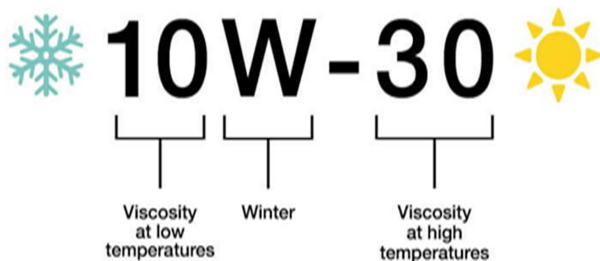


Figure 38. Engine Oil Grades Explained [41].

2.6.7. What Is Multi-Grade of Engine Oil

Answer: Motor oil grades are a scale developed by the Society of Automotive Engineers (SAE) to describe the

viscosity of the oil. Multi-grade oils must fulfill two viscosity specifications, their viscosity grades consist of two numbers.

For example; 10W30. 10W is the low-temperature viscosity (winter) whereas 30 is the high-temperature viscosity oil (summer).

2.6.8. Why Is There a VIN QR Code in a Car

Answer: A QR (quick response) Code attached to a vehicle can help users retrieve information such as country of origin, safety measures, troubleshooting, and even car parts to stay abreast of product updates and model recalls.



Figure 39. VIN QR Code in a Car [42].

2.6.9. How to Read Car's Tire

Answer: The tire has very useful information molded into the sidewall. It shows the name of the tire, its size, whether it is tubeless or tube type, the maximum load and maximum inflation, the important safety warning and much other information.

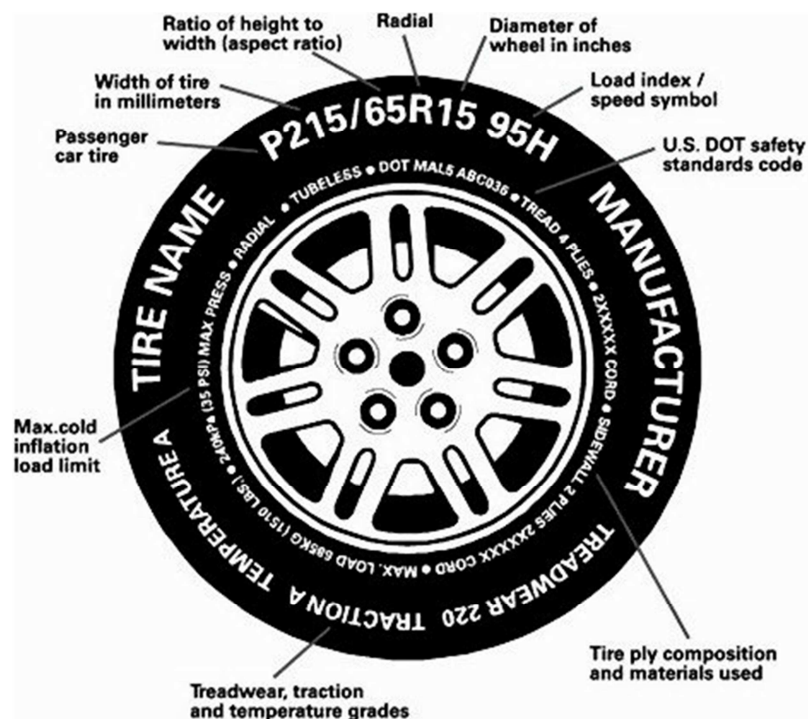


Figure 40. Typical passenger tire [43].

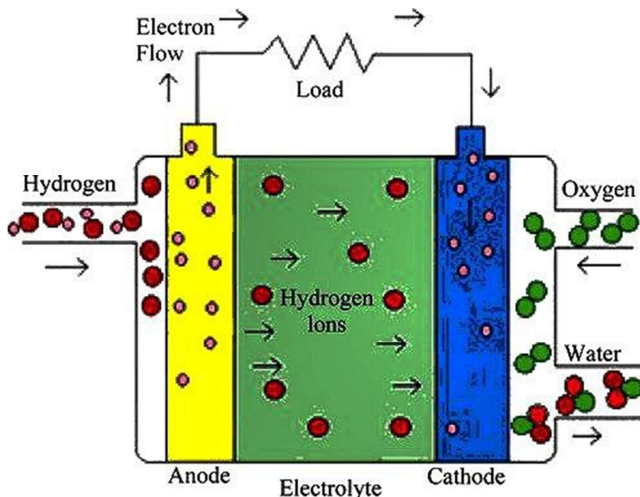


Figure 41. Simplified diagram of the polymer electrolyte fuel cell (PEMFC) operating process [44].

2.7. Fuel Cell, EGR, Brake Pads, MPFI and TPFC Systems

2.7.1. What Is a Fuel Cell and How Does It Work

Answer: A fuel cell is an electrochemical energy conversion device that produces electricity by combining hydrogen and oxygen (Figure 41).

Fuel cells work by using a catalyst, such as platinum, to separate the hydrogen atoms into protons and electrons.

2.7.2. Describe the Exhaust Gas Recirculation System

Answer: The exhaust gases are recycled into the intake system of the engine as part of an emission control system called Exhaust Gas Recirculation (EGR). There will be less of the air-polluting gas nitrogen oxides (NO_x) produced as a result of this.

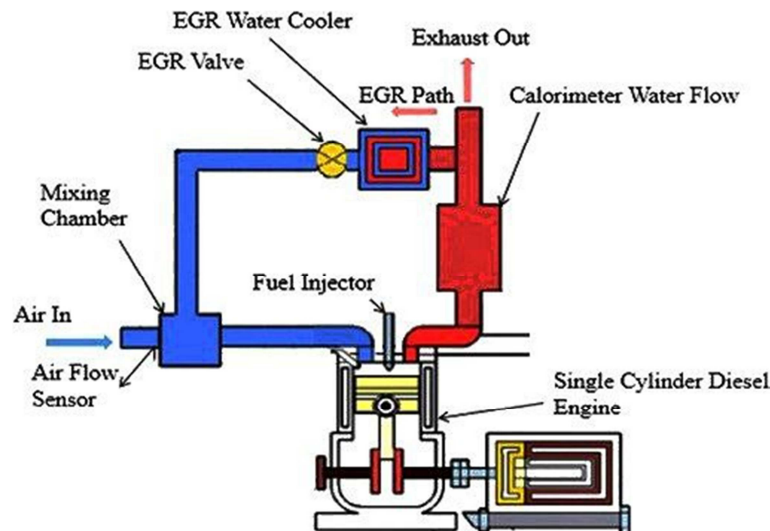


Figure 42. A schematic diagram of the EGR system [45].

2.7.3. What Are MPFI and TPFC Systems

Answer: MPFI stands for Multi-Point Fuel Injection. In this system, fuel is injected into the intake ports which are situated just upstream of each cylinder's intake valve (Figure 43).

TPFC stands for transient power fuel control system. In these systems, the throttle valve creates a vacuum that opens the slide and which controls the air-fuel ratio through a tapered jet.

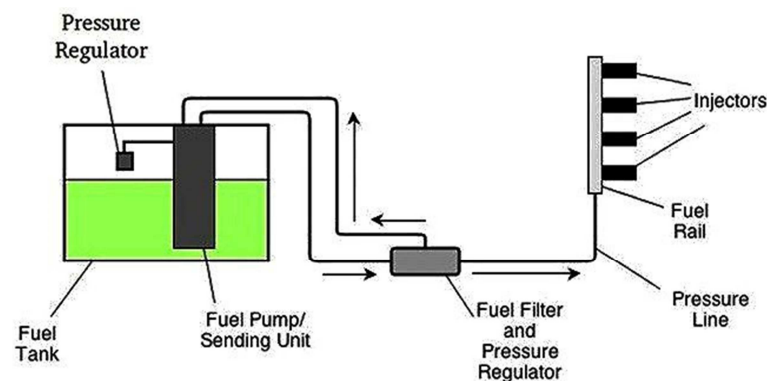


Figure 43. Multi-Port Fuel Injection System (MPFI) [46].

2.7.4. What Are the Configurations of Different Pads

Answer: There are four types of brake pads a) Basic pad, b) pad with radial chamfers, c) Pad with vertical chamfers, and d) Pad with diamond chamfers.

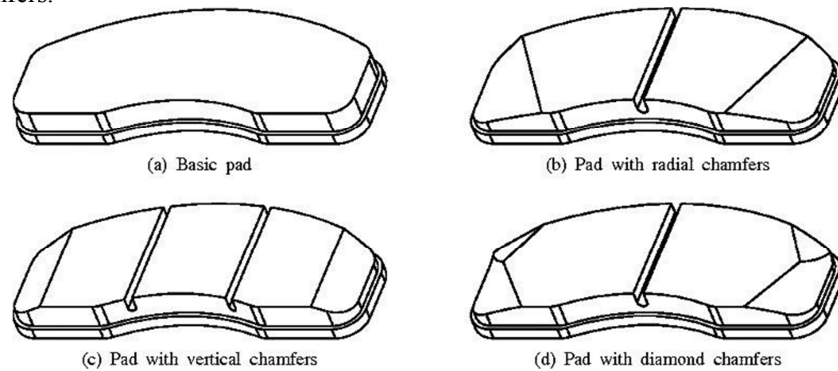


Figure 44. Different Configurations of Pads [47].

2.8. Catalytic Converter, Sensors and Troubleshooting

2.8.1. What Is the Function of a Catalytic Converter

Answer: The catalytic converter is located upstream of the muffler, close to the engine, and it helps to reduce airborne

pollutants that could harm people as well as the environment, turning 90% of harmful emissions into less harmful gasses. A well-maintained catalytic converter improves the efficiency of the car, directly affecting its overall health and performance.

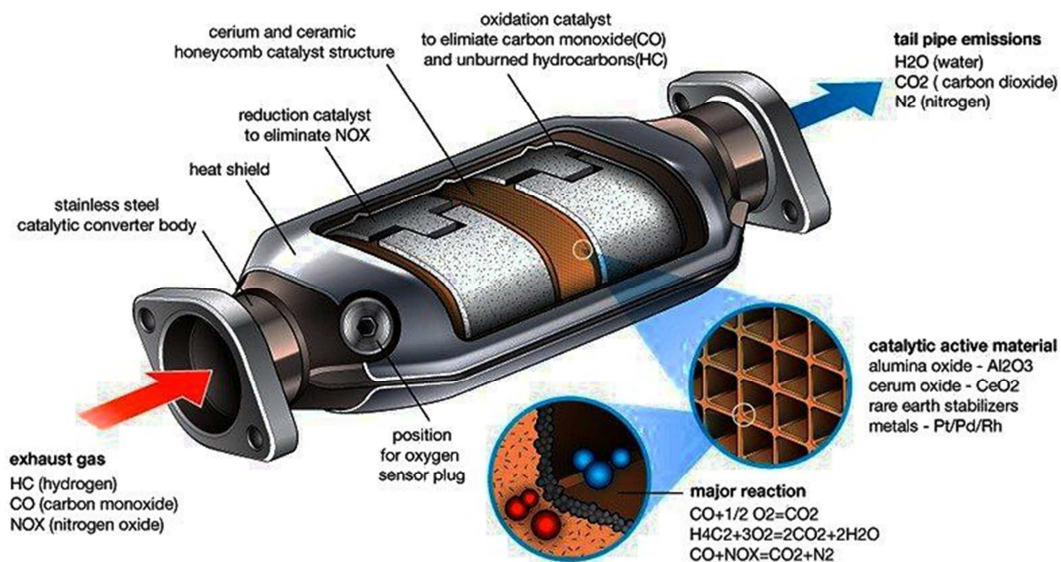


Figure 45. Main Parts of Charcoal Canister [48].

2.8.2. What Are the Types of Car Sensors

Answer: There are various vehicle sensors based on advanced embedded Micro-electromechanical systems (MEMS) technology. The following are the eighteen universal key sensors of the car.

Table 3. The Below Table Denotes Different Types of Sensors in a Car and Their Functions.

Sensor	Function
Air-flow sensor	It measures the density and volume of the air entering the combustion chamber.
Engine knock sensor	It monitors engine knocking and ensures the air-fuel mixture is ignited correctly.
Engine speed sensor	It monitors the spinning speed and position of the crankshaft.
Engine Coolant Temperature Sensor	Moreover, it measures the engine temperature
Crank Position Sensor	Monitors piston's TDC position in the engine
Camshaft position sensor	It monitors the position and proper timing of the camshaft.
Manifold Absolute Pressure (MAP) sensor	Monitors engine load by measuring the difference between the manifold and outside pressure.
Mass Air Flow or MAF Sensor	Further, it notifies the mass of air entering the engine to ECU
Throttle position sensor	Monitor the position of the throttle valve.
Voltage sensor	It manages the idling speed of the vehicle.
Oxygen sensor /O ₂ / Lambda Sensor	It helps to measure the oxygen level present in the exhaust gases.

Sensor	Function
NOx sensor	It measures the Oxides of Nitrogen (NOx) present in the exhaust gases.
Temperature sensor	It monitors the engine temperature.
Fuel temperature sensor	It monitors the temperature of the fuel entering the engine.
Fuel Pressure Sensor	Additionally, it measures pressure in the fuel system
Vehicle Speed Sensor (VVS)	It measures the speed of the wheels.
Parking sensor	It recognizes any obstacle present in the front or rear of the vehicle.
Rain sensor	It detects rain and sends a signal to ECU to activate the wipers.

2.8.3. Write Down Troubleshooting of the Lighting System

Answer: The lighting system requires periodic inspection and service. This maintenance is very important for

unwanted accidents occurring. The specific problems, their possible causes, and troubleshooting are given in the following table:

Table 4. Troubleshooting of Lighting System [49].

Problem	Probable Cause	Action or Items to be Checked
The bulb does not light up (No light).	1) Blown up the fuse. 2) Faulty light switch. 3) Completely discharge the battery. 4) Burned-out filament.	1) Check for the reason, and after repairing it, replace the fuse. 2) Check and replace the fuse. 3) Charge or replace the battery. 4) Replace the bulb.
Dim light.	1) Weak battery. 2) Bulb may be for a voltage higher than specified. 3) Reflectors or lenses may be dirty. 4) Bad contact at terminals. 5) Bad contacts in the switches.	1) Check the battery and charge as needed. 2) Change the bulb as per the required specifications. 3) Cleaning as per the procedure. 4) Properly clean the contacts. 5) Check and replace the switches.
Lamps light, but gradually fade out. Lights flickers	1) Insufficiently charged battery. 1) Loose connections.	1) Recharge the battery. 1) Clean and tighten connections.
Frequent burning out of the bulbs.	1) Battery voltage higher than specified. 2) Vibration of bulb mount. 3) Insufficient heat emission around bulb.	1) Check for battery voltage and correct, if required. 2) Check for proper installation of bulb mount. 3) Check for proper installation of bulb as per specifications.
Poor light distribution.	1) Wrong adjustment of lighting direction. 2) Deformed reflector.	1) Perform the aiming of headlights. 2) Replace headlight.
Wrong light was activated.	1) Wrong wiring inside the coupler. 2) Defective grounding.	1) Check and correct the wiring. 2) Check and correct the grounding.

2.9. Lightning Protection System and Electromagnetic Shielding

2.9.1. What Is Shandun Lightning Rod

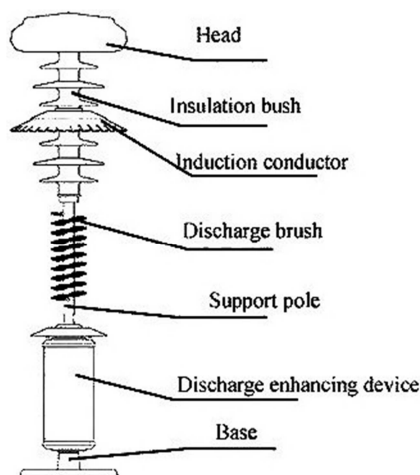


Figure 46. Configuration of Shandun Lightning Rod [50].

Answer: Shandun lightning rods that can significantly reduce the probability of lightning stroke compared with ordinary lightning rods, down conductors, and fast-installation earth electrodes are applied for external

lightning protection.

The Shandun lightning rod can significantly reduce charge density over its rod head in two ways:

- 1) Bipolar space charge dissipation method: It is applied to continuously dissipate induced charge to the atmosphere around by such components as discharge brush in the formation process of induced charge on the rod body.
- 2) The rod head: which is designed based on the result of finite element analysis, can significantly reduce discharge density around the rod head.

Therefore, the rod can provide the following function and performance:

- 1) Interception voltage of the rod is 150% higher than that of an ordinary rod so that probability of lightning stroke on the rod can be significantly reduced.
- 2) It can work normally under earthing resistance of no more than 100k Ω , largely relaxing earthing requirements on vehicles.
- 3) Its protection radius is calculated by the rolling sphere method. Since its lightning interception position is higher than the ordinary rod, its protection angle is bigger, generally reaching 55° and above.

2.9.2. How Lightning Protection System Work

Answer: New lightning protection systems for vehicles can reduce lightning interception probability to a level as low as

possible so as to minimize damage to vehicles by direct lightning stroke. The vehicles as well as their electronic

equipment and systems inside can thus be effectively protected against lightning and their safety can be ensured.

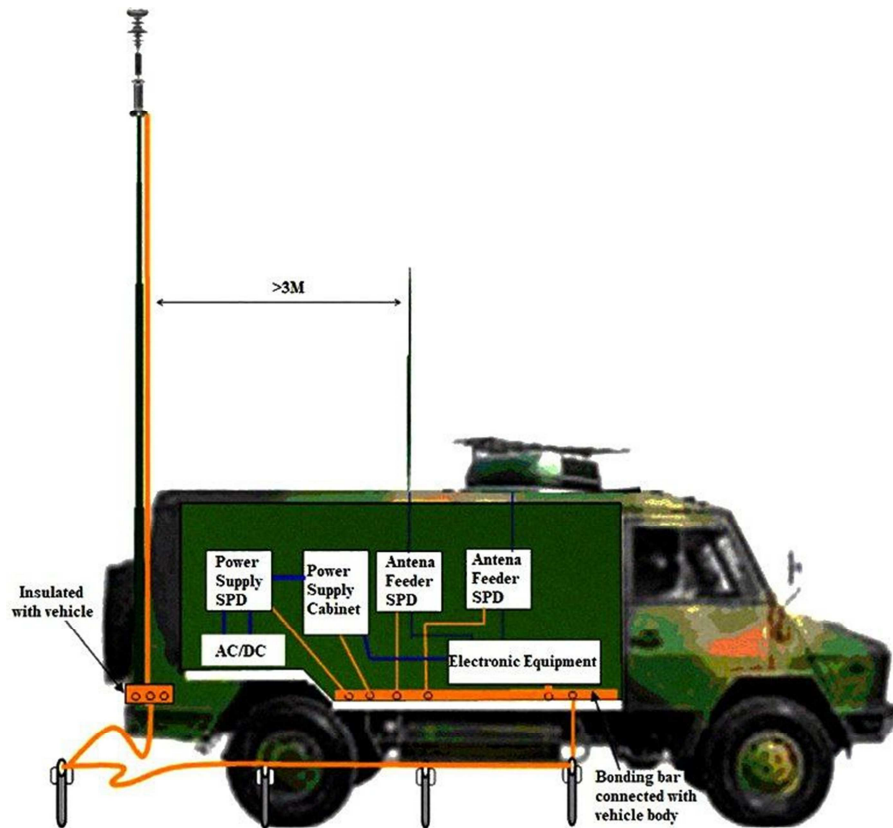


Figure 47. Overview of Lightning Protection System for a Military Vehicle [50].

2.9.3. What Is the Electromagnetic Shielding of Signal Jammers for Cars

Answer: A signal-jammer car has to be shielded to protect the people inside it from the powerful electromagnetic fields and radio frequencies that are emitted by the jammers on the car's roof.

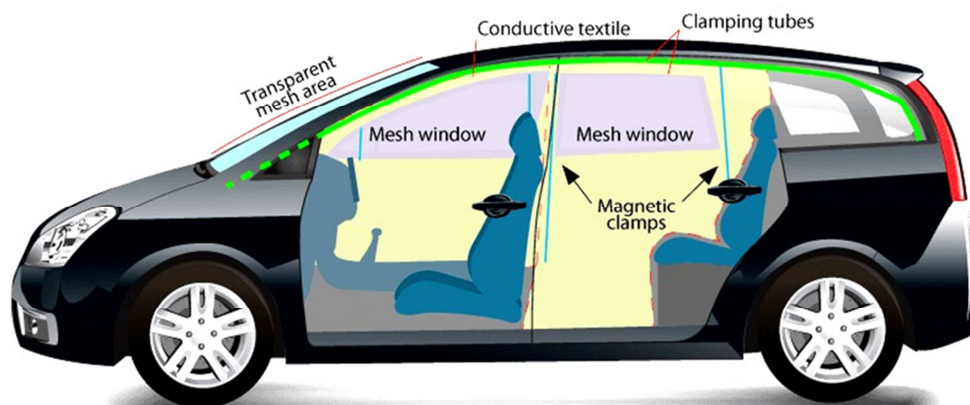


Figure 48. Full Compartment Car Shielding [51].

To shield a car from the inside there is also an option to place a frame at the inside of the car. This option makes it possible that no radiation can get in or out of the car when the passengers are joined for your trip. Conductive textile will be clamped into the frame so that the fabric can be placed from the frame, car seat, roof and dashboard of the car for optimal shielding performance to prevent radiation to get into the car.

2.9.4. What Is Lightning Protection System (LPS) for Military Vehicles

Answer: Lightning is a serious threat to military vehicles. The resulting damage of even a single lightning strike can be the loss of any equipment on the mast and possible damage to mobile vehicles driven on military personnel. Now, there is finally a 100% successful solution to stop lightning strikes on

military telescopic masts.

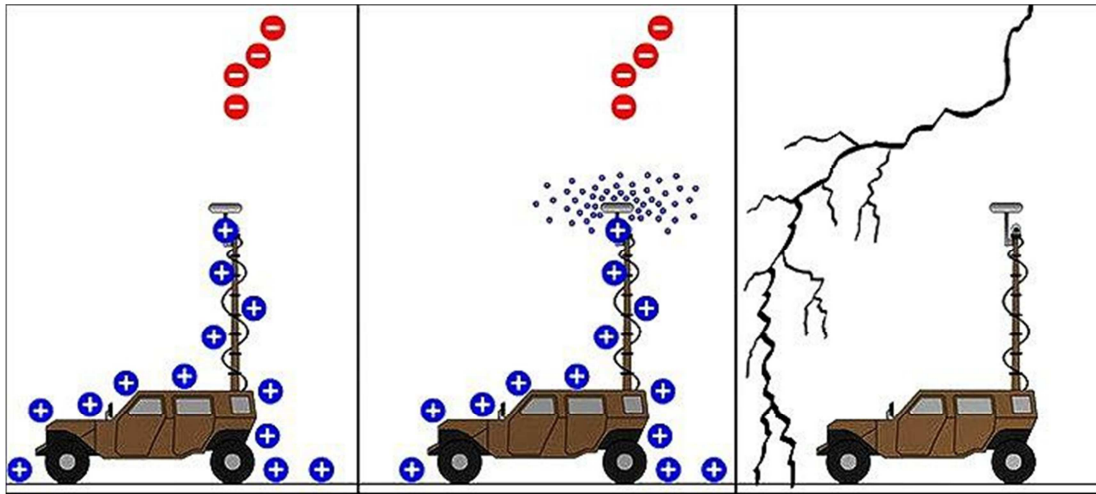


Figure 49. Lightning Protection for Military Vehicles [52].

2.9.5. How Many Protection Accessories Should Have a Car

Answer: The protective accessories can help prevent any minor or major accident that happens over time and eventually leads to a secure life.

There are eight car protection accessories should have every car: (1) Car Cover; (2) Body Side Molding; (3) Front-End Car Bra; (4) Grill Guards; (5) Bug Shields; (6) Floor Mats; (7) Safety Film; (8) Car Alarm.



Figure 50. Car Protection Accessories a car [53].

2.9.6. What Is SAE

Answer: SAE stands for Society of Automotive Engineers. SAE International is a global standards development and professional association with over 128000 engineers and technical experts in mobility engineering. Engine Oil Codes are 0W, 20, 0W, 30, 5w30, 5w40, 10W30, 10w40, 15w40, SEA30 etc.

2.9.7. Describe Some Automobile Products in Bangladesh and Their Brand Name

Answer: Bangladesh has several large automobile factories which assemble Mitsubishi, Proton, Hino, Tata and other commercial vehicles. There are the product names and brand names are given below in detail in Table 5.

Table 5. Some Automobile Products in Bangladesh and Their Brand Name [54].

Products	Brand Name
Heavy Bus	Hino, Isuzu, Volvo, Scania, Hyundai, Tata, Mercedes Benz, Man etc.
Mini Bus	Hino, Mitsubishi, Isuzu, Toyota, Sawraj Mazda, Tata, Eicher etc.
Microbus	Nissan, Mitsubishi, Toyota etc.
Heavy Truck	Hino, Tata, Bed Ford, Isuzu, Ashok Leyland
Mini Truck	Hino, Tata, Mitsubishi, Isuzu, Toyota, Eicher, Sawraj, Mazda etc
Motor Car	Toyota, Mercedes-Benz, Nissan, Mitsubishi, Ford, Daewoo, Proton Saga, Proton Wira, Hyundai, BMW, Maruti Suzuki etc.
Four Wheels	Toyota, Tata, Mitsubishi, Nissan etc
Auto Tempo	Bajaj, Krishan
Scooter	Bajaj, Krishan
Motor-cycle	Honda, Xingfu, Jialing, Zongshen, Yamaha, Suzuki, Hero, TVS Victor, Bajaj, Vespa etc.
Light and Heavy Commercial Vehicles	Nissan, Daewoo, Hyundai, Volvo, Ashok Leyland, Tata, Hino, Mitsubishi etc.
Farm and Agricultural Vehicles	Hyundai, Daewoo, Dongfang, Dong- chang etc.

2.10. Rules and Regulations in Automobile Industries

2.10.1. What Are the Sectors in Automobile Industry

Answer: The major business sectors of the automotive industry are suppliers, auto manufacturers, and auto dealerships.

2.10.2. What Are the Services of the Automobile Industry

Answer: There are many different types of automotive services. In addition to automotive design and automotive engineering, companies may provide automotive repair, coating and finishing, part fabrication, processing, equipment and system services, repair and maintenance, testing, and electronics manufacturing.

2.10.3. How Are the Categories of Automotive Businesses in Bangladesh

Answer: Automotive businesses in Bangladesh are of the following categories:

- Importing vehicles of a variety of brands (including reconditioned cars).
- Manufacturing buses, min-bus, trucks and sedans.
- Manufacturing auto-rickshaws and scooters.
- Manufacturing motorcycles.
- Manufacturing of three-wheeler motor vehicles.
- Assembling vehicles of various brands.

2.10.4. What Are the Following Steps Needs to Follow from a Company

Answer: The following steps need to follow to form a Company:

- A Name Clearance for the proposed Company needs to be obtained from the Registrar of Joint Stock and Companies.

2) Drafting and signing the following:

- Memorandum and Articles of Association of the company.
- Form I: Declaration on Registration of Company.
- Form VI: Notice of Situation of Registered Office.
- Form IX: Consent of the director to act.
- Form X: List of Personal Consenting to be Directors.
- Form XII: Particulars of the directors, manager and managing agents.

3) Opening a temporary bank account for the Proposed Company in any scheduled Bank in Bangladesh.

4) Remit the paid-up capital amount from the account of each foreign shareholder to the Bank Account of the Proposed Company in Bangladesh.

5) Obtain an encashment certificate for each foreign transaction from the Bank of the Proposed Company.

6) Submit all the required to the Company House.

7) Pay the Govt Fees for registration.

8) Obtain the registration certificate from the Company House.

2.10.5. What Are the following Required Documents Needed for Forming a Company

Answer: Required Documents for forming a Company:

- Copy of Valid Name Clearance for the proposed company.
- Executed copy of Memorandum and Articles of Association of the Company.
- Executed copy of Form I: Declaration on Registration of Company.
- Executed copy of Form VI: Notice of Situation of Registered Office.
- Executed copy of Form IX: Consent of director to act.
- Executed copy of Form X: List of Personal Consenting

to be Directors.

- g) Executed copy of Form XII: Particulars of the directors, manager and managing agents.
- h) Copies of the National ID of shareholders and directors (for Bangladeshi Nationals).
- i) Copies of the TIN Certificate of shareholders and directors (for Bangladeshi Nationals).
- j) Copies of passports of shareholders and directors (for Foreign Nationals).
- k) Passport-size photos of shareholders and directors.
- l) Bank Encashment Certificate with respect to each foreign shareholder.
- m) Receipt of payment of the governmental fees.

2.10.6. What Are Required Additional Licenses for Forming a Company

Answer: The additional licenses required for establishing an automotive industry are mentioned below:

- a) Trade License.
- b) TIN Certificate.
- c) VAT Registration Certificate.
- d) Registration of Industrial Investment Project.
- e) Factory Layout Approval.
- f) License of Factory.
- g) Membership Certificate.
- h) Import Registration Certificate (applicable for Import Business).
- i) Export Registration Certificate (applicable for Export Business).
- j) Environment Clearance Certificate.
- k) Fire License.
- l) Registration of Trademark.

3. Result and Discussion

This section discusses various issues such as Supplementary duty, Import duties on hybrid vehicles, Transportation play, Existing assemblers and the number of registered motor vehicles in Bangladesh. As a result, the rise in the demand for vehicles in Bangladesh can be specified and the prosperity of the automotive industry has been understood.

3.1. What Are Vehicles Users Per 1,000 Population in Bangladesh, Myanmar, India and Vietnam

Answer: This table is a list of countries by the vehicle's users per 1,000 Population on the road.

Table 6. Vehicles Users Per 1,000 Populations in Bangladesh, Myanmar, India and Vietnam [55].

Country	Ratio/ 1000 Population	Person
Bangladesh	Vehicles Users Per 1,000 Population	: 2.5
Myanmar	Vehicles Users Per 1,000 Population	: 12
India	Vehicles Users Per 1,000 Population	: 30
Vietnam	Vehicles Users Per 1,000 Population	: 31

Compared to other Asian countries, passenger car penetration is still very low in Bangladesh. There are only 2.5

car owners per 1000 population. In India, 30 people among 1000 individuals owned a car at the end of 2018. In Myanmar, about 12 people out of 1000 own a car.

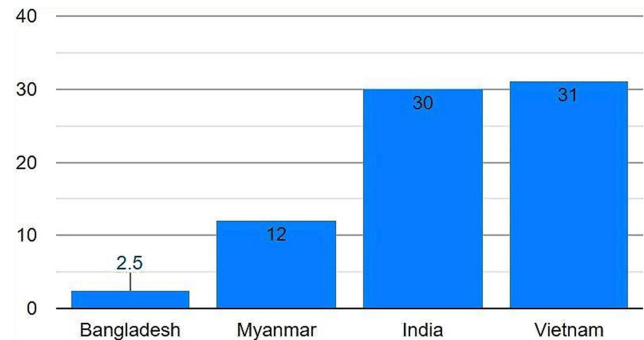


Figure 51. Vehicles Users Per 1,000 Population [55].

3.2. What is the supplementary duty in Bangladesh

Answer: In Bangladesh, most of the cars have been imported. Present supplementary duties for imported regular and hybrid cars are given below:

Table 7. The supplementary duty in Bangladesh [56].

Automobile Industry Heads	Current Scenario	
	Regular Car	Hybrid Car
1500 CC	45%	30%
1501-2000 CC	100%	60%
2001-2700 CC	200%	150%

Motorcycle assembling and manufacturing companies have to pay a 20 percent supplementary duty on imported parts and components. It will help motorcycle assemblers to integrate backward more easily. The importers of Human Hauler have to pay 25 percent customs duties and 30 percent supplementary duty.

3.3. What Are the Import Duties of Hybrid Vehicles

Answer: The import duties imposed on hybrid vehicles are sufficiently lower than those imposed on conventional fuel vehicles in each class of cylinder capacity. For example, hybrid CBUs with less than 1,800cc and 1,801-2,000cc are taxed at 91.41% and 130.2%, respectively, while conventionally-fueled vehicles with the same cylinder capacity are taxed at 215.6% [57].

3.4. What Does Transportation Play on Our Country's Economic Growth

Answer: Bangladesh achieved considerable economic growth (GDP of more than 7 percent) with a stable unemployment rate and a rise in foreign investments. A huge number of vehicles are imported every year, which includes reconditioned cars, spending a huge amount of foreign currency.

Table 8. Current Scenario of Automobile Industry in Bangladesh [58].

Automobile Industry Heads	Current Scenario
Local Demand	\$ 2.5 Bn
Raw material source (Local: Imported)	5:95
Future Investment possibility	\$ 2.5-3 Bn
Future employment option	1.5m
Import situation	2.01 Bn

3.5. What Are Existing Assemblers in Bangladesh

Answer: Bangladesh has a few large car plants which assemble passenger cars from Toyota and Mitsubishi, as well as commercial vehicles from Tata and Hino. Motorcycles, auto rickshaws and the locally designed Mishuk three-wheeler are manufactured in Bangladesh. The existing assemblers in Bangladesh are listed below:

Table 9. Existing Assemblers in Bangladesh [57].

Name	Main Stakeholders (Brand)	Vehicles Assembled
Aftab Automobiles Ltd	Navana Group (Toyota, HINO)	PV: SUV CV: Bus, Truck
BD Machine Tools	State-owned enterprise	CV: Army truck
IFAD Auto Ltd.	IFAD group (Ashok Leyland)	CV: Truck, Prime-mover, Covered van, Tractor, Pick-up, Cabinet
PHP Automobiles Ltd.	PHP Group (Proton)	PV: Sedan
Pragati Industries Ltd.	State-owned enterprises (Tata, Mitsubishi, Mahindra, Foday)	PV: SUB CV: Bus, Pick-up
Rangs Ltd.	Rangs Group (Mitsubishi, Mahindra)	PV: SUV CV: Human hauler, Pick-up, Mini-truck
Millennium Auto Assembly Ltd.	Millennium Group of SG/BD Machine & Tools (Hyundai)	PV: Sedan, SUV
Nita Co. Ltd.	Nitol Niloy Group (TATA)	CV: Truck, Bus, Pick-up
ACI Motors Ltd.	ACI Group (Foton)	Commercial vehicle (plan)
BD Auto Industries Ltd.	Mango Telecom	Electric vehicle (plan)
Nitol Motor Ltd.	Nitol Niloy Group	Electric vehicle (plan)
Rangs Motors Ltd.	Rangs Group (Mercedes Benz)	Passenger vehicle (plan)
Runner Motors Ltd.	Runner Group (Eisher)	CV: Truck (plan)
BD Machine Tools	State-owned enterprise	CV: Army truck

* Note: PV = Passenger Vehicle, CV = Commercial Vehicle.

3.6. What Do Mean by BAAMA and ACAMA

Answer: Bangladesh Automobile Assemblers & Manufacturers Association (BAAMA): BAAMA provides support to local vehicle makers, and lobbies to formulate policies related to the industry.

Automobile Component and Accessories Manufacturers Association (ACAMA): ACAMA is an interesting body of 13 parts suppliers to automobile (and motorcycle) assemblers. The number of local companies that currently supply parts to assemblers (motorcycles) is estimated to be around 10 including ACAMA members.

3.7. Write Down the Special Tariff Duty Benefit to Passenger Vehicles Manufacturer

Answer: To accelerate the local assembly of affordable passenger vehicles and develop a brand-new vehicle market, the Bangladeshi government issued a Statutory Regulatory Order (SRO 176/2019/33) in July 2019, which allows an exemption of VAT/ supplementary duty (SD) imposed on

imported parts and materials for CKD assembly of passenger vehicles below 1,600cc. Manufacturers intending to avail of this benefit shall satisfy several conditions, including the availability of required equipment/ facilities (e.g. paint-shop), use of locally produced parts (e.g. tire, battery), employment of at least 250 local workers, attainment of local value addition (30%), and materialization of at least BDT 5 billion investment within one year. This SRO remains valid until 30 June 2021 [57].

3.8. Write down the Number of Registered Motor Vehicles in Bangladesh (Year-wise)

Answer: Every day, there are lots of vehicles registered in Bangladesh. Motor vehicles registered in Bangladesh: total data is updated yearly, averaging 140,316.000 Units from December 1995 to 2022, with 28 observations. The data reached an all-time high of 578,151.000 Units in 2022 and a record low of 28,764.000 Units in 2000 [59]. The number of registered motor vehicles is listed below year-wise:

Table 10. Number of Registered Motor vehicles in Bangladesh (year-wise) [60].

Type of Vehicles	Up to-2017	2018	2019	2020	2021	Up to Feb/ 22	Grand Total
Ambulance	4801	563	665	788	755	135	7707
Auto Rickshaw	228226	21593	29807	16724	9158	640	306148
Auto Tempo	15098	609	224	77	25	2	16035
Bus	39133	2755	3558	2395	1517	315	49673
Cargo Van	8251	1280	4	2	3	0	9540

Type of Vehicles	Up to-2017	2018	2019	2020	2021	Up to Feb/ 22	Grand Total
Covered Van	26352	5728	3070	2023	3800	921	41894
Delivery Van	25825	2105	1523	1170	1436	216	32275
Human Hauler	15267	1418	509	122	52	2	17370
Jeep (Hard/Soft)	48851	5547	5627	4911	7602	1654	74192
Microbus	92836	4131	3682	2779	4941	1325	109694
Minibus	25262	436	835	620	392	72	27617
Motor Cycle	2019640	393545	401452	311016	375252	84583	3585488
Pick Up (Double/Single Cabin)	97480	13060	11918	10498	10897	1751	145604
Private Passenger Car	318537	18222	16779	12403	16049	3123	385113
Special Purpose Vehicle	7945	1334	1179	703	518	64	11743
Tanker	4687	527	417	304	248	57	6240
Taxicab	35929	159	11	8	0	2	36109
Tractor	33744	3553	2561	2498	2567	398	45321
Truck	112518	12644	8318	4719	5789	935	144923
Others	38222	5973	5293	3900	4029	683	58100
TOTAL	3198604	495182	497432	377660	445030	96878	5110786



Figure 52. Vehicle Sales in Bangladesh (Note: *f* is Denoting Forecasted Values) [60].

Bangladesh is also facing a rise in the demand for motorized vehicles. In 2020, a total of 0.37766 million vehicles has been registered in Bangladesh according to the list given on the official website of Bangladesh Road Transport Authority (BRTA). In 2021, there has been an increase in registered vehicles totaling 0.44503 million vehicles. For the last couple of years, it has been increasing as per the data. The latest update shows that in the first two months of the year 2022, 96878 registered vehicles have been listed (Table 10).

4. Conclusion

The automotive industry in Bangladesh is growing day by day. The industry has the potential to contribute to Bangladesh's economic growth. The increasing demand for transport and the variety of vehicles in the country is attracting big investment in this sector. This paper almost holds everything relating to the procedure of establishing a vehicle manufacturing factory and also ensures the requirements of expert technicians and service engineers for the smooth operation of that industry. At the end of this paper, the authors discussed the above advance questionnaires with answers for technicians and service engineers in the automobile sector and

it will help to find their advanced questionnaires answers for automobile-related work and improve their theoretical knowledge. This paper can be used for different kinds of automobile-related job examinations. Also, these advanced questionnaires can be used for general training for technicians and service engineers in the automobile sector.

Acknowledgements

The authors would like to express their gratitude to Dhaka University of Engineering & Technology, Gazipur, Bangladesh for their cooperation and guidelines to complete this research work. The authors also thank to Mawlana Bhashani Science and Technology University, Santosh, Tangail for their cooperation. This study was funded by Hazi Md. Shajahan Bhuiyan Foundation (HMSBF) through the Najmun Nahar.

References

- [1] FM Associates, Leading Law Firm in Bangladesh. <https://www.fmassociatesbd.com/doing-business/how-to-setup-automotive-business-in-Bangladesh-doing-business-in-Bangladesh> (Accessed on January 2023).

- [2] Ahmed, N., The Future of Automobile Industry in Bangladesh (2021). https://www.linkedin.com/pulse/future-automobile-in-dustry-bangladesh-noman-ahmed?trk=pulse-article_more-articles_related-content-card (Accessed on January 2023).
- [3] Shueb Ahmed, Sep 26, 2019. The future of the automobile industry in Bangladesh, <https://www.thedailystar.net/shift/automobile-industry-in-bangladesh-the-future-of-it-1805257>.
- [4] Automotive industry in Bangladesh, https://en.wikipedia.org/wiki/Automotive_industry_in_Bangladesh.
- [5] <https://www.thedailystar.net/supplements/30th-anniversary-supplements/going-digital/news/brief-look-the-auto-industry-bangladesh-2043941> (Accessed on January 2023).
- [6] Types of electric vehicles. <https://e-amrit.niti.gov.in/types-of-electric-vehicles> (Accessed on January 2023).
- [7] Foley, B., Degirmenci, K. and Yigitcanlar, T., 2020. Factors affecting electric vehicle uptake: Insights from a descriptive analysis in Australia. *Urban Science*, 4 (4), p. 57.
- [8] Febbraio, (2018). An EV taxonomy, One Wedge. <https://onewedge.com/2018/02/19/an-ev-taxonomy>.
- [9] Kieckhäfer, K., 2020. Strategic planning towards electric mobility in the automotive industry (Doctoral dissertation, Technische Universität Carolo-Wilhelmina zu Braunschweig).
- [10] Elaphe Propulsion Technologies, Ltd., Internal archive (formats: .pdf, .cae, .odb, .sldprt, .sldasm, .stp, .sat). Ljubljana, Slovenia, 2017.
- [11] Shahzad, Muhammad Haseeb & Amjad, Hasan. (2018). Modern Technologies in Automobiles.
- [12] Alsaeed, Ali & Inman, Daniel. (2023). Dynamic Stability Evaluation of an Automotive Turbocharger Rotor-Bearing System.
- [13] Le Saussel, P., Fabrie, P., & Arnou, D. (2013). Axial length impact on high-speed centrifugal compressor flow. *Fluid-Structure Interaction VII*, 129, 263.
- [14] Bencs, Péter & Alktrane, Mohammed. (2021). The potential of vehicle cooling systems the potential of vehicle cooling systems. *Journal of Physics: Conference Series*. 1935. 10.1088/1742-6596/1935/1/012012.
- [15] Islam, S., Islam, M. S., & Abedin, M. Z. (2021). Review on Heat Transfer Enhancement by Louvered Fin. *International Journal of Engineering Materials and Manufacture*, 6 (1), 60–80.
- [16] Ali, M., El-Leathy, A. M. and Al-Sofyany, Z. J. A. I. M. E., 2014. The effect of nanofluid concentration on the cooling system of vehicles radiator. *Advances in Mechanical Engineering*, 6, p. 962510.
- [17] Karim Nice, (2021). How Four-Wheel Drive Works, Steering & Suspension, Under the Hood, Auto, HowStuffWorks. <https://auto.howstuffworks.com/four-wheel-drive.htm>.
- [18] Pehan S., Lajqi Sh., Pšeničnik J., Flašker J.: Modelling and simulation of off-road vehicle with Four-wheel steering. *Proceedings of IRMES 2011, Zlatibor, April 2011*, 77-83.
- [19] Nima E.: Development of semi – active Intelligent Suspension System for Heavy Vehicles. Ph. D Dissertation. University of Waterloo, Canada, 2008.
- [20] Živković, Vladica & Nedici, Bogdan & Đurić, Stefan. (2020). Manufacturing specificity of vehicle's independent suspension system parts. *Mobility and Vehicle Mechanics*. 46. 31-41. 10.24874/mvm. 2020. 46. 01.03.
- [21] Biček, Matej & Connes, Raphaël & Omerović, Senad & Gunduz, Aydin & Kunc, Robert & Zupan, Samo. (2020). The Bearing Stiffness Effect on In-Wheel Motors. *Sustainability*. 12. 4070. 10.3390/su12104070.
- [22] Lajqi S., Pehan S., Lajqi N., Gjelić A., Pšeničnik J., Emin S.: “Design of independent suspension mechanism for a terrain vehicle with four wheels drive and four wheels steering”, *MOTSP 2012 Conference Proceedings*, 2012, pp. 230-237.
- [23] <https://kmengineering.ru/bs/damping-elements-of-the-suspension-purpose-and-classification-of-carsuspension-brackets> (Accessed on February 2023).
- [24] Thomas G.: *Fundamental of Vehicle Dynamics*. Published by Society of Automotive Engineering, Warrendale, USA, 1992, pp. 470.
- [25] Giannakis, Efstratios & Malikoutsakis, Michail & Savaidis, G. (2016). Fatigue Design of Leaf Springs for New Generation Trucks. *IOP Conference Series: Materials Science and Engineering*. 161. 012065. 10.1088/1757-899X/161/1/012065.
- [26] Karthik, J. P., Chaitanya, K. L. and Sasanka, C. T., 2012. Fatigue life prediction of a parabolic spring under non-constant amplitude proportional loading using finite element method. *International Journal of Advanced Science and Technology*, 46, pp. 143-156.
- [27] How it Works: Torsion Bar Suspension, unique cars and parts. https://www.uniquecarsandparts.com.au/how_it_works_torsion_bar_suspension (Accessed on January 2023).
- [28] Antonia Wigg, (2015). Chapter 26, Suspension System. <https://slideplayer.com/slide/3570691>.
- [29] Air Lift 57399 Load Lifter 5000 Air Springs for 2017-2019 Ford F250/F350 4WD Nylon Air Line, Amazon.de. <https://www.amazon.de/-/en/57399-LoadLifter-Springs-2017-2019-Nylon/dp/B01LZTJN7M> (Accessed on March 2023).
- [30] Common Adjustment Issues, Harry's Alignment. <http://harrysalignmentastoria.weebly.com> (Accessed on February 2023).
- [31] How to Get Optimal Caster Alignment for Racing, (2019). White line USA. <https://whitelineperformance.com/blogs/Whiteline-blog> (Accessed on February 2023).
- [32] Aiden Chong, (2020). A Beginner's Guide: Setting Up Your Car's Alignment – Toe, Camber, & Caster, Car Guides. <https://www.motorist.sg/article/698/a-beginner-s-guide-setting-up-your-car-s-alignment-toe-camber-caster>.
- [33] Bilal Ahmed Firfiray, (2020). Car Wale Gyaan: What is Anti-Lock Braking System (ABS) and how ABS work, car wale. <https://www.carwale.com/features/carwale-gyaan-what-is-anti-lock-braking-system-abs-and-how-abs-works-46502>.
- [34] Aiman Laghari, (2018). Brake Bias and Its Direct Impact On Driving, Pak Wheels. <https://www.pakwheels.com/blog/brake-bias-direct-impact-driving> (Accessed on February 2023).

- [35] Akshat Ajeya, (2018). ABS, EBD, BA: Car Braking Technology Explained, GoMechanic Informative. <https://gomechanic.in/blog/car-braking-technology-explained>.
- [36] Samiullah Sharief, (2016). Understanding the Car's Braking System, Pak Wheels. <https://www.pakwheels.com/blog/under-standing-cars-braking-system> (Accessed on March 2023).
- [37] Manual of Navana Toyota 3S Center, Dhaka, Bangladesh, 2022. <https://toyota.com.bd>.
- [38] 2016 2017 2018 2019 BMW 740i 750i SERIES DISPLAY KEY SMART SCREEN 9877464-01 OEM. <https://www.ebay.com/itm/284607873478> (Accessed on February 2023).
- [39] Nissan is using a new VIN barcode type that is linear but not Code 39 or 128! Can someone help identify what type it is, <https://www.reddit.com/>; <https://images.app.goo.gl/W4YgXD6LsvpKJzE5A> (Accessed on April 2023).
- [40] Stephanie Nieves, (2022). What is a Vehicle Identification Number (VIN), Insurance rates by car, Auto insurance, Policygenius. <https://www.policygenius.com/auto-insurance/what-is-a-vehicle-identification> (Accessed on March 2023).
- [41] Understanding Oil Grades (2020). Online Lubricants, News & Blog. <https://www.online-lubricants.co.uk/blogpost/understand-ding-oil-grades> (Accessed on March 2023).
- [42] Gm Pro Codes, Axle / Differential Identification. <http://www.rockauto.com/genImages/AxleID/axleDims.html#ford>.
- [43] James Kennedy, (2020). Uniroyal Tiger Paw Touring Review, Shed Heads. <https://shedheads.net/tire-reviews/uniroyal-tiger-paw-touring> (Accessed on March 2023).
- [44] Awulachew, Shinie & Nigussa, K. (2022). Molecular dynamics simulation of ion dynamics within electrolyte of PEM Fuel Cells. 10.48550/arXiv.2206.03355.
- [45] Kumar, Megavath & Sudhakara, S & Reddy, S. (2021). Experimental investigation of B20 blend in the DI diesel engine with a modification of smaller orifice injection nozzle and after-treatment systems (EGR+DPF). International Journal of Ambient Energy. 43. 10.1080/01430750.2021.1919202.
- [46] Robbers Dog, 2008. Returnless Fuel System Question. <http://antilag.com/forums/showthread.php?64653-Returnless-Fuel-System-Question> (Accessed on March 2023).
- [47] Adeseko, A. & Kareem, Buliaminu. (2018). Operational Programmable Logic Control of a Non-Disposable Brake pad Sensor. 2278-8719.
- [48] Catalytic Converter, Glossary, Service & repair, cars.com. <https://www.cars.com/auto-repair/glossary/catalytic-converter>.
- [49] Gupta, S. K., 2020. A Textbook of Automobile Engineering. S. Chand Publishing.
- [50] Yang, G., Wang, X., Liu, T., Zhu, C., & Wang, D. (2010). A new lightning protection system for vehicles. 2010 Asia-Pacific International Symposium on Electromagnetic Compatibility, 1259-1262.
- [51] Jammer shielding, Faraday cages and components, Faraday cages, standard & custom-made EMI shielded test boxes, Holland Shielding Systems. <https://hollandshielding.com/Signal-jammer-shielding-for-cars> (Accessed on March 2023).
- [52] Lightning Protection for Military Telescopic Masts, MTO, (Accessed on March, 2023). <https://www.mto.com.tr/single-post/lightning-protection-of-military-telescopic-masts>.
- [53] 8 Car Protection Accessories You Should Definitely Have, Armormax, Jun 2020. <https://www.armormax.com/blog/8-car-protection-accessories-you-should-definitely-have>.
- [54] Wikipedia. (Access on 2023, January). <https://en.wikipedia.org>. Retrieved from https://en.wikipedia.org/wiki/Automotive_industry_in_Bangladesh.
- [55] Business Inspection BD, September 6, 2021. Bangladesh Automobile Industry: Current Trends and Future. <https://businessinspection.com.bd/automobile-industry-of-Bangladesh>.
- [56] Ministry of Finance. (2017). Budget Brief 2016-2017. Ministry of Finance, Bangladesh.
- [57] Automobile Industry, Bangladesh Investment Development Authority, December 2020 (Accessed on March 2023).
- [58] Board of Investment Bangladesh. (2017). Automobile.
- [59] Bangladesh road transport authority, 1995-2022, Motor Vehicle Registered: Bangladesh: Total. <https://www.ceicdata.com/en/Bangladesh/motor-vehicle-registered/motor-vehicle-registered-bangladesh-total> (Accessed on June 2023).
- [60] Bangladesh Road Transport Authority (BRTA), (2023). <https://brta.portal.gov.bd> (Accessed on March 2023).

Biography



Samsul Islam received his B.Sc. degree in Mechanical Engineering from the International University of Business Agriculture and Technology, Dhaka-1230, Bangladesh and M.Sc. degree in Environmental Sciences and Management from Jahangirnagar University, Savar, Dhaka-1342, Bangladesh, respectively. Now he is a Post Graduate student in the Mechanical Engineering Department at Dhaka University of Engineering & Technology, Gazipur-1707, Bangladesh.



Zahid Ahsan received his B. Sc. degree in Mechanical Engineering from the International University of Business Agriculture and Technology (IUBAT), Bangladesh and M. Engg. candidate in Mechanical Engineering from Dhaka University of Engineering & Technology (DUET), Bangladesh. His areas of interest are production engineering, industrial management, supply chain engineering management, operations research and automobile engineering.



Md. Abdul Hannan Miah received his B.Sc. degree in Mechanical Engineering from Rajshahi University of Engineering & Technology (RUET, Bangladesh) and M.Sc. degree in Industrial & Production Engineering from Bangladesh University of Engineering and Technology (BUET, Dhaka-1000, Bangladesh), respectively. His research areas include Thermal Engg, Heat Transfer, Thermodynamics, Refrigeration & A/C, Optimization, Renewable Energy, POM, QC & QA. He has around 42 years of experience in the fields of teaching, research, consultancy and administrative duties.



Arif Md. Shahed Iqbal received his B.Sc. degree from IUBAT-International University of Business Agriculture and Technology, Dhaka-1230, Bangladesh. He has done his M.Sc. in Mechanical Engineering from Dhaka University of Engineering and Technology (DUET), Gazipur, Bangladesh.

His area of interest is thermo-fluid, renewable energy and energy management. He has more than 18 years of experience in teaching, research, consultancy and industry.



Mohammad Zoynal Abedin received his B.Sc. and M.Sc. Engg. in Mechanical Engineering from Bangladesh University of Engineering and Technology (BUET), Dhaka-1000, Bangladesh. He completed his Ph.D. from Nagoya Institute of Technology (NIT), Japan and later he also completed his

Postdoctoral Research from Yonsei University and Incheon National University of South Korea. His research areas include convective heat transfer, thermo-fluid mechanics and computational fluid dynamics, HVAC, Fire Safety and so on. He has more than 24 years of experience in the fields of teaching, research, consultancy and administrative duties.