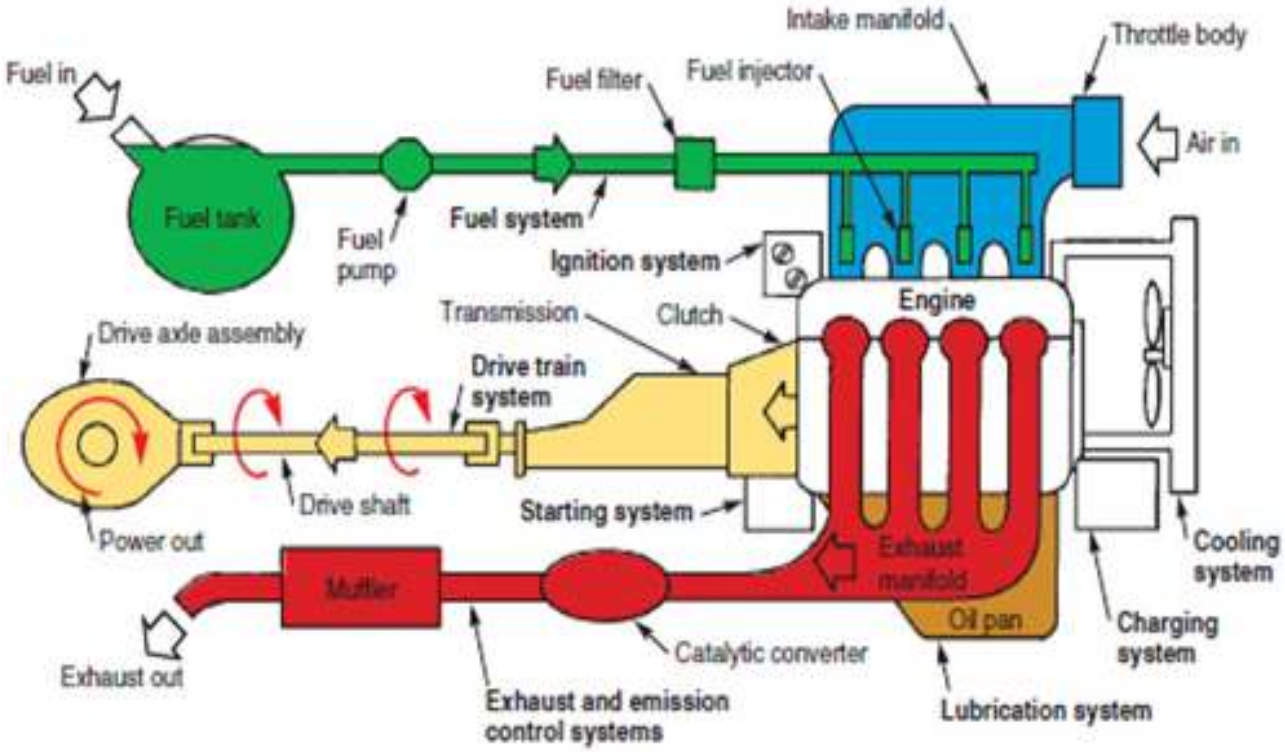
Automotive Body Repair and Paint Work

Level-II

Based on March 2022, Curriculum Version 1



Module Title: - Applying Automotive Systems Fundamentals

Module code: EIS BRP2 M03 0822

Nominal duration: 90Hour

Prepared by: Ministry of Labor and Skill

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Acronym

OS	Occupational Standard
LAP test	Learning Activity Performance test
RWD	Rear Wheel Drive
CV joints	Constant Velocity joint
ECU	Electronic Control unit
PSI	Pascal esquire inch
TSB	Technical service bulletins
LAP	Test Practical Demonstration

TABLE CONTENT

Introduction to the Module

This module describes the performance outcomes required to demonstrate basic knowledge and awareness of automotive terminology, terms and principles as they apply to vehicle systems, components and technologies found in automotive vehicles.

This module covers the units:

- System fundamentals
- operation of system or component
- Locate system or component on vehicle
- Apply system fundamentals

Learning Objective of the Module

- Identify system fundamentals
- **i**dentify operation of system or component
- Locate system or component on vehicle
- Apply system fundamentals

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the "LAP test" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Identifying Automotive system fundamentals

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Sources of information
- Overview of Automotive system fundamentals
- mechanical and electrical terminology and operating principles

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Suitable relevant sources of information mechanical fundamentals
- General automotive system fundamentals
- Mechanical/electrical terminology and operating principles of systems and components

1.1 Sources of information

In general there are three types of sources of information; primary, secondary and tertiary. It is important to understand these types and to know what type is appropriate for your coursework prior to searching for information.

1. **Primary sources**

They are the original documents of an event or discovery such as results of research, experiments or surveys, interviews, letters, diaries, legal documents, and scientific journals articles. Primary sources are also records of events as they are first described.

2. **Secondary sources**

Secondary sources are used to persuade the reader. Secondary sources may be considered less objectives .Example of secondary source include dictionaries, encyclopedias, textbooks, articles and editorials

3. **Tertiary sources**

Definition: tertiary sources consist of information which is a distillation and collection of primary and secondary source generally, tertiary sources are not considered to be acceptable material on which to base academic research.

Table 1.1 Difference between primary, secondary and tertiary sources of information

Primary sources	Secondary sources	Tertiary sources
• Autobiographies • Correspondence: email, letters • Descriptions of travel • Diaries, • Eyewitnesses • Oral histories • Literary works • Interviews • Personal narratives • First-hand newspaper and magazine accounts of events • Legal cases, treaties • Statistics, surveys, opinion polls, • scientific data, transcripts • Journal articles • Records of organizations and government agencies • Original works of literature, art or music • Cartoons, postcards, posters Map, paintings, photographs, films	• Biographies, Encyclopedias, dictionaries, handbooks • Textbooks & monographs on a topic • literary criticism & interpretation • history & historical criticism • political analyses • reviews of law and legislation • essays on morals and ethics • analyses of social policy • study and teaching material • Articles, such as literature reviews, • Commentaries, research articles in all subject disciplines • Criticism of works of literature, art and music	• Chronologies • Classifications • Dictionaries • Encyclopedias • Directories • Guidebooks and manuals • Population registers statistics • Fact books • Abstracts • Indexes • Bibliographies • Manuals/Guide books

1.1.1 Vehicle workshop manuals

As automobiles evolve, new systems and features are incorporated in the new models. Thus, it is becoming increasingly difficult for technicians to service the highly complex vehicles by relying on their experience alone.

In order to fulfill the customer satisfaction,service and parts personnel should have up-to-date product knowledge,technical information,skills in trouble diagnosis and repair techniques.

To over come this concern,manufacturersare publishing various types of manuals and catalogs to serve as reference materials.

figure 1 1 work shop service manual

1.1.2 Owner's manual

The main purpose of owner's the vehicle owner's manual is an instructional booklet that is specific to your vehicle. It includes important information to make you a better driver and car owner, including maintenance and troubleshooting advice.

Owner's Manual provides important information to ensure the proper operation of the vehicle.It is published for every model, given to the owner of the vehicle and reference for modelinformation and technical specifications. Normally the owner's manual includes the following information :

- **Setup Instructions**

While some cars still don't require any setup, many newer models have technological features that require some user input. The owner's manual can make this process easy. In order to take full advantage of your vehicle's available options, learn all of the setup instructions before driving your new car.

- Maintenance Schedule

Taking preventative care for your vehicle is money well spent. When you catch problems early on, they are cheaper and easier to fix. Your vehicle will last longer, have higher resale value and better performance.

In addition to saving money on repairs, a well-maintained car is also more efficient, saving you on fuel costs as well. Additionally, any warranty claims normally request a complete service record.

- **How to Check and Refill Fluids**

If you want to know where the windshield wiper fluid, coolant, or motor oil is located, save yourself time and trouble by checking the owner's manual first. You will also learn if it's better to check the fluid while it's hot or co

- **Oil Change**

Make sure you are filling up with the proper engine oil and gas by consulting your owner's manual. The "Engine Oil" section tells you how to check your oil level, what kind of oil and filter to use, and how long you can go between oil changes. Bookmark this page for easy referee

- **Gas Grade**

What kind of gasoline should you use for your vehicle? Check your owner's manual to learn the proper octane level. Premium or plus gasoline isn't automatically superior. Different types of engines are designed to run on different types of gasoline. Use the gas grade (octane rating) that is recommended in the "Fuel" section of your owner's manual.

- **Seat Positions and Head Restraints**

In order to provide the safest and most comfortable position in your car, check the owner's manual for how to adjust seat positions and head restraints. Adjusting the head restraints to the proper height will help cushion the head and spine in the case of an accident, reducing whiplash injuries and increasing effectiveness.

- **How to Change Tires**

Your vehicle owner's manual will tell you how to remove tire and operate a car jack. Since every car is different, you want to make sure you are lifting the car up at the proper location. Always reference your owner's manual for the correct location to place the car jack. We highly recommend consulting the owner's manual so you can make the ideal tire change.

- **Deal Tire Pressure**

Instead of using the tire pressure on the sidewall of your tire, consult your owner's manual for the proper tire PSI. The PSI printed on your tire is normally the maximum allowed pressure. Never inflate the tire over this number. If you overinflate your tires, you risk overheating, a blowout, or worse. Fuel efficiency. ALWAYS check the owner's manual for the proper PSI level for your tires.

- **How to find your owner's manual online**

Although vehicle owner's manuals normally stay put, occasionally they do get lost or misplaced. If you are missing your vehicle's owner's manual, you could find yourself in significant trouble. Luckily, there are ways (mostly free) to obtain your car's service manual if it has gone missing.

- **Find Your Vehicle's Year, Make, and Model (and/or VIN Number)**

When searching for your missing owner's manual online, you will normally need either the vehicle's YEAR/MAKE/MODEL information of the Vehicle Identification Number (VIN). The VIN can provide more accurate results depending on the manufacturer. For instance, the VIN can provide a more customized maintenance schedule based on your specific vehicle.

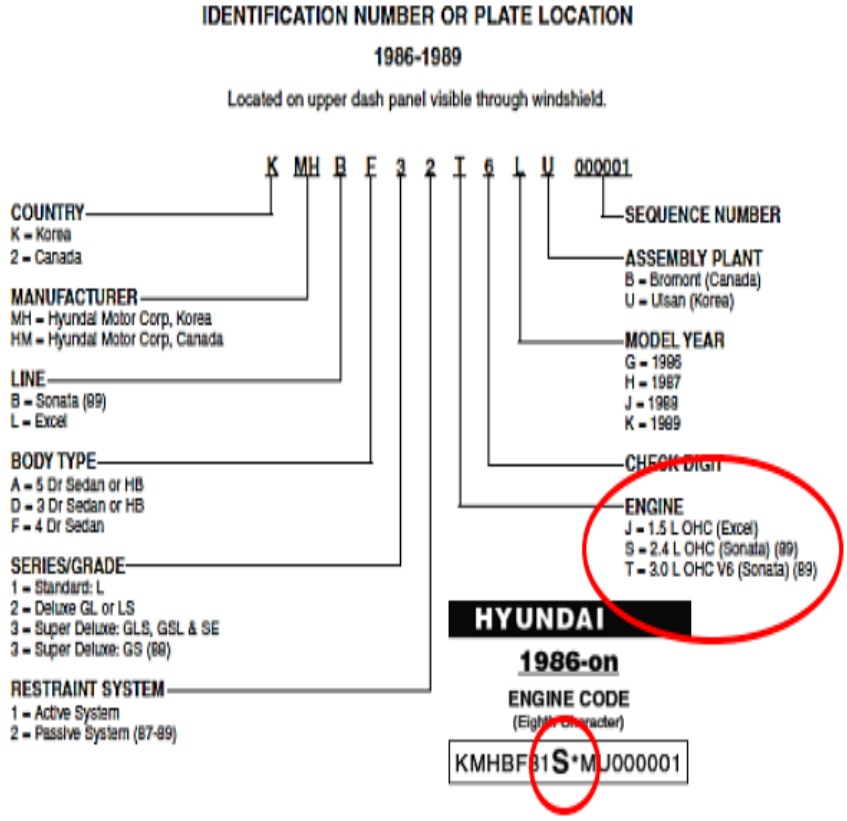


Figure 1 2 Sample of Vehicle Identification found in a vehicle service manual

1.1.3 Service bulletins

Definition. A Service Bulletin is the document used by manufacturers of aircraft, their engines or their components to communicate details of modifications which can be embodied in aircraft. A new National Highway Traffic Safety Administration database allows you to search your vehicle's make, model, and year to find **technical service bulletins**, or TSBs, that are created by the manufacturer and shared with dealers about how to repair recurring problems

Overview of Automotive system fundamentals

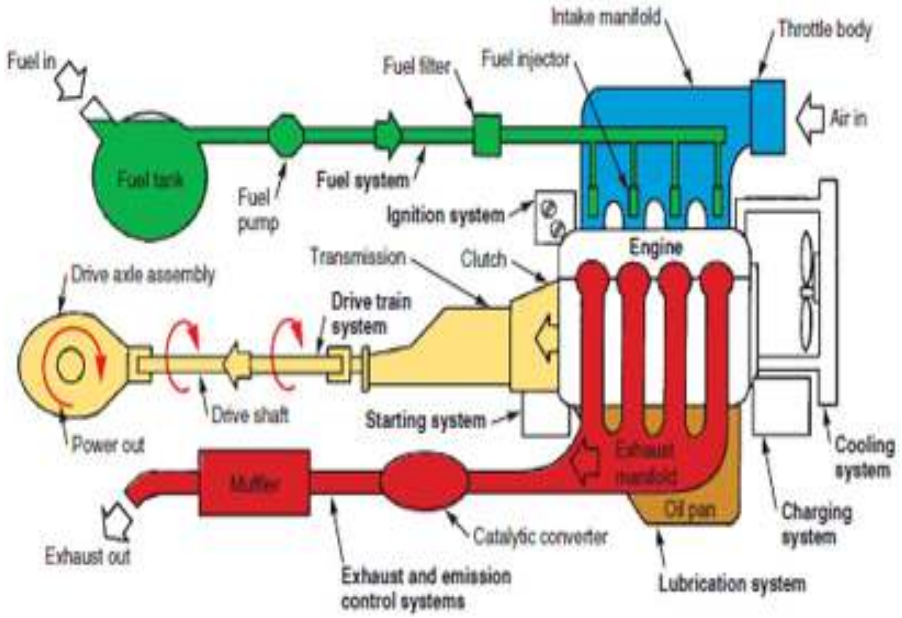


Figure 1 3 General of Automotive system

1.1.4 Engine system fundamental

A. Engine

The automobile's source of power is called "engine". The engine is made up of many components that combined together to perform its primary job efficiently

B. Air induction system

The whole purpose of the air induction system is to supply, filter, meter, and measure intake air flow into the engine. The air enters into the system through the special holes created in front of the car.

Air Induction System Components

a) Air Cleaner

The air cleaner actually contains an air filter which removes solid particles such as dust, pollen, and mold from air that enters the engine. Air enters the engine through the air intake

or air induction system.

figure 1 4 types of Air cleaner in engine

Air cleaners also perform the following functions.

- **It captures moisture and carbon soot** that are present in the atmospheric air.
- **It acts as a silencer** and **reduces the noise** caused by the intake air as the intake valves open and close. The task of reducing intake air noise in particular makes it necessary to use a large-volume air cleaner housing containing a filter of a suitable type with the largest possible total surface area and ample dust storage capacity (to increase the intervals between filter element renewal).
- **It acts as aflame arrestor** if the engine backfires through the air-intake systems. Backfiring causes a momentary flashback through the carburetor. Without air cleaner, the flame could erupt from the carburetor or air intake system and cause a fire in the engine compartment.

b) Intake Manifold

The primary function of the intake manifold is to evenly distribute the combustion mixture (or just air in a direct injection engine) to each intake port in the cylinder head(s). Even distribution is important to optimize the efficiency and performance of the engine. It may also serve as a mount for the carburetor, throttle body, fuel injectors and other components of the engine. The Intake manifold connects to the throttle body with the intake ports in the cylinder

C. Fuel system

Fuel Used and its Combustion Automobile engines get its power from the combustion of air fuel mixture. Combustion is defined as the burning of proper combination of fuel, oxygen and heat.

Automotive engines can be classified according to the fuel used

- **Gasoline fuel system**

Gasoline engines burn gasoline fuel. The mixture of gasoline and air is ignited inside the cylinder with the spark plug.

- **Diesel fuel system**

Diesel engines burn a light oil called diesel fuel. It does not use spark plug in combustion. The heat of compression is used in producing heat needed in combustion of diesel fuel and air

- **Electronic fuel injection(EFI) system**

EFI is a way of delivering fuel to the engine by electronically controlling injection directly into the intake manifold near the intake valve

- **Electronic gasoline fuel injection**

The fuel-injection system replaces the carburetor in most new vehicles to provide a more efficient fuel delivery system. Electronic sensors respond to varying engine speeds and driving conditions by changing the ratio of fuel to air. Electronic diesel fuel injection .

D. Cooling system

The engine cooling system keeps the engine maintains its normal operating temperature.

There are two types of cooling system

a. direct (air) cooling system
b. indirect(liquid) cooling system

Component Parts of the Indirect Cooling System

1. Radiator
2. Expansion Tank –
3. Radiator Hoses
4. Radiator Pressure Caps
5. Water Pump
6. Engine Fan and Electric Cooling Fan
7. Thermostat
8. Radiator Hose Clips
9. Fan Belt
10. Temperature Gauge
11. Water Jackets

E. Lubrication system

The lubricating system supplies lubricating oil to all moving parts in the engine. It also control of friction and wear by the introduction of a friction–reducing film between moving surfaces in contact

Types of Lubricating System

1. splash lubricant system
2. pressurized(pump) lubricant system

Function of Lubricants

- ✓ Minimize Friction
- ✓ Prevent Wear
- ✓ Act as a coolant
- ✓ Act as a Hydraulic Medium
- ✓ Prevent Corrosion
- ✓ Prevent formation of deposits
- ✓ Carry away contaminants

Component Parts of the Lubricating System

1. crankcase / oil pan
2. oil pump
3. oil filters
4. oil gallery
5. dipstick
6. oil pressure gauge
7. lub

F. Exhaust system

Function. The exhaust system collects the exhaust gases from the cylinders, removes harmful substances, reduces the level of noise and discharges the purified exhaust gases at a suitable point of the vehicle away from its occupants. The exhaust system can consist of one or two channels depending on the engine.

G. Starting system

Starting system is:- one of the engine`s system, which provides an engine start. To make it, the crankshaft must be turned at some speed, so the engine sucks air-fuel mixture and compresses it

H. Ignition system

Ignition system, in a gasoline engine, means employed for producing an electric spark to ignite the fuel–air mixture the burning of this mixture in the cylinders produces the motive force.

1.1.5 Electrical system fundamental

Electricity is the movement of electrons from atom to atom through a conductor. Electricity can flow only if there is a complete circuit from the battery through wires to components and back to the battery again.

A. Battery

The battery is the primary "source" of electrical energy on vehicles. It stores chemicals, not electricity. Two different types of lead in an acid mixture react to produce an electrical pressure. This electrochemical reaction changes chemical energy to electrical energy

Battery energy is used to operate the lighting & accessory systems

Battery energy is used to operate the starter motor and to provide current for the ignition system to during cranking. Battery energy may be needed when the vehicle's electrical load requirement exceeds the supply from the charging system.

B. Charging system

The charging system provides the electricity that powers the starter motor and runs electric accessories, such as lights, audio system, air conditioner, window defroster and other components. Its main parts are the battery, alternator and voltage regulator. If any parts of the charging system are worn, a vehicle will be hard to start or may not start at all.

1.1.6 Transmissions and drive trains systems

Power transmission has to take place between engine and driven wheels. The torque of the engine is transmitted via the function of any transmission is transferring engine power t the driveshaft and rear wheels (or axle half shafts and front wheels in a front-wheel-drive vehicle). Gears inside the transmission change the vehicle's drive-wheel speed and torque in relation to engine speed and torque.

1.1.7 Under chassis system fundamental

A. Steering system

The steering system converts the rotation of the steering wheel into a swiveling movement of the road wheels in such a way that the steering-wheel rim turns a long way to move the road wheels a short way. The system allows a driver to use only light forces to steer a heavy car.

B. Suspension system

Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems must support both road holding/handling and ride quality, which are at odds with each other.

C. Brake system

A brake system is designed to slow and halt the motion of vehicle. To do this, various components within the brake system must convert vehicle's moving energy into heat. This is done by using friction. Friction is the resistance to movement exerted by two objects on each other. Braking system means the components required to stop a motor vehicle including the braking pedal, master cylinder, connecting

Mechanical and electrical terminology and operating principles

1.1.8 Automobile fundamentals

Theterm“**auto**”means **seIf** and“**mobiIe**“means **moving**.Automobile is a common type of self moving locomotive used to carry passengers and

On the history of aut

figure 1 5 1886 by Benz first gasoline automobile three wheel car

the remarkable vehicles shown in Fig. 1-5 to1-9 becomes the bench mark in the early development stage of productionand manufacturing of automobiles.

figure 1 6 1894 by Benz first gasoline automobile four wheel car

Features and functions

Automobile is designed as a transport

Machine with the the following functions:

(a) Consistsofon-board energy source andengine

(b) Driven on roads by way of rubber tires

(c) Can carry people and cargo

(d) Can be driven by a person

figure 1 7

a) Consists of on – board energy

Source and engine

A vehicle driven by internal combustion Engine and analternate electricmotors. RefertoFig.1.8

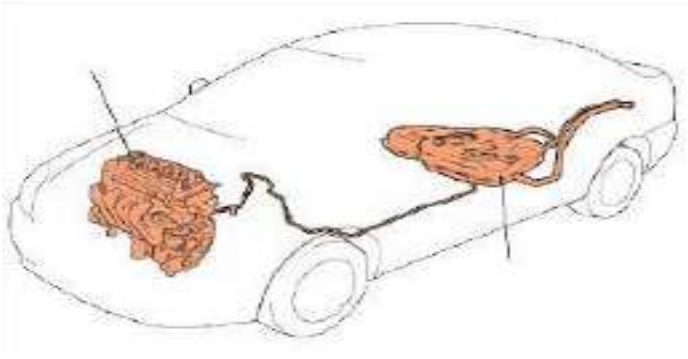
Engine runs by using different types of fuels As follows:

1) Gasoline

2) Diesel

3)LPG-Liquefied Petroleum Gas

4)CNG-Compressed Natural Gas



A vehicle driven by electric motor powered By series of automotive batteries.

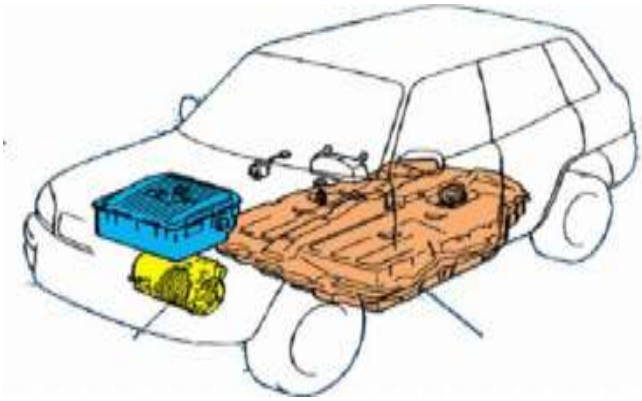


figure 1 8 The first developed electric Motors driven

b) Drive on road by way of rubber tires

figure 1 9 vehicle driven by electric motor powered

Move the vehicle through friction resistance on the road surface.

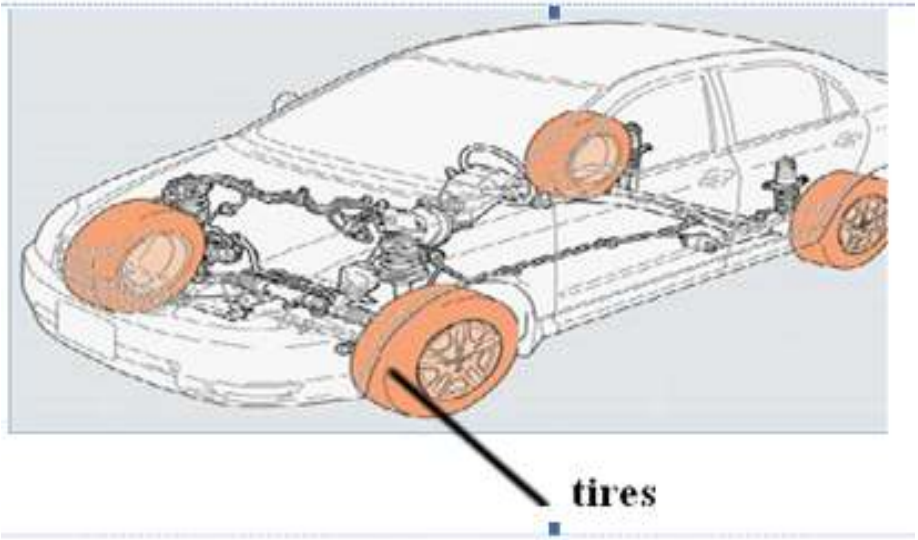


figure 1 10 rubber tires

figure 1 11 light cargo

figure 1 12 heavy cargo

c) Can be driven by a person

Automobile is a kind of machine that can bedriven by a person. Automobile is designed with three (3) major operations to provide a remarkable driving performance.Its major function is to **Run**, Various vehicle models are designed and manufactured to satisfy the increasing demandsof customers in terms of driving performance, comfort, safety and fuel efficiency.

1.1.9 Classification of modern automobile's

Automobiles are commonly classified according to the following design and configurations

A. Source of energy

The following are the common classification of vehicles according to the source of power generations and operations:

B. Battery

A vehicle driven by electric motors powered by series of automotive batteries.

The first developed electric caris the Baker producedin 1902.

C. Engine construction

A. Rotary engine

A compact and lightweight engine that generally converts the pressure generated in a space inside of oval like shaped housing and triangular rotor to a rotating motion.

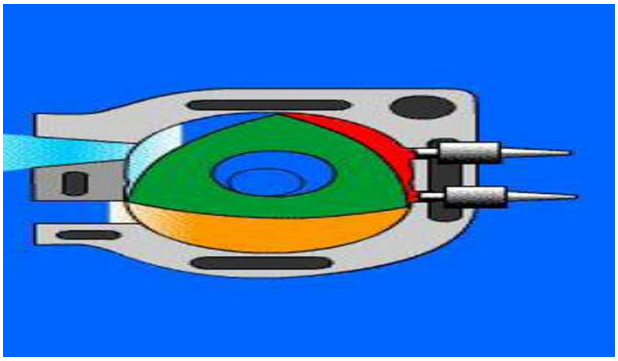


figure 1 13Rotary engine

D. **Turbo charge engine**

An engine with a turbocharger, a forced Induction compressor operated by turbine impeller that is driven by engines exhausts Gas. Turbocharger increases the amount of air that enters to the engine to produce more power.

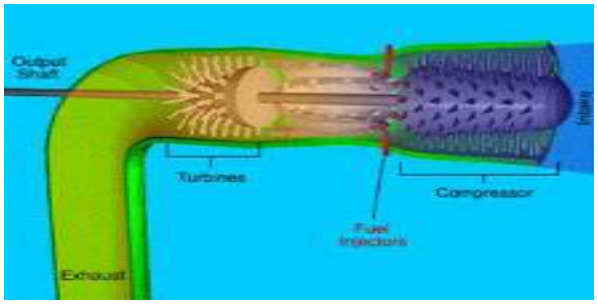


figure 1 14 Turbo charge engine

E. Engine mounting position

The following are classifications of vehicles according to engine mounting and drive train components positions:

(A) Front engine, Front wheel drive (FF)

FF vehicle has no propeller shaft that pro vides spacious interiors and comfortable ride.

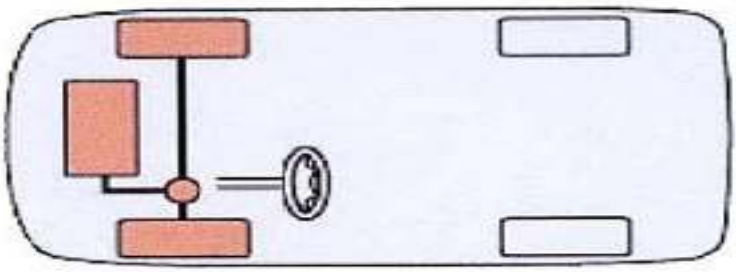


figure 1 15 Front engine, Front wheel drive

(B) Front engine, Rear wheel drive (FR)

FR vehicle is well balanced that provides the best control and driving stability.

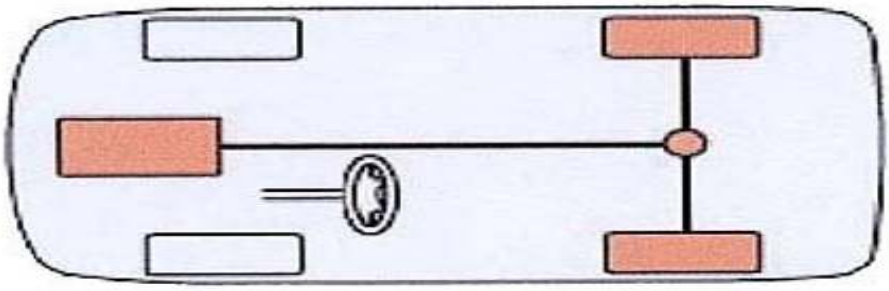


figure 1 16 Front engine, Rear wheel drive

(C) Rear engine, Rear wheel drive (RR)

RR vehicle has an engine mounted at the rear that drives the rear wheels.

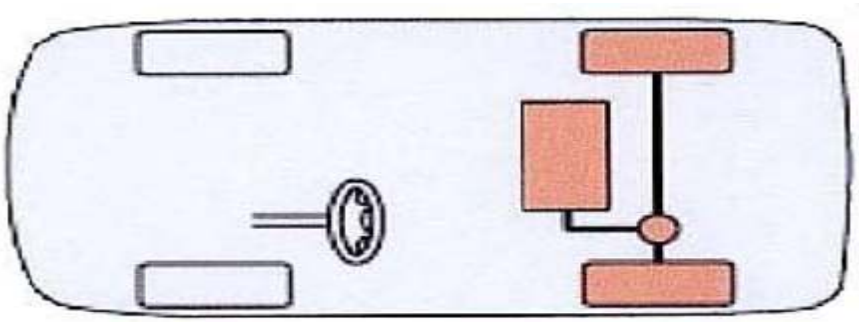


figure 1 17 Rear engine, Rear wheel drive

(D) Mishap engine, Rear wheel drive (MR)

MR vehicle has an engine mounted on the middle that allows good weight distribution on the front and rear axles that makes it easy to control.

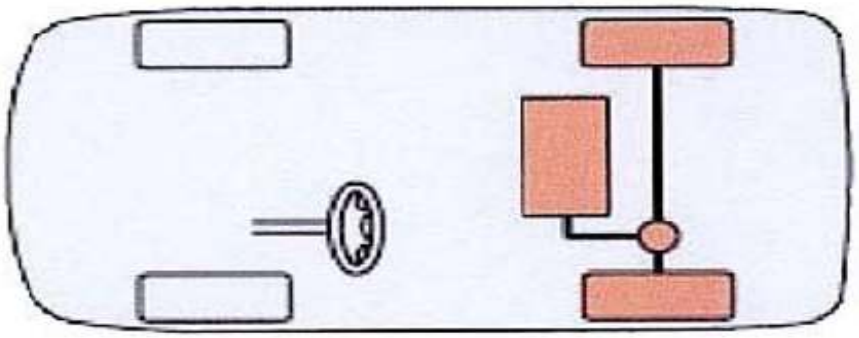


figure 1 18 Mishap engine, Rear wheel drive

F. Application

The following are the classifications of vehicles according to its applications.

(A) Passenger vehicle

Designed to mainly transport small number of passengers and carry light luggage's.

figure 1 19 Passenger vehicle

(B) Commercial vehicle

Designed for commercial purposes to carry cargo or transport group of passengers.

figure 1 20 Commercial vehicle

(C) Bus

Designed to transport group of passengers and carry their luggage's.

figure 1 21 Bus

D) Truck

Designed to carry heavy and large cargos.

figure 1 22 Truck

E) SpeciaI purpose vehicIe

Designed and manufactured for its special purpose and particular applications.

figure 1 23 Special purpose vehicle Truck

G. Body style and shape

The body is the part of vehicle that carries people or luggage. The following are the common types of body styles.

(A) Sedan

Most common passenger car which is designed for the comfort of driver and passenger with rows of seats in the front and back.

figure 1 24 Sedan

B) Coupe

Sporty look with 2 seats for the driver and passenger that emphasizes style and performance the roof is smaller and height of the vehicle is lower.

figure 1 25 Coupes

(C) Hatchback or Lift back

Similar to coupe in which the passenger and luggage areas are open to one another.

Rear door and window can be lifted up or opened like hatch of a ship.

figure 1 26 Hatchback or Lift back

(D) Hardtop

to Sedan without window frames (no door sash) and center pillars. Refer

figure 1 27 Hardtop

The back and front windows open up as one that offers wide or good views. The style with center pillars without sash is called the “pillared hardtop”.

(E) Convertible

Passenger sedan or coupe that can be driven with its roof in up or down condition.

figure 1 28 Convertible

(F) Pickup

Compact truck with engine compartment extends in front of the driver’s seat.

figure 1 29 Pickup

(G) Wagon and van

It has integrated passengers and luggage's space. Wagon mainly carries group of passengers. Mainly carries light luggage's.

figure 1 30 Wagon and van

(H) Limousine

Long passenger vehicle with a partition between the driver and passenger cabins to provide privacy on the occupants of the rear seats.

figure 1 31 Limousine

H. Space

The following are the classifications of engine, passenger and luggage spaces:

(A) 3 box type

It has separate partition space for engine, passengers and luggage's.

Refer to Fig. 1-52

a. Engine space
b. Passengers space
c. Luggage space

figure 1 32 Space

B) 2 box type

Compact vehicle with integrated space for passengers and luggage's. It has a separate engine Space.

figure 1 33 box type

1. Engine space
2. Passengers and luggage’s space
3. Passengers and luggage’s space

C) 1 box type

It has integrated space for engine, passengers, luggage’s and cargos. Commonly used for commercial purposes in transporting group of passengers, luggage's and cargos.

figure 1 34 box type

a. Engine space

b. Passengers and luggage's space

c. Passengers and luggage's space

I. Body construction

The following are the commonly types of vehicle body constructions:

J. Frame body

Constructed with separate body and frame. Engine, transmission and suspension are **Mounted in the frame**.

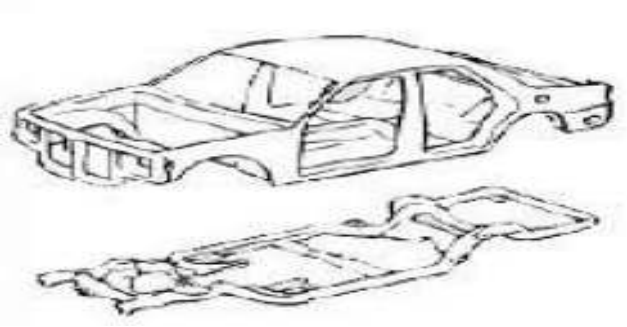


figure 1 35 Body construction

Monocoque ../../../prince fuaz/Desktop/A.A.M.SAND F/2018 Audi A8 Body Structure - Engineering Wonder (Excellence)%5bvia torchbrowser.com%5d.mp4**body**

Constructed with integrated body and frame. Body and frame are joined together to form a strong single unit box.

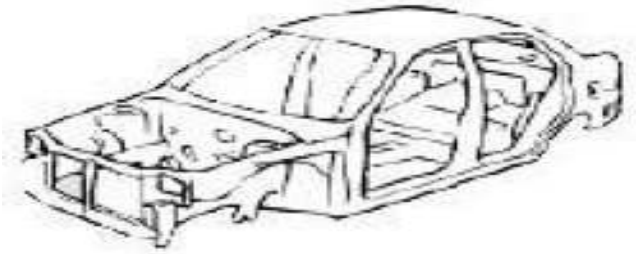


figure 1 36 Monocoque body

K. Number of doors

The following are the classifications of vehicles according to the number of doors:

(A) 2 door
Vehicle with driver and passenger doors

(B) 4 door Vehicle with driver, front and rear passengers' doors.

figure 1 37 Number of doors

1.1.10 Basic function of an automobile

A driver shall be able to control the vehicle to "**RUN", "TURN",** and **"STOP"** according to the required driving situations.

The following are the major drive ability funcions of vehicles:

1) Enable the vehicle to run

The engine power allows the vehicle to run. The drive train transmits the power from the engine to the driving wheels. The drive train system consists of **clutch, transmission, propeller shaft, differential, axle shaft or drive shaft.**

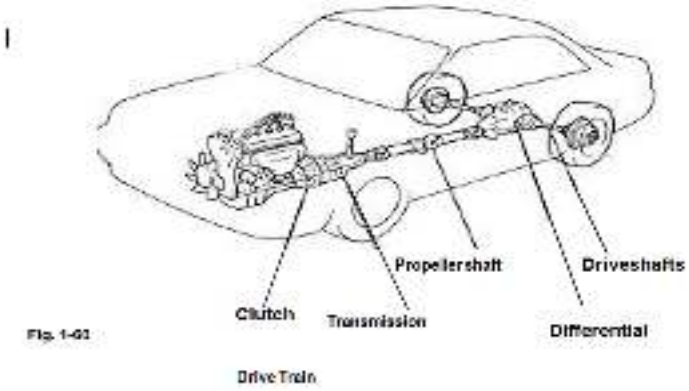


figure 1 38 transmits the power from the engine to the driving wheels

(2) Enable the vehicle to turn

The tire is mounted on the axle by means of the disc wheel. The axle is mounted to the body through the suspension system and supported by springs and other parts to absorb the bouncing effect due to the unevenness of the road surface.

(a) Steering system

Mechanism that enables the vehicle to turn. It has steering wheel that controls by the driver and devices that transmits this movement to the tires in order to change the direction of the Vehicle.

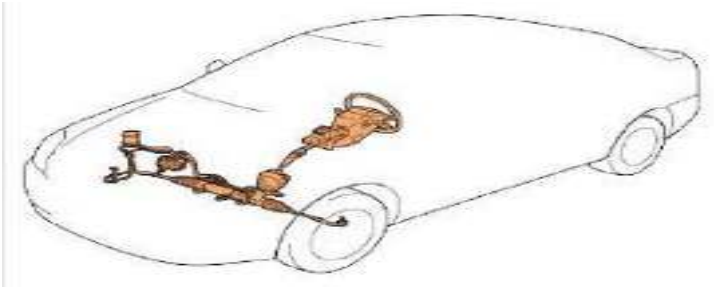


figure 1 39 Steering system

(b) Suspension system

Undercarriage mechanism that supports the body to provide a comfortable ride

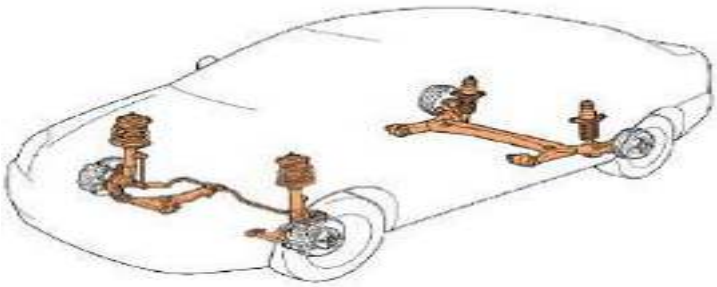


figure 1 40 Suspension system

(3) Enable the vehicle to stop

Brake system enables the vehicle to stop and slowdown. Braking force takes place when the driver applies pressure and continuous application to the brakes will enable the vehicle to stop.

The following are the methods of stopping the rotational movement of the tires :

(a) Foot brakes

Foot brakes are used to control the speed and stop the vehicle. Generally, disc brakes are used in the front wheels and disc or drum brakes are used in the rear wheels.

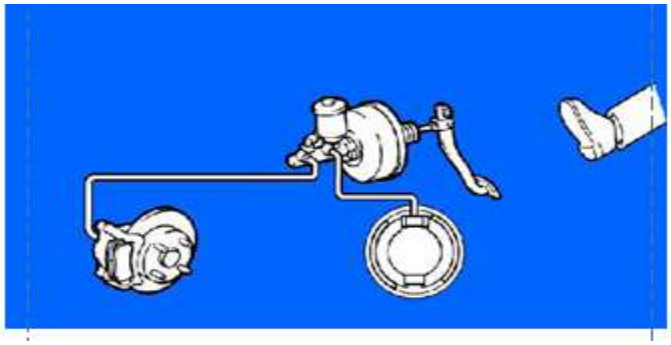


figure 1 41 Foot brakes

(b) Parking brakes

Parking brakes or handbrakes are mainly used when the car is parked. The mechanical brake system locks the rear wheels.

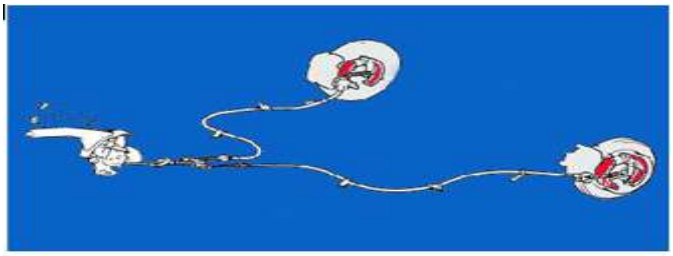


figure 1 42 Parking brakes

(c) Engine brake

Engine brake used the retarding effect of engine when the vehicle is in gear and throttle valve is closed.

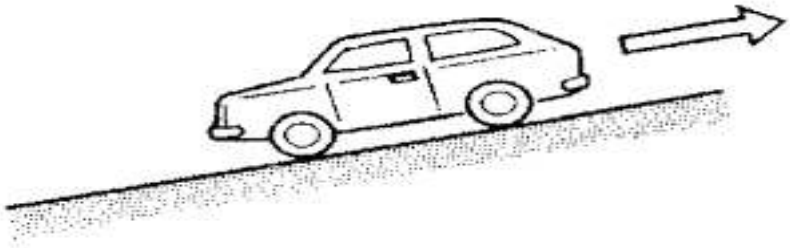


figure 1 43 Engine brake

1.1.11 Automobile safety and comfort

An automobile must provide the following various functions in order to be driven safely and Comfortably.

- The driver must be able to control the vehicle according to his needs.
- The driver needs devices to inform other drivers of his intentions.
- Devices that make driving at night, in fog, Rain or Snow possible.
- Safety design and devices that prevent injury in a collision.

- Air cooling and heating conditioners.
- Comfortable ride and quiet operation.

The following are the components of vehicle that provides comfort and safety:

1) Seats

It supports the driver and passengers' body to maintain a comfortable ride.

Parts of vehicle seat

1. Head rest
2. Seat back
3. Lumbar supports
4 .Seat cushion

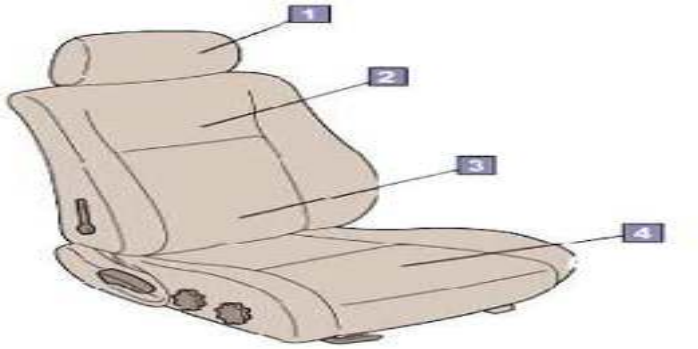


figure 1 44 vehicle Seats

2) Seat belts

When the brakes are suddenly applied or when collision occurs, the body of passengers' moves forward with strong inertial force. Seat belts secured the body of driver and passengers to their seats to prevent from colliding to steering wheel, front windshield or being thrown out of the vehicle. The two types of seat belts are **2 point type** that supports only the hips and **3 point type** that supports both the hips and chest area.

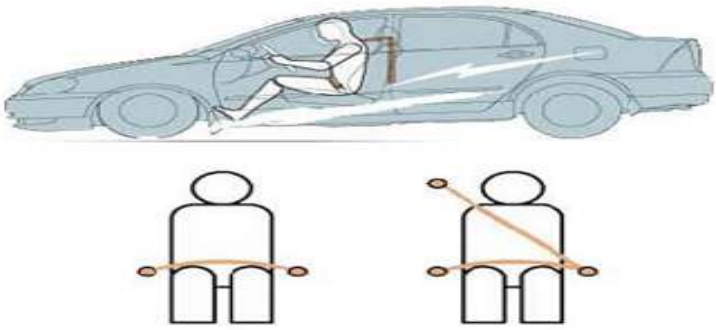


figure 1 45 vehicle Seat belts

3) Door Locks

Door locks prevent the doors to open easily by vibration or impact. It prevents people from opening the vehicle without permission of the owner. It can protect luggage and valuable personal belongings inside and trunk of the vehicle. The following are the conditions of the door locking mechanism:

A/ Door is open

B /Door is partly opened

C/ Door is closed

4) Air conditioner

Air conditioner system regulates humidity and temperature inside the cabin of vehicle. a dehumidifier, controls heating and cooling conditions. Removes obstructions of frost, ice and condensation from the interior surfaces of the windows.

1.1.12 Economy/vehicle durability

1) Fuel economy

Represents the volume of fuel that engine consumes when the vehicle travels a given distance. The two methods of calculating the fuel consumption rate:

(a) Volume of fuel consumed (used) while traveling a given distance (L/100km).

L/100km = fuel (L) / distance (100km)

(b) Distance traveled while consuming a given volume of fuel (km/L).

Km/L = distance (km) / fuel (L)

2) Vehicle durability

A condition of the vehicle free from rust, corrosion, wear and exhaustion. Paint is a film that is applied to the body surfaces. Its primary purpose is to enhance the appearance of the body and protects the vehicle from rust, sunrays dust and rain.

3) Serviceability and reparability

The serviceability and reparability are index which shows degree of easiness to service or repair the vehicle. In case the vehicle has good serviceability and repair ability, it means that the total labor cost will be less.

1) Self check 1

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction I say true or false

1. _____A brake system is designed to slow and halt the motion of vehicle.

2. _____A cooling system works by sending a liquid coolant through passages in the engine block and heads.

Instruction II: choose the correct Answer Questions

1._____ provides the electricity that powers the starter motor and runs electrical accessories. (2pts)

1.7 Charging system B. Starting system C. ignition system D ALL

2._____ in a gasoline engine, means employed for producing an electric spark to ignite the fuel(3pts)

A. Ignition system B. Charging system C. Starting system D ALL

3_____ system is designed to slow and halt the motion of vehicle. (3pts)
A. .brake system B. steering system C. suspension system D. ALL

Instruction III: Give a short answer

1. Write at list four engine systems? (3)

2) Unit Two: Identify operation of system or component

This unit to provide you the necessary information regarding the following content coverage and topics:

- component or system
- potential unsafe conditions or safety hazards

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- To Identify component or system
- To Identify potential unsafe conditions or safety hazards

2.1 Identify component or system

2.1.1 Definition of an engine

An Engine is a mechanical device used to convert heat energy into mechanical energy. And is usually called a Heat Engine.

Basically there are two types of heat engines: ***External combustion*** and ***internal combustion (IC)* engines.**

a) External combustion engine is an engine in which combustion (burning of a fire) is taking place outside of the engine. *E.g. Steam engine*

b) *Internal combustion* *(IC) engine* is an engine in which combustion is taking place within the engine itself. *e.g. Gasoline engine*

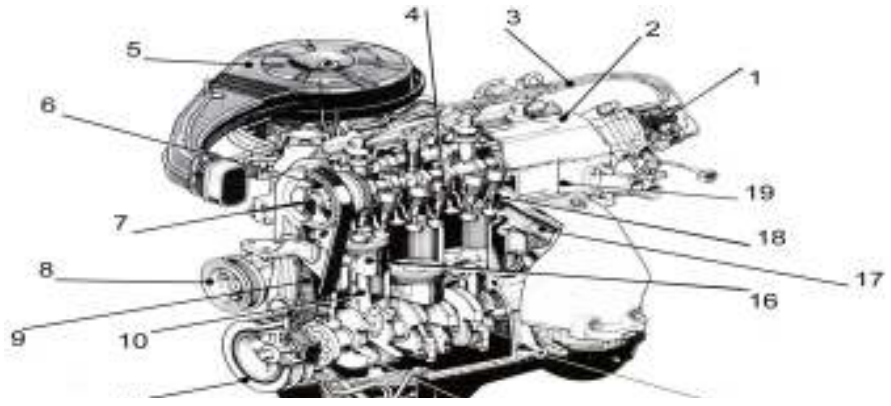


figure 2 1 Engine component parts

Engine component parts

1 - Distributor
2 - Valve cover
3 - High tension cables
4 - Tappet
Figure
5 - Air cleaner
6 - Timing pulley
7 - Camshaft
8 - Water pump
19 - Cylinder head
9 - Timing belt
10 - Connecting rod
11 – Crankshaft pulley
12 - Oil sump
13 - Strainer
14 - Crankshaft
15 - Engine block 16 – piston
17 - exhaust manifold
18 – Valve

2.1.2 Main Parts of an engine

Cylinder Block. It is considered the foundation block of the engine. It has bores for the pistons, passages for the water to cool the cylinder, galleries for the lubrication system, and tunnels for push rods if these are used to operate the rocker arms.

Cylinder blocks

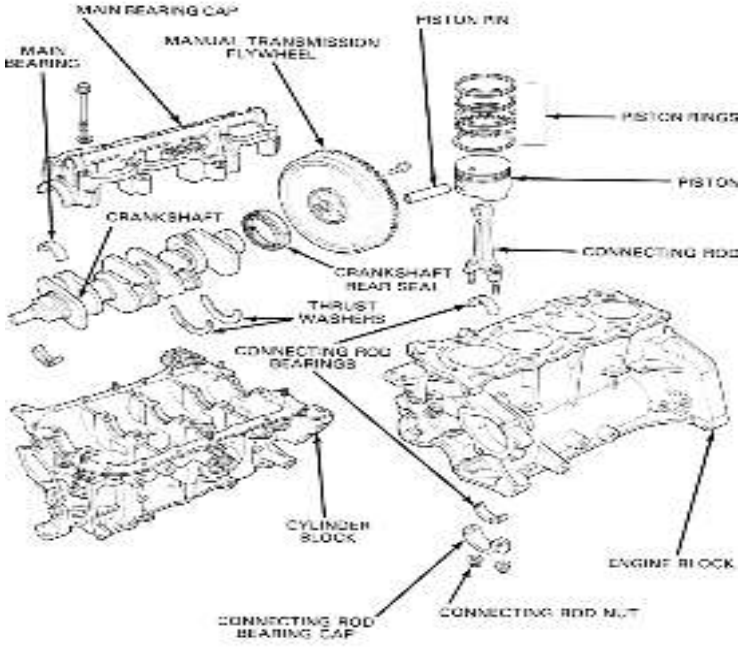


figure 2 2 Component parts of cylinder

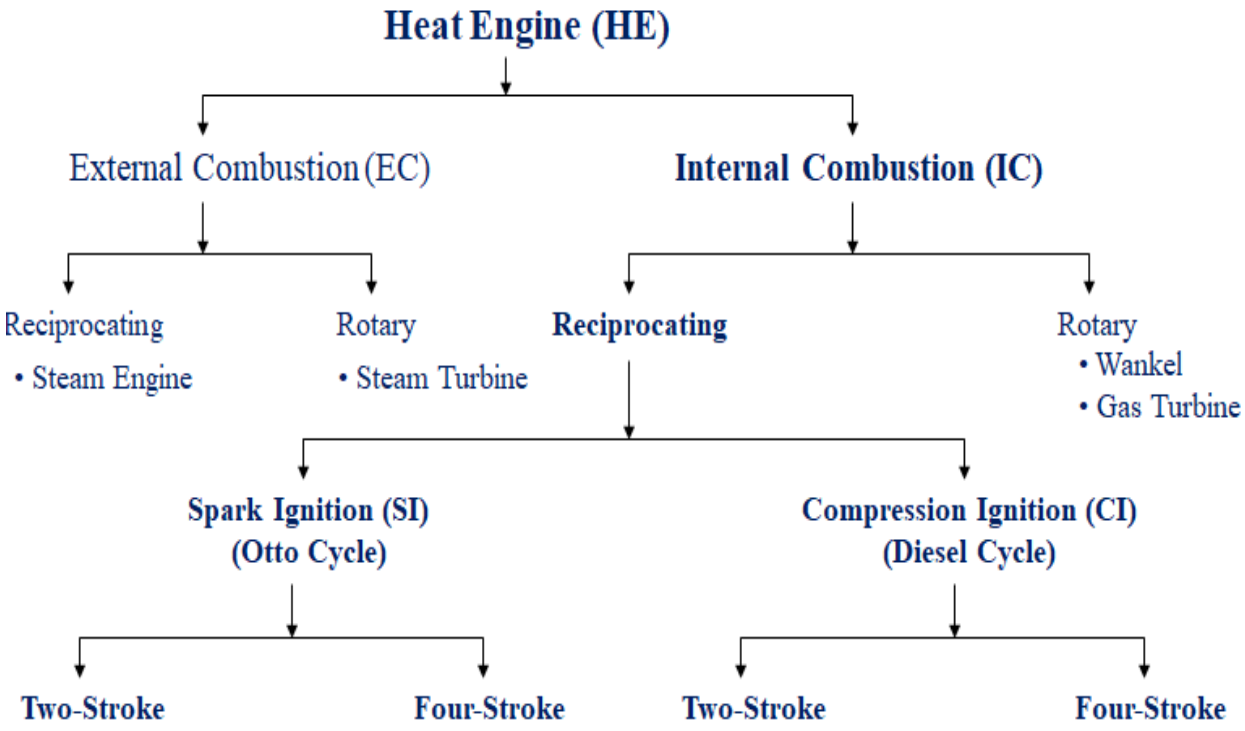
***Crankcase (Oil Pan)*. It is consider as the storage of oil in the engine.**

Oil pump

oil sump

figure e 2 3Crankcase (Oil Pan

A **Heat Engine (HE)** is a **work developing** machine which converts **Thermal (Heat) Energy** into **Mechanical Energy (Work or Power)**.



Note: In this course, only '**Reciprocating**' type '**IC Engines (SI 'Otto' and CI 'Diesel')**' will be discussed ! 2

Basic Concepts in IC Engines

Main Parts of a Motor Vehicle (Automobile)

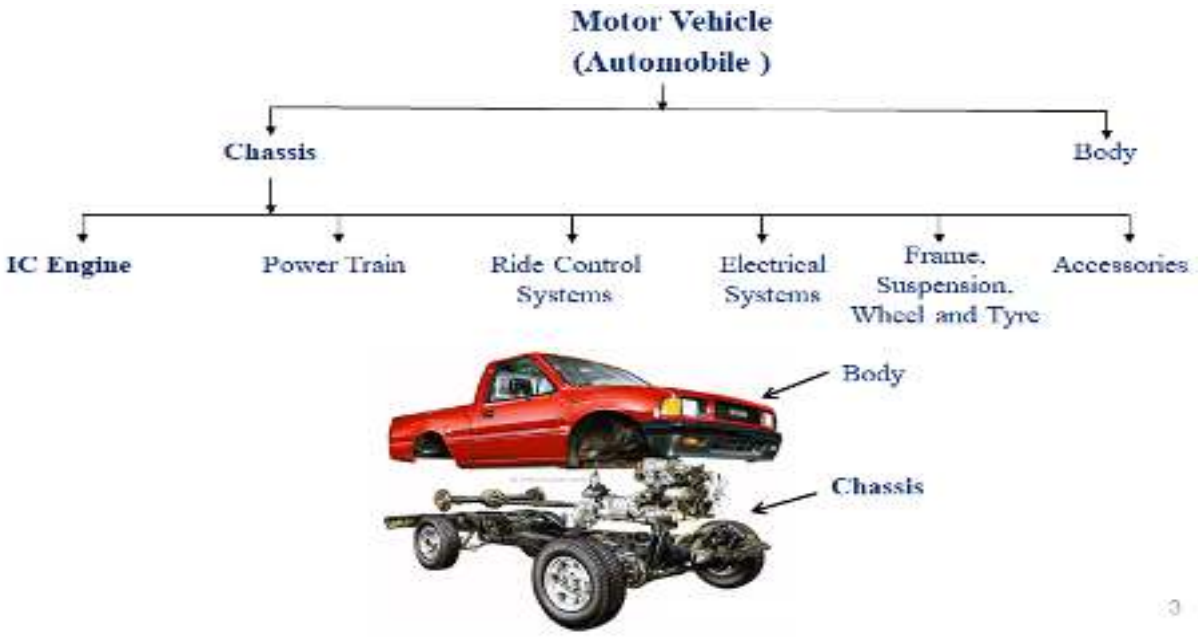
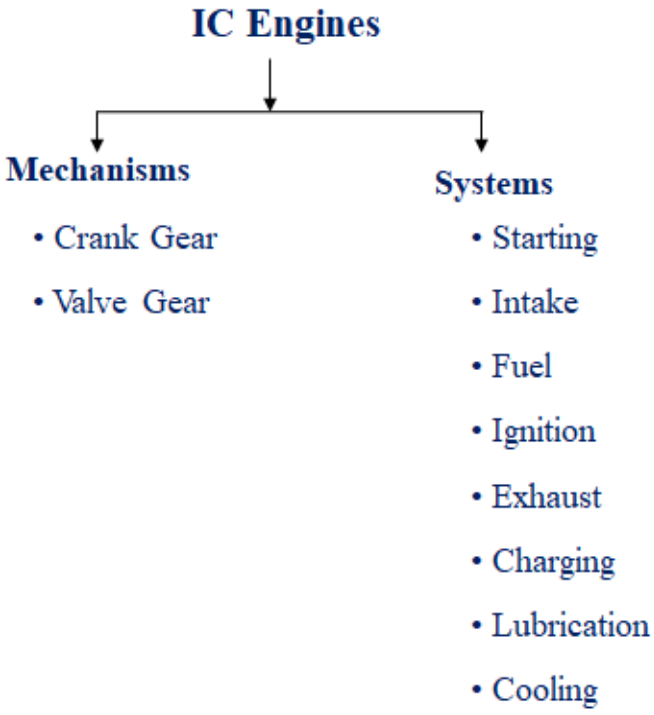
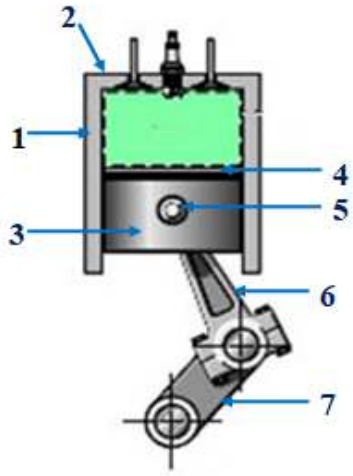


figure 2 4 chassis and Body

Main Components of IC Engines

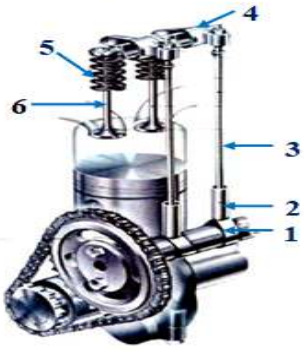


Main component parts (elements) of the **Crank Gear Mechanism (CGM)**



1. Cylinder
2. Cylinder Head
3. Piston
4. Piston Rings
5. Piston Pin
6. Connecting Rod
7. Crankshaft

Main components parts (elements) of the **Valve Gear Mechanism (VGM)**



1. Camshaft (Cam)
2. Follower
3. Push Rod
4. Rocker Arm
5. Valve Spring
6. Valve

Valve Timing Diagram

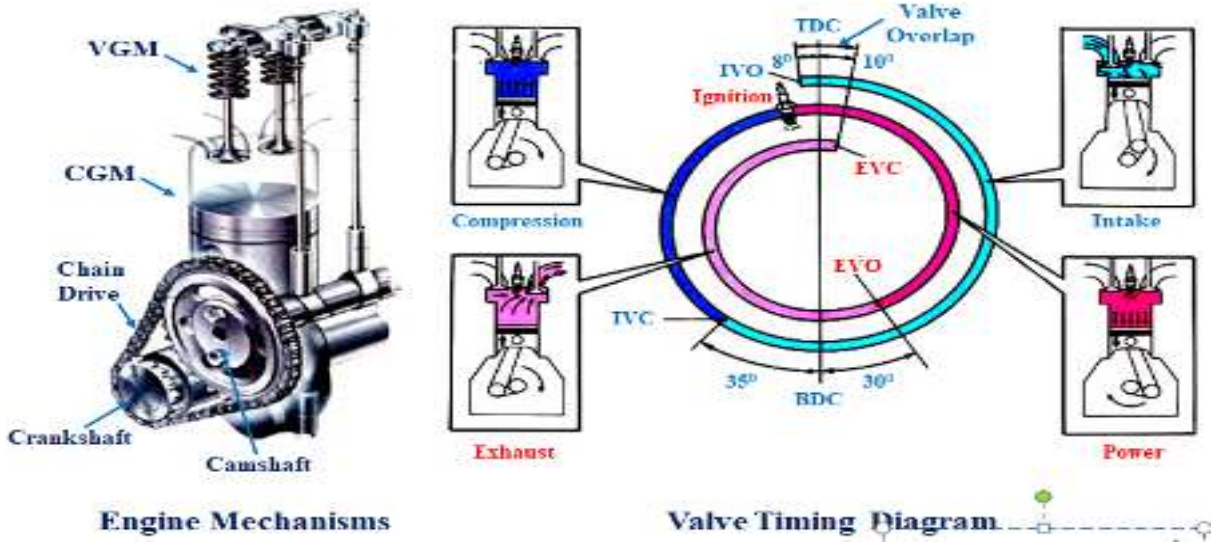


figure 2 5 engine mechanism and valve Timing

Cylinder Numbering and Direction of Crankshaft Rotation

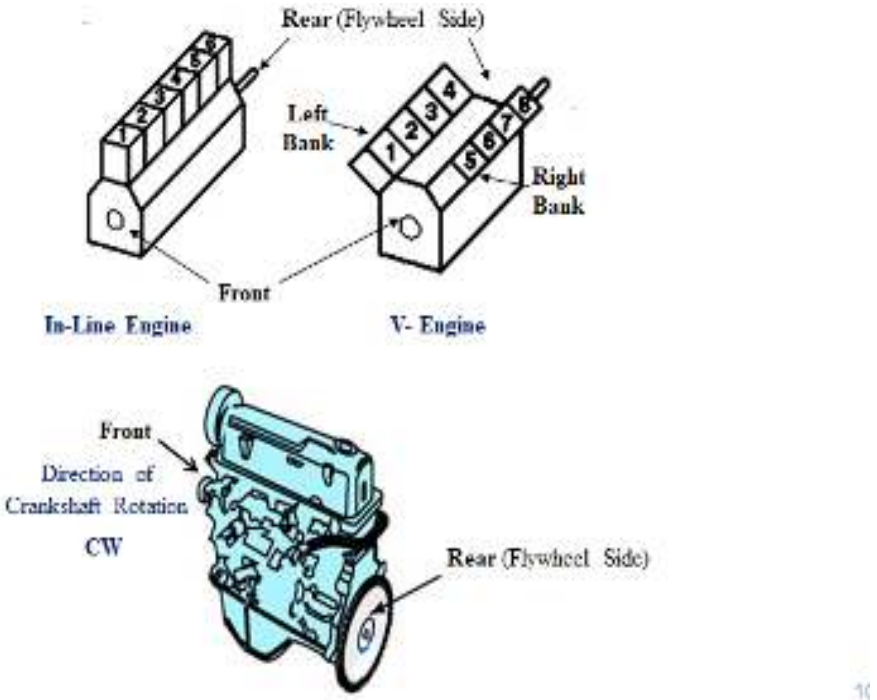
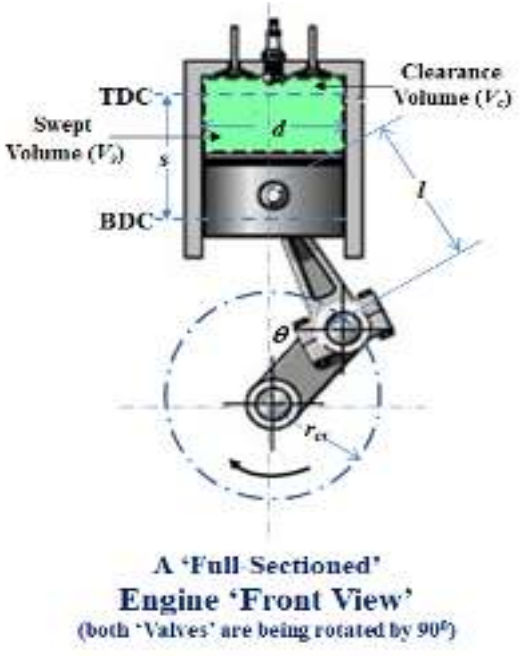


figure 2 6 Cylinder Numbering and Direction of Crankshaft Rotation

2.1.3 IC Engine Terminologies

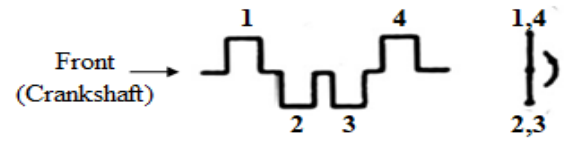


Engine Terminologies

TDC = Top Dead Center
BDC = Bottom Dead Center
Stroke (s)
Bore (d)
Clearance Volume (V_c) or Combustion Chamber
Swept Volume (V_s) = $\frac{\pi d^2}{4} \times s$
Cylinder Volume (V) = $V_c + V_s$
Compression ratio (r) = $\frac{V}{V_c} = 1 + \frac{V_s}{V_c}$
Con-Rod length (l)
Crank radius (r_{cr}) = $\frac{s}{2}$
Crank angle (θ)

Figure 2.6 IC Engine Terminologies

Firing Order (FO) and Firing Interval (FI)



Firing Order (FO) → 1 – 3 – 4 – 2

Firing Interval (FI) = $\frac{720^0}{4} = 180^0$

Firing Order	Strokes			
1	P	E	I	C
3	C	P	E	I
4	I	C	P	E
2	E	I	C	P

0⁰ 180⁰ 360⁰ 540⁰ 720⁰

Firing Order (FO) and Firing Interval (FI) of a Four-Stroke, Four-Cylinder, In-Line Engine.

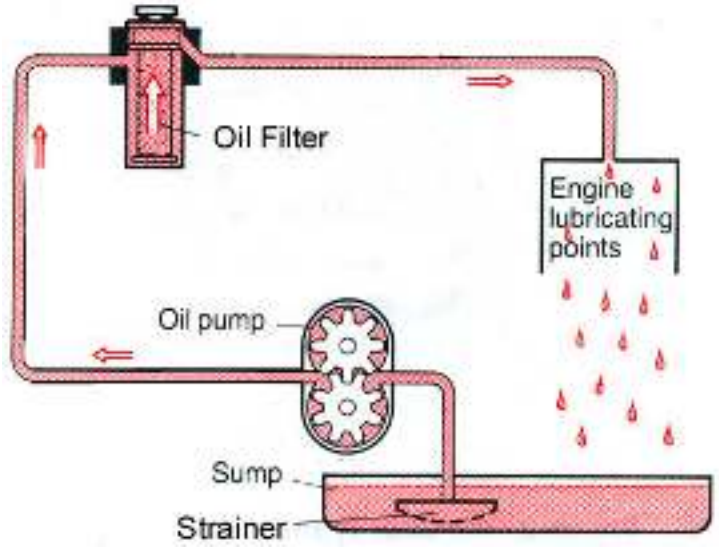
figure 2 7 Firing Order

Table 2.1 Comparison of IC Engine

Stroke	SI Engine	CI Engine
Intake	• The piston moves from TDC to BDC and a partial vacuum of ≈ 0.1 to 0.4 bar will be created. • Intake valve is opened and a combustible 'air-fuel' mixture is drawn into the engine cylinder.	• The piston moves from TDC to BDC and a partial vacuum of ≈ 0.1 to 0.3 bar will be created. • Intake valve is opened, and a clean 'air' is drawn into the engine cylinder.
Compression	• Both valves are closed. • The piston moves from BDC to TDC and the 'air-fuel' mixture is compressed into the clearance volume (combustion chamber). • At the end of compression stroke, the cylinder pressure may reach ≈ 12 to 16 bar and the temperature may reach ≈ 300 to 600⁰C.	• Both valves are closed. • The piston moves from BDC to TDC and 'air' alone is compressed into the clearance volume (combustion chamber). • At the end of compression stroke, the cylinder pressure may reach ≈ 18 to 40 bar or more and the temperature may reach ≈ 500 to 900⁰C.
Power	• Both valves remain closed and ignition is initiated by an electric spark and combustion and expansion is taking place. • A maximum combustion temperature of about 2000 to 2500⁰C and a maximum cylinder pressure of about 25 to 50 bar can be attained.	• Both valves remain closed and ignition is initiated as a highly pressurized and atomized fuel is injected onto a very hot air (without an eclectic spark). • A maximum combustion temperature of about 2500 to 3000⁰C and a maximum cylinder pressure of about 40 to 80 bar or more can be attained.
Exhaust	• At the end of power stroke, the cylinder pressure drops down to about 3 to 5 bar and the 'exhaust valve' starts to open. • Due to the pressure difference within and outside of the cylinder, the burned gases rush out of the engine cylinder and is called 'blow down' process. • The remaining gases then pushed out of the engine cylinder as the piston starts to move from BDC towards TDC and is called 'displacement' process.	• At the end of power stroke, the cylinder pressure drops down to about 3 to 4 bar and the 'exhaust valve' starts to open. • Due to the pressure difference within and outside of the cylinder, the burned gases rush out of the engine cylinder and is called 'blow down' process. • The remaining gases then pushed out of the engine cylinder as the piston starts to move from BDC towards TDC and is called 'displacement' process.

2.1.4 The main system and component of automotive

ENGINE MAIN SYSTEMS



LUBRICATION SYSTEM

Oil sump

Strainer & Oil pump

Filter & lines (gallery)

Points of Lubrication

COOLING SYSTEM

Radiator

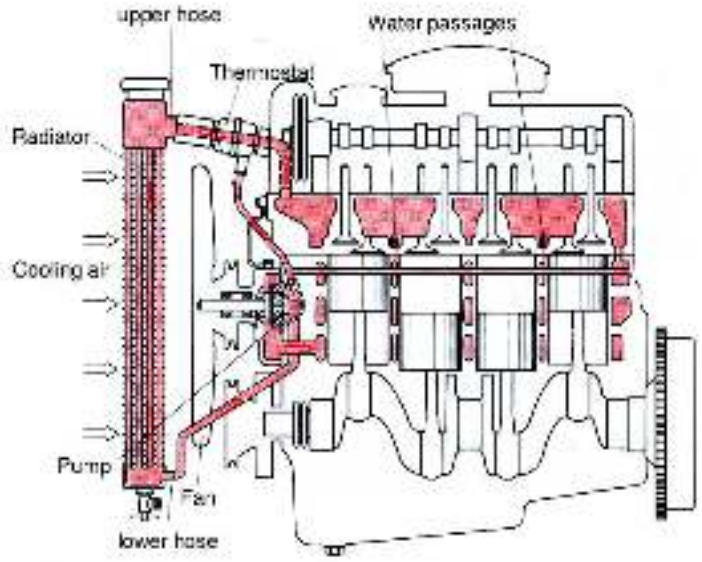
Lower hose

Water pump & Fan

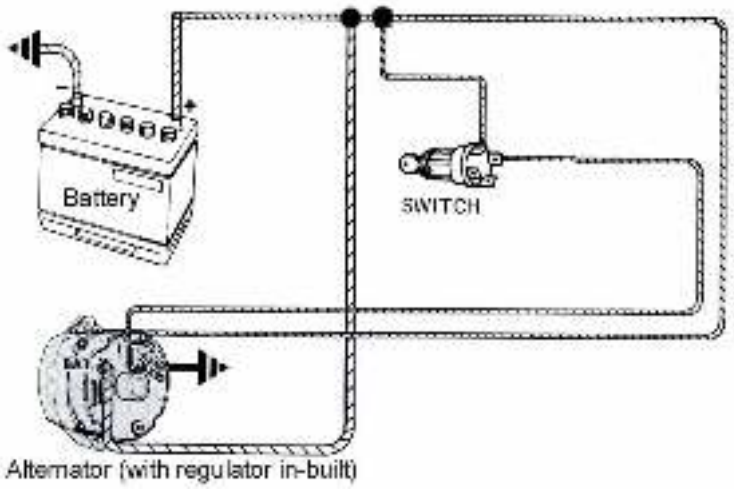
Water jacket

Thermostat

Upper hose



Cooling circuit with pump



CHARGING SYSTEM

Battery

Switch

Alternator

(Generator)

Regulator

IGNITION SYSTEM

(Gasoline engines only!)

Battery

Switch

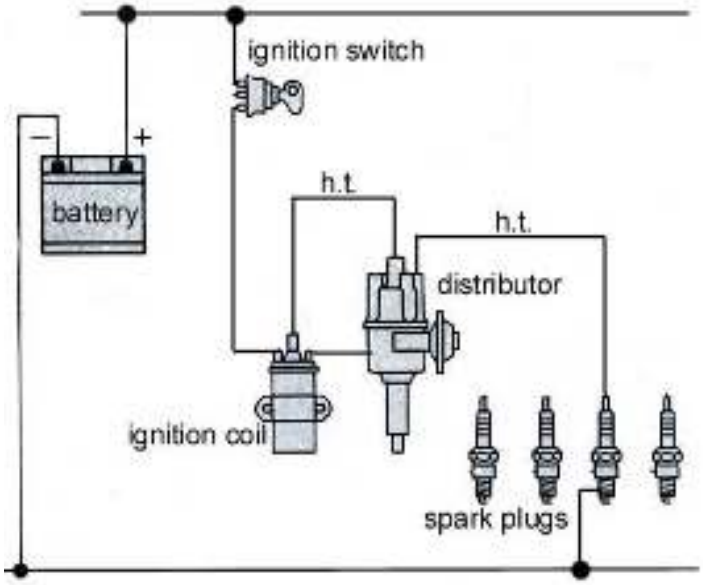
Ignition coil

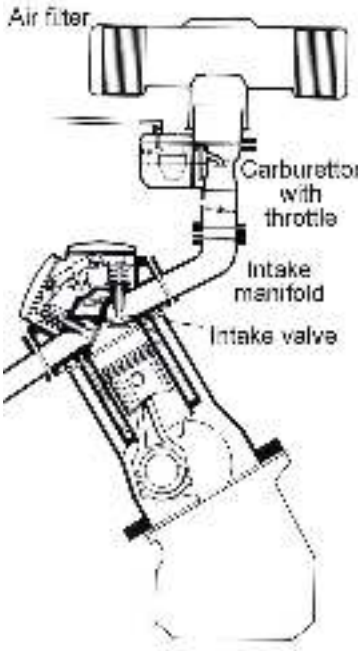
Ht. cable

Distributor

High tension cable &

Spark plug



	INTAKE SYSTEM Air cleaner (Filter) Carburettor *(Diesel: no carburettor!)* Intake manifold Intake valve

2.1.5 Exhaust *system*

Exhaust system: - The exhaust system collects exhaust gases from the engine & expels them out. It consists of: -

- Exhaust valve
- Exhaust port
- Turbo charger
- Muffler
- tail pipe

- **Exhaust manifold:-**The exhaust manifold collects exhaust gases from the exhaust of various cylinders & conducts them from each and to a central exhaust passage
- **Turbo Charger: -** Is an exhaust gas driven turbine which drives a centrifugal compressor wheel
- **Muffler: -**reduces the noise of the exhaust gases by reading the pressure of the used gases by low expansion & cooling. The muffler must not cause any appreciable restriction to the flow of oil that could raise back pressure excessively

figur 2 8 Exhaust manifold

EXHAUST SYSTEM

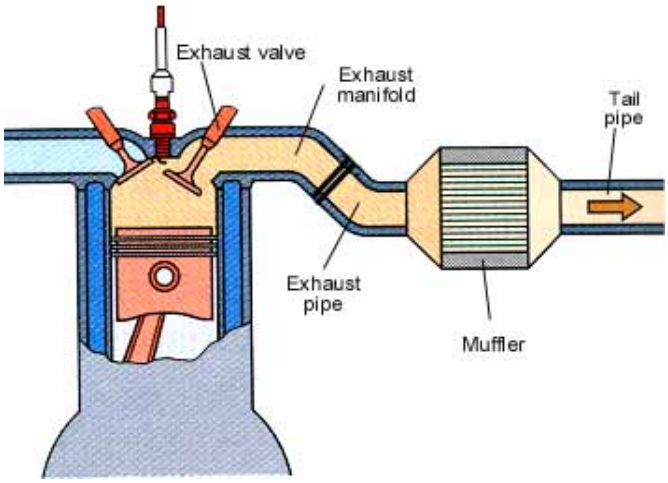
Exhaust valve

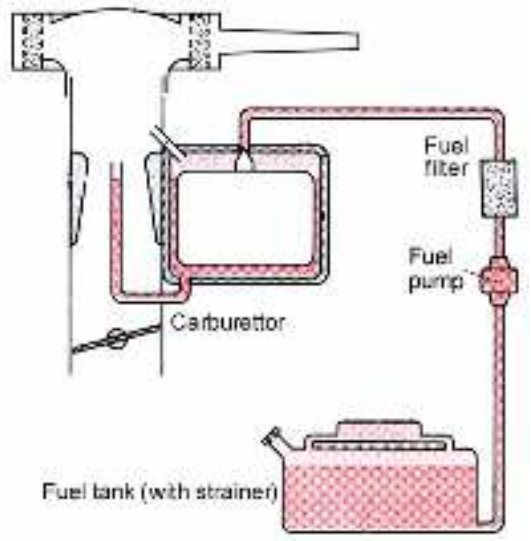
Exhaust manifold

Exhaust pipe

Muffler

Tail pipe





FUEL SYSTEM

(Gasoline Engine)

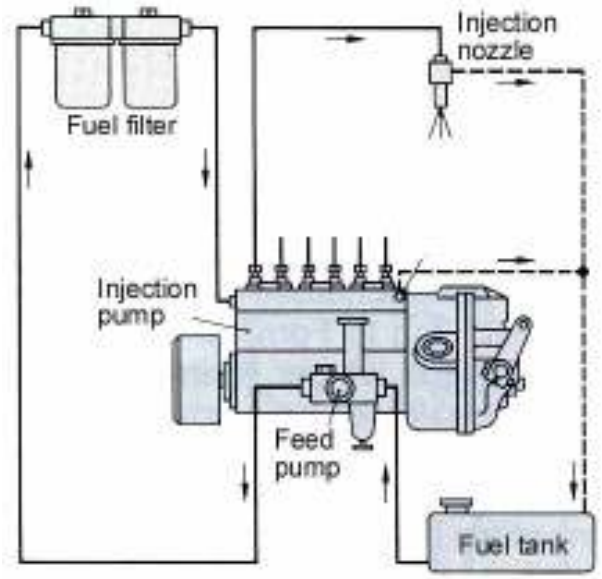
Tank & strainer

Line

Fuel pump

Filter

Carburettor



FUEL SYSTEM

(Diesel Engine)

Tank & strainer

Line

Feed pump

Filter(s)

Injection pump

Lines & nozzles

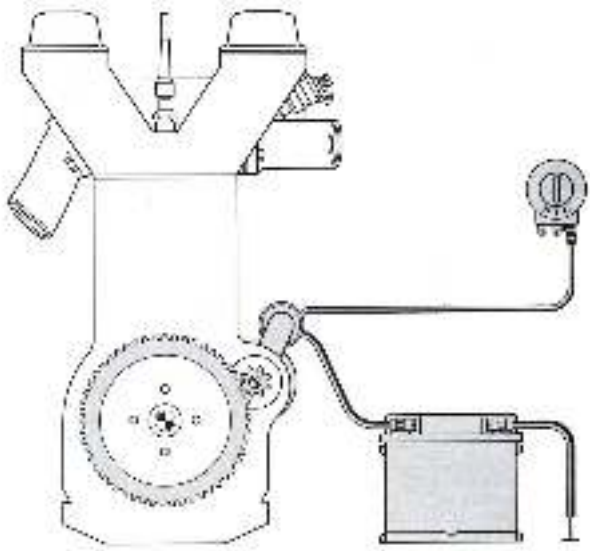
STARTING SYSTEM

Battery

Switch

Starter motor

Ring gear at flywheel



2.1 The Drive train and the Transmission

The drivetrain and the transmission are actually two very different concepts. The main function of the transmission is similar to the chain on a bicycle: it keeps the engine turning in time with the wheels, regardless of what gear the vehicle is in. The drivetrain represents everything that is behind the transmission involved in propelling the vehicle. The main function of the drivetrain is

basically to convey power from the vehicle's engine, through the transmission to the drive wheels on the vehicle to control the amount of torque. "Torque" is turning or twisting force.

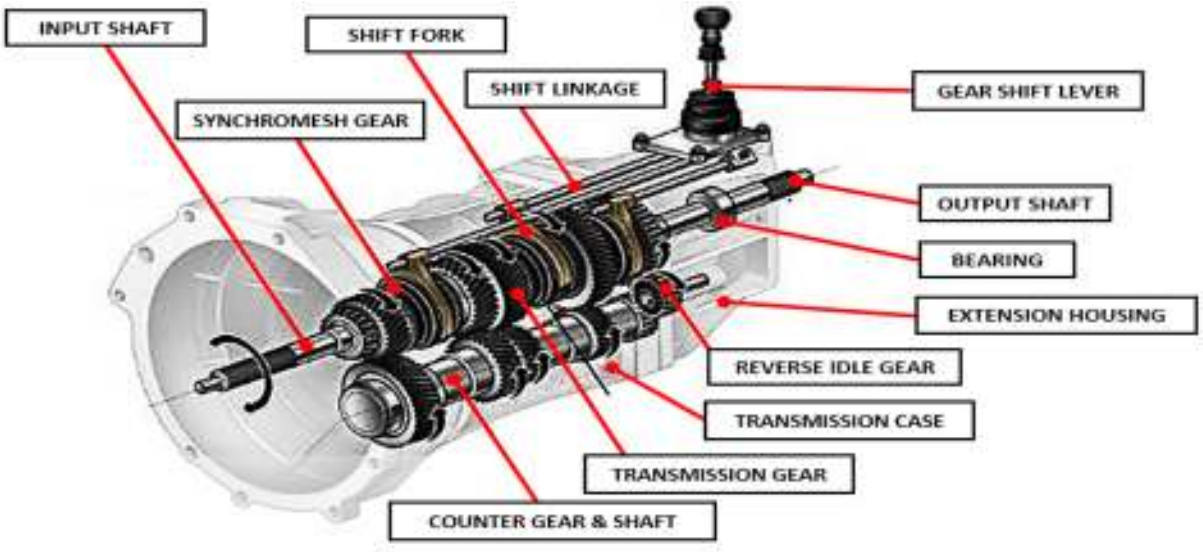


figure 2 9 Transmission

2.1.1 Parts of a Drivetrain

The drivetrain is comprised of a collection of components in a vehicle that transfer power from the transmission to the wheels/ drive it forward. These components include the driveshaft, CV joints, the differential, the axle shafts and the U-joints.

- A driveshaft is a long tube of steel that is linked to a car's transmission at one end and the wheels at the other. It transfers **the**mechanical power from the transmission to the other components of the vehicle.
- A U-joint, or universal joint, is a flexible pivot point that transmits power allowing for varying angles of the driveshaft.
- CV joints, or constant-velocity joints, are part of the driveshaft. These joints are designed to be able to bend in any direction while continuing to turn the drive wheels at a constant velocity.
- The differential is where the power makes its last stop before spinning the wheels (see 'How Differentials Work').
- Axle shafts are a single rotating shaft, on either side of the differential, which delivers power from the final drive assembly to the drive wheels.

a) Driveline, Drivetrain, Powertrain

Technicians sometimes refer to driveline, drivetrain and powertrain interchangeably when referring to the drivetrain system of an automobile. This can cause confusion, but in essence, all of these terms describe the same system within the vehicle.

The powertrain in a vehicle is composed of everything that makes the vehicle move. This includes everything from the engine to the transmission to all the parts that allow the power from the engine to get to the wheels. A vehicle's driveline consists of all of the powertrain's components except for the engine. The drivetrain is the part of a motorized vehicle which connects the engine and transmission to the wheel axles.

The driveline includes everything in the chain from the engine to the drive wheels, but the drivetrain consists of everything after the transmission all drive shafts, axles, joints, differentials and wheels. Mister Transmission technicians are all certified drivetrain and transmission specialists who service drivetrain and transmission issues in all modern vehicles.

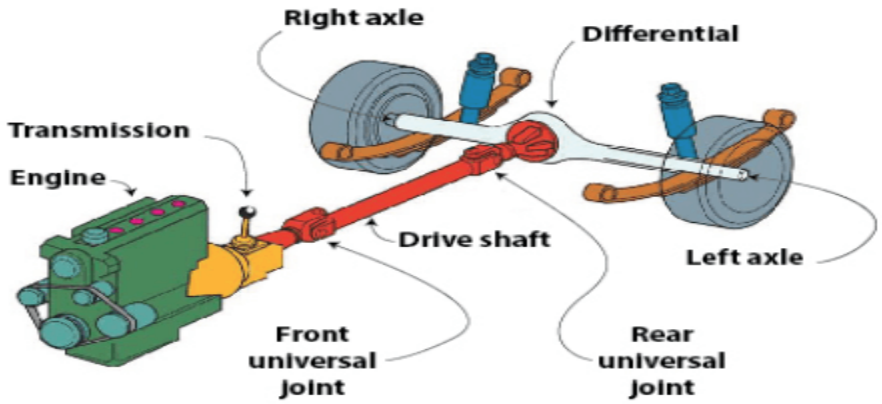


figure 2 10 Drive train

b) Steering System

In front wheels can be turned to left and right by steering system so that the vehicle can be steered. The steering wheel is placed in front of driver. It is mechanically linked to the wheels to provide the steering control. The primary function of the steering system is to provide angular motion to front wheels so that vehicle can negotiate a turn. It also provides directional stability to vehicle when the vehicle moves ahead in straight line. Now-a-days, many vehicles are equipped with power steering which uses pressure of a fluid to reduce steering effort. When

driver turns the steering wheel, a hydraulic mechanism comes into play to provide most of the effort needed to turn the wheel.

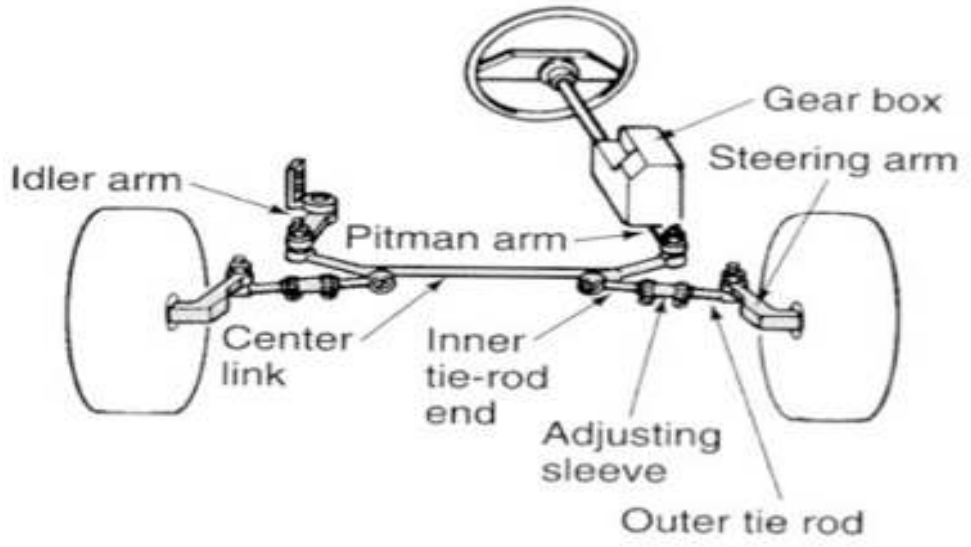


figure 2 11 Steering System

Function of steering system

- Conterol of front steering wheel (some time rear wheel) direction.
- Transmit road feel (slight steering wheel pull caused by the road surface) to the driver's hand
- Maintain correct amount of effort needed to turn the wheel
- Absorb most of the shock going to the steering wheel as the tire hits holes and bumps in the road
- Allow for suspension action

c) Suspension System

Suspension system of an automobile separates the wheel and axle assembly of the automobile from its body. Main function of the suspension system is to isolate the body of the vehicle from shocks and vibrations generated due to irregularities on the surface of roads. Shock absorbers are provided in the vehicles for this purpose. It is in the form of spring and damper. The suspension system is provided both on front end and rear end of the vehicle.

A suspension system also maintains the stability of the vehicle in pitching or rolling when vehicle is in motion.It supports the body on the axles and maintains the proper geometrical relationship between the body and wheels.

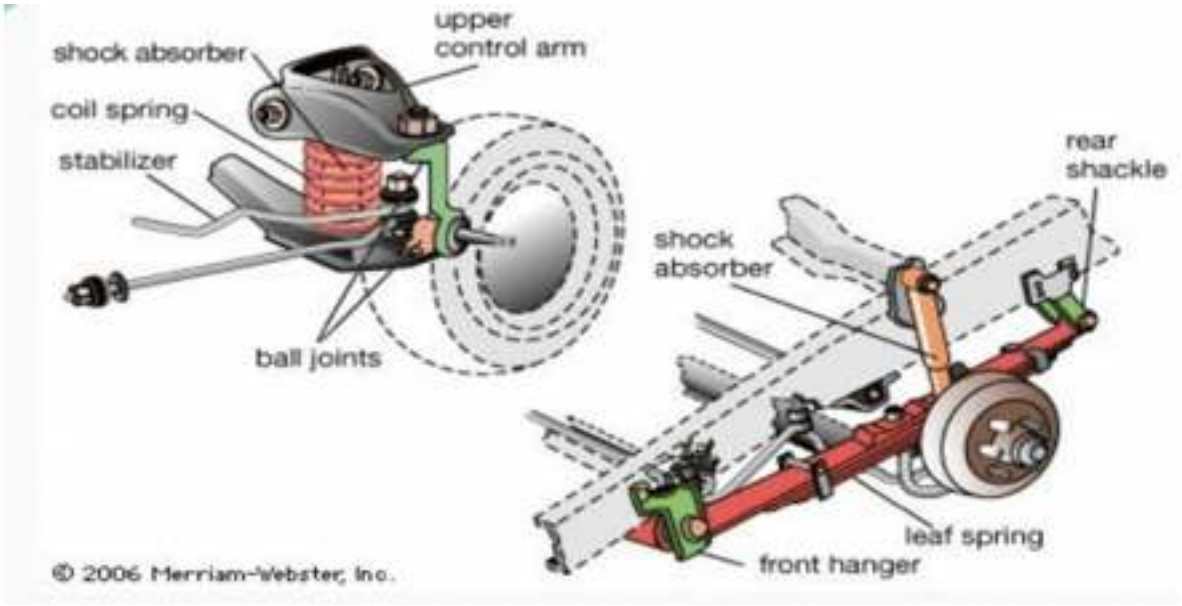


figure 2 12 Suspension System

a) Brake system

Brakes are used to slow down or stop the vehicle. Hydraulic brakes are generally used in automobiles, where brakes are applied by pressure on a fluid. Mechanical brakes are also used in some vehicles. These brakes are operated by means of leavers, linkages, pedals, cams, etc. Hand brake or parking brake is known usually mechanical brake. These are used for parking the vehicles on sloppy surfaces and also in case of emergency.

Brake Pedal:-When the brake pedal is depressed, force is applied to the master cylinder.The force that the pushrod applies to the master cylinder piston is, therefore, much greater than the force applied to the brake pedal.

Master Cylinder Reservoir: The reservoir may be cast as one piece with the cylinder body, or it may be a separate molded nylon or plastic container.

Hydraulic Tubes And Hoses

Steel tubing and flexible synthetic rubber hosing serve as the arteries and veins of the hydraulic brake system. These brake lines transmit brake fluid pressure(the blood) from the master cylinder (the heart) to the wheel cylinders and calipers (the muscles and working parts) of the drum and disc brakes.

hydraulic brake system with a booster unit located between the brake pedal and the master cylinder to help activate the brakes

Master cylinder (Structure and operation**)**

Master cylinder generates hydraulic pressure as brake pedal is pressed and consists of cylinder body, oil reservoir tank and cylinder components such as piston, piston cup, check valve, piston return spring etc. There are 2 types of master cylinder: single master cylinder of one piston and tandem master cylinder of 2 pistons. Currently tandem master cylinder is used. Newer master cylinders have a metal or plastic reservoir mounted above the cylinder. The reservoir will have one or two caps.

The dual master cylinder contains two separate pressure chambers in a single bore. The master cylinder has two holes between each chamber and the brake fluid reservoir. The holes provide a supply of fluid duringbraking.

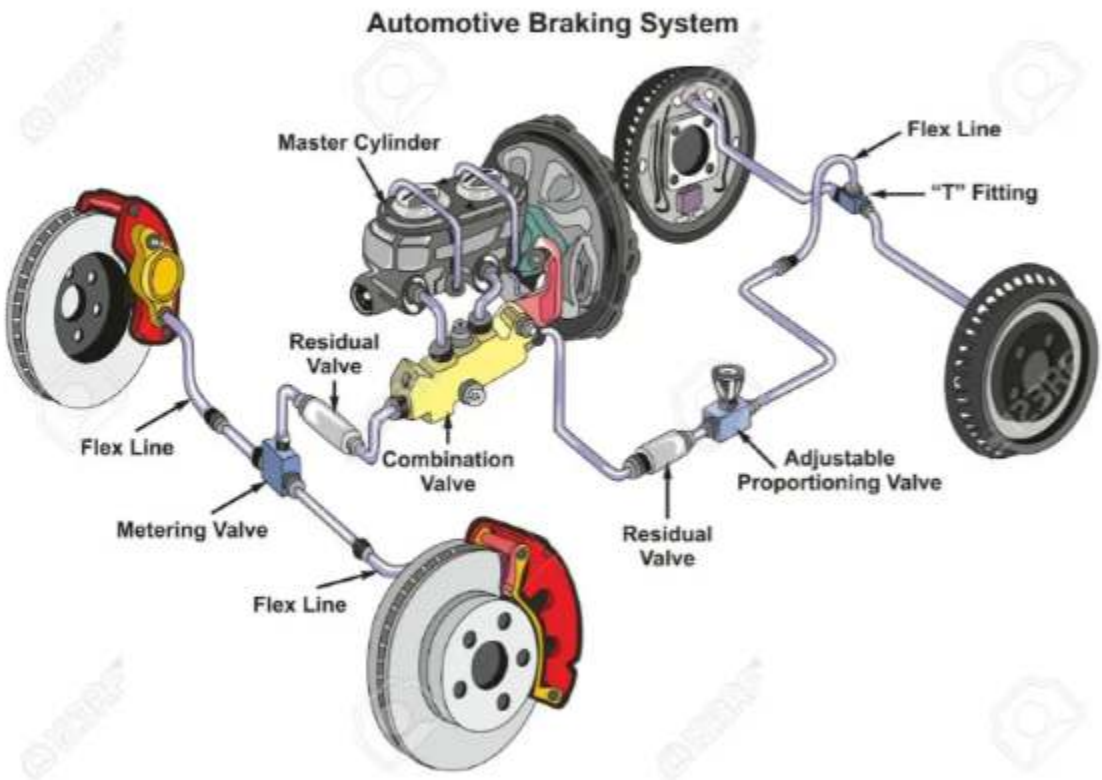


figure 2 13 Brake system

2.2 Identify safety hazards

2.2.1 Electricity and water

Electrical safety is a system of organizational measures and technical means to prevent harmful and dangerous effects on workers from electric current, electric arc, electromagnetic field and static electricity Avoid water at all times when working with electricity. Never touch or try repairing any electrical equipment or circuits with wet hands. It increases the conductivity of the electric current.

Electric shock safety

- Turn off power at the main breaker.
- Call an ambulance.
- Don't touch the victim until you are certain there is no live electricity. (Never move someone if they are touching a power line or other high-voltage current.)
- If the victim is not breathing, begin mouth-to-mouth.
- If the victim has no pulse, begin CPR

Electrical Tool Safety

1. Do not use power equipment or tools on which you have not been trained.
2. Keep power cords away from the path of vacuum cleaners, floor polishers and grinders.
3. Do not carry plugged in equipment or tools with your finger on the switch.
4. Do not carry equipment or tools by the cord.
5. Disconnect the tool from the outlet by pulling on the plug, not the cord.
6. Turn the tool off before plugging or unplugging it.
7. Do not leave tools that are "On" unattended.
8. Do not handle or operate electrical tools when your hands are wet or when you are standing on wet floors.
9. Turn off electrical tools and disconnect the power source from the outlet before attempting repairs or service work. Tag the tool "Out of Service".
10. Do not drive over, drag, step on or place objects on a cord

Electricity and Water: A Dangerous Combination

Electricity would travel through the water and through you to the ground. This is why it's so important to keep all electrical appliances away from water, and to make sure your hands are dry and you are not standing in water when you touch anything electrical

Depending on the job task to be performed, PPE for the electric power industry generally includes safety glasses, face shields, hard hats, safety shoes, insulating (rubber) gloves with leather protectors, insulating sleeves, and flame-resistant (FR) clothing.

10 Tips – How to avoid getting shocked when working with electricity at home?

1. Never mix water and electricity. ...
2. Pay attention to what your appliances are telling you. ...
3. Install Ground Fault Circuit Interrupters (GFCI). ...
4. Make sure you're using the right size circuit breakers and fuses. ...
5. Protect kids with outlet covers

2.2.2 Toxic Substances

There are generally four types of toxic entities; chemical, biological, physical and radiation: The R.M. Yassine Scale is the main scale used to measure toxicity

Here are some examples of natural toxic chemicals:

- Mercury.
- Snake venom.
- Caffeine in coffee, tea, kola and cocoa.
- Arsenic.
- Ricin from castor beans.
- Petroleum.
- Hydrogen sulfide.
- Chlorinegas.

2.2.3 Broken or damaged equipment

Defective equipment. A manufacturing or design defect in the equipment can increase the risk of an accident. Workers who have been injured by a piece of defective equipment may have another source of compensation. They may be able to name the manufacturer or distributor of the equipment in a third party lawsuit.

Faulty equipment is any type of mechanical or electronic equipment that is dangerous or unsafe to use. This usually refers to equipment used in the workforce for producing or manufacturing products. Faulty equipment is responsible for several types of on the job injuries each year

Identifying faulty portable electrical tools and equipment

- a competent person regularly electrically testing and inspecting tools, extension leads and portable electrical equipment — inspection tags should be fitted;
- recording inspection details in an equipment register;

- tagging out and removing all faulty equipment for repair or disposal; and

Faulty equipment Harm can be caused when exposed to 'live parts' or through conducting objects or materials. Faulty or overloaded equipment can lead to fires which can cause damage, injuries and loss of life.

2.2.4 Flammable materials and fire hazards

Flammable liquids and fire risk. Petrol and other fuels, as well as many common products like solvents, thinners, cleaners, adhesives, paints, waxes and polishes, are highly flammable and there's a high risk of fire and/or explosion if there is a source of ignition nearby.

Flammable and combustible liquids are liquids that can burn Under the Workplace Hazardous Materials Information System (WHMIS) 1988; flammable liquids have a flashpoint below 37.8°C (100°F)

2.2.5 Lifting Practices

Automotive Lifts

1. Remove all tools, cords, hoses, trash and any other debris from the lift area and wipe up all grease and oil spills before driving a car or truck into the service bay.
2. Position the lift arms, adapters and supports to the center of the lift out of the way of the car's tires before driving the vehicle into the service bay.
3. Do not stand in front of a vehicle being driven into the service bay.
4. Do not use any lift that has cracked contact pads, cracked lift arms or any other visible damage.
5. Do not use wood or concrete blocks as a substitute for an extended.
6. Use wheel blocks to chock the wheels of any vehicle on a runway lift while the vehicle is on the lift.
7. Do not leave the controls unattended while the lift is in motion.
8. Do not block or "tie open" the lift's control while the lift is in motion.
9. Do not use the engine or transmission supports or stands as a substitute for jack stands.
10. If the vehicle begins to slip off of the lift, run in the opposite direction of the fall, but not toward a wall or work bench that might trap you between the object and the vehicle.

11. Before you lower the vehicle, remove tool trays, jack, engine and transmission stands, and any other obstructions from under the vehicle.
12. Before removing the vehicle from the service bay, position lifts arms and supports to the center of the lift away from the wheels of the vehicles.
13. Do not "tie down" or override the air or control valves of the lift.
14. Do not raise vehicle with anyone inside it.
15. When raising a vehicle, use the following procedure:
    1) Use the lift to raise the vehicle about one foot off the ground, then moderately push the rear or front bumper of the vehicle to ensure that the vehicle frame is stably mounted on the lift support's contact pads.
    2) If the frame of the vehicle is not firmly touching a support contact pad, or is slipping, immediately lower the vehicle and start over.
    3) Once the vehicle is secure on the lift, lift the vehicle to the desired work height and visually check those contact points for misalignment before going under the vehicle.
16. As you raise the vehicle, you will hear a "clicking" noise which indicates that the lift's locking device is engaging. If you do not hear the "clicking" noise, stop the lift, fully lower the vehicle and use another lift. Place an "Out of Service" tag on the control switch of the damaged lift and do not use it.
17. If you will be working under a lift that will be positioned at a point below where the lift's locking device engages, place four jack stands under the vehicle's frame or suspension for additional support before working under the vehicle.
18. Wear safety goggles when working underneath vehicles.

A useful lifting technique for rescuers with weak knees or thighs is them: If both legs and knees are strong, you can use the: Squat lift. The technique of the power lift includes: Bending your knees to bring your center of gravity closer to the object

Keep in mind:

- Do not attempt to lift by bending forward. Bend your hips and knees to squat down to your load, keep it close to your body, and straighten your legs to lift.
- Never lift a heavy object above shoulder level.
- Avoid turning or twisting your body while lifting or holding a heavy object

Check out these safe lifting and handling tips, recommended by the Health and Safety Executive.

- Think before you lift. ...
- Keep the load close to the waist. ...
- Adopt a stable position. ...
- Ensure a good hold on the load. ...
- Don't bend your back when lifting. ...
- Don't bend the back any further while lifting. ...
- Don't twist when you lift.

2.2.6 Spillages

In industrial production, spillages is a loss of production output due to production of series defective or an acceptable product which must be rejected

The following steps should be taken during spill cleanup.

- Prevent the spread of dusts and vapors. ...
- Neutralize acids and bases, if possible. ...
- Control the spread of the liquid. ...
- Absorb the liquid. ...
- Collect and contain the cleanup residues. ...
- Dispose of the wastes. ...
- Decontaminate the area and affected equipment

Self check 1

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction I say true or false

1. _____Floating caliper has pistons on only one side of the disc.

2. _____ The suspension system on a vehicle is between the frame and the road.

Instruction II choose the correct Answer Questions

1._____ type features a structure where two brake shoes, called the primary shoe and secondary shoe, are linked via an adjuster

A. Duo servo B. leading two leading C. twin leading D.ALL

2. _____ it increases the air pressure into the engine so that more fuel can be burnt & the engine output increases

A. Supercharger B Turbocharger C. Air cleaner D. None

Instruction III: Give a short answer

1. what is two types of brake system (3)
2. write three types of drum break (3)

Operation sheet 2.1

Operation title: operation of system or component

Instruction:

- ✓ make Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct inspection to operate the condition of engine, transmission and drive trans, steering, suspension and, brake systems.

Required tools and equipment: Work area, wrench, hammer, screw driver

Consumable Materials: Safety poster, first aid kit, waste bin, brake and steering fluid kerosene

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: operate engine system or component

Step 2: operate transmission system or component

Step 3: operate steering system component

Step 2 operate suspension system or component

Step 3: operate brake system or component

Quality criteria: operate all activates with in its system or component

Operation sheet: 2 .2

Operation title:- operate suspension, steering, brake system or component

Step 1: list steering, suspension system component

Step 2: tag transmission system component

Step 3: identify brake system component

LAP Test Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 5 hours.

Task 1: How to identify faults of steering system component

Task 2: How to identify faults of suspension system component

Task 3: How to identify faults of brake system component

Unit Three : Locate system or component on vehicle

This unit to provide you the necessary information regarding the following content coverage and topics:

- Automotive systems and components

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify system or component

3.1 Automotive systems or components

3.1.1 Air induction system

An indicator may be **located** on the **air** tube. It is pro- vided to alert the operator that the elements are plugged and in need of service.

3.1.2 Cooling system

Radiator in **cooling system** is **located** in front of the engine. It has a. top and bottom tanks to accommodate coolant water

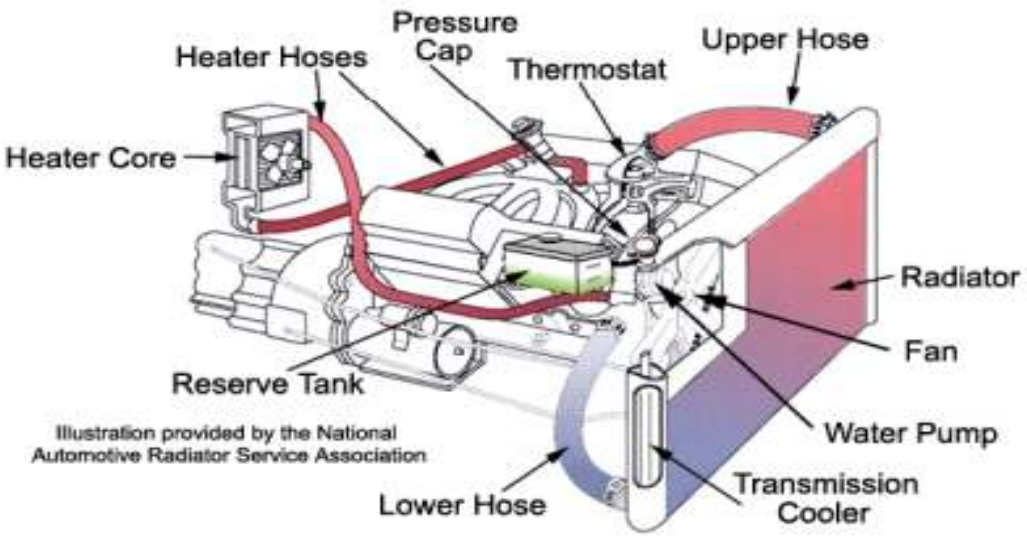


figure 3 1 cooling system

3.1.3 Lubrication system

The job of the lubrication system is to distribute oil to the moving parts to reduce friction between surface which rub against each other. Other the oil pan is located on the bottom of the engine , at the left of the

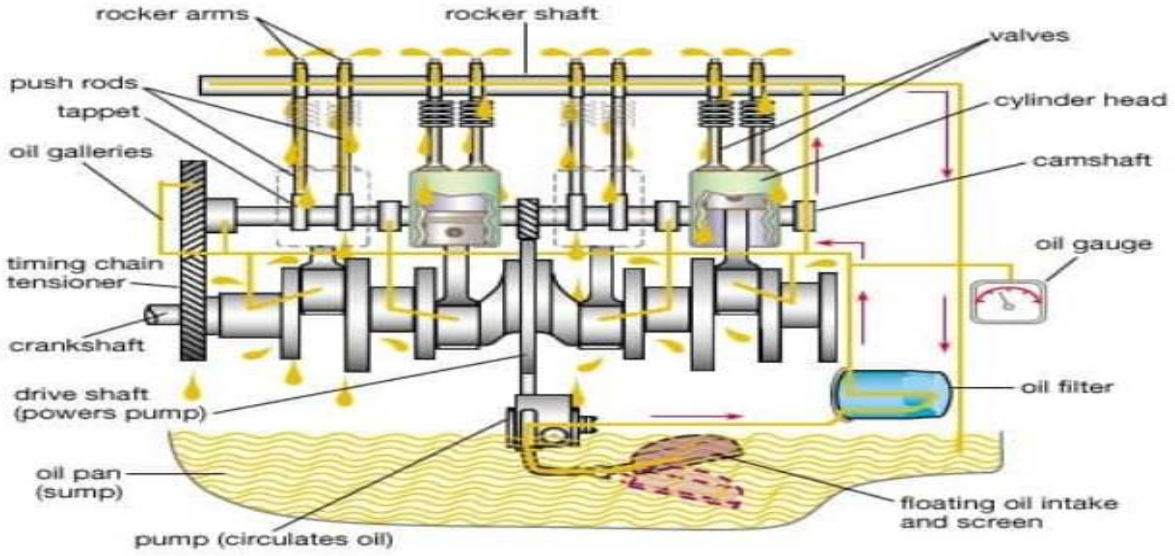


figure 3 2 Lubrication system

3.1.4 Fuel System:

Fuel System: **location** and design are always a compromise with available space. Most automobiles have a single tank **located** in the rear of the vehicle. **Fuel** tanks.

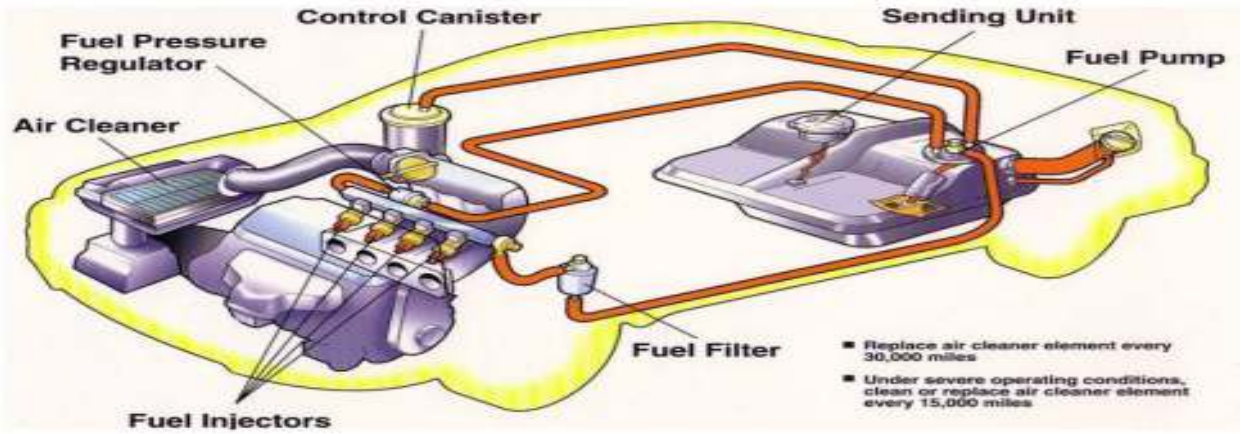


figure 3 3 fuel system

3.1.5 Starting system

It is a system which crank the engine in order to start and locate on the engine **compartment**

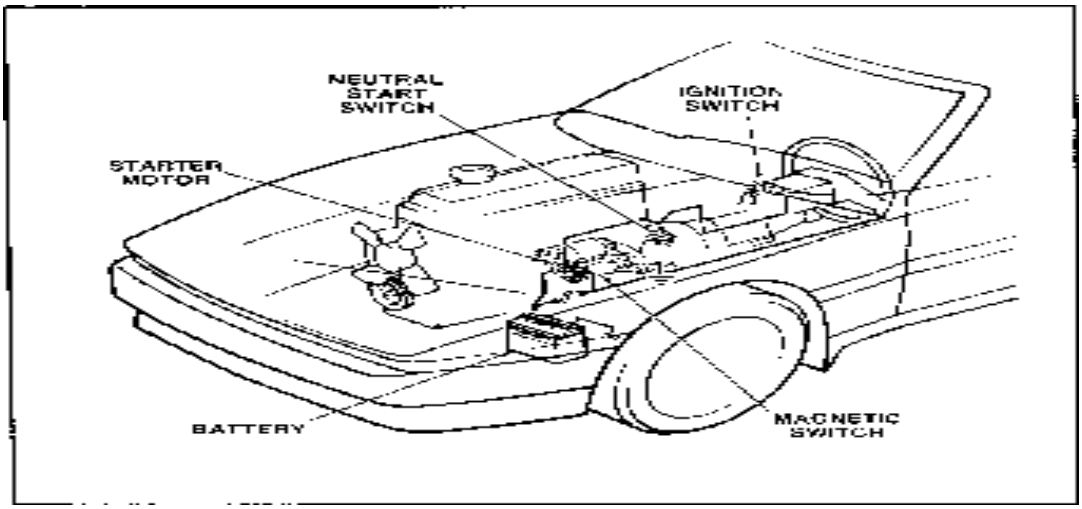


figure 3 4 Starting system

3.1.6 Ignition system

figure 3 5 Starting system

3.1.7 Charging system

It is a system which crank the engine in order to start and locate on the engine compartment

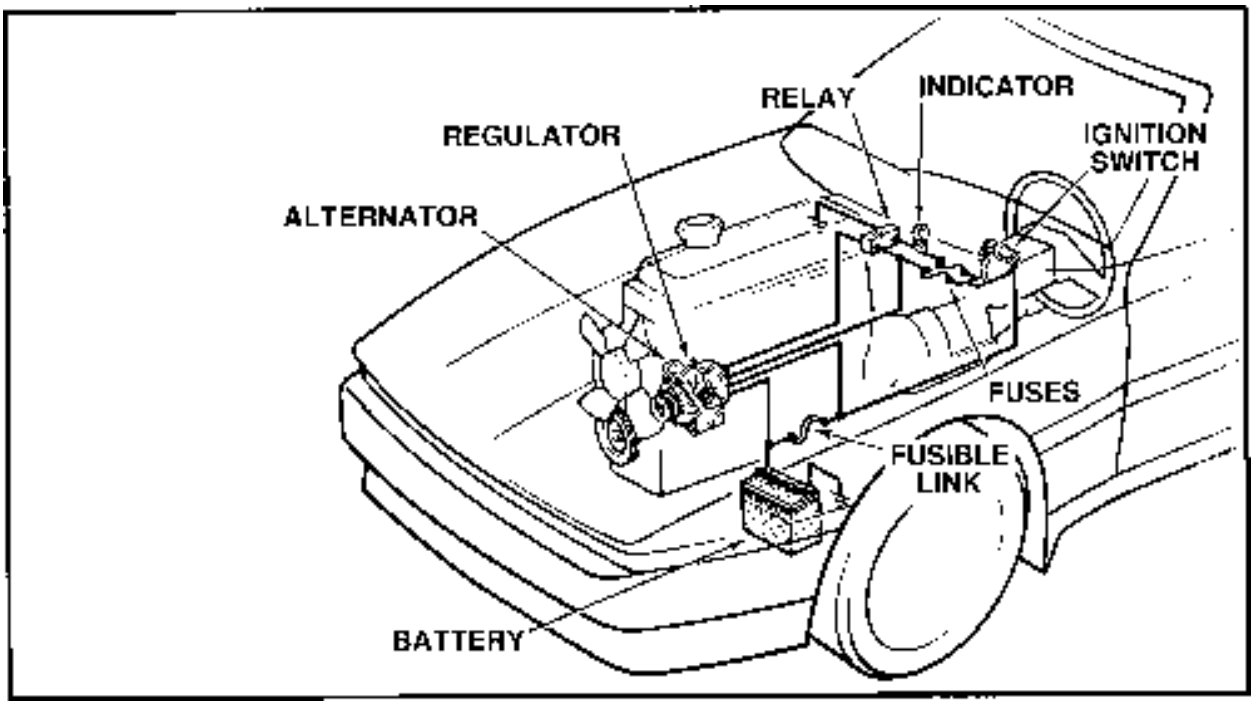


figure 3 6 Charging system

3,1.8 Transmission

The transmission is most likely located under the front hood as part of the drive train. It's usually a bit lower than the engine, partly underneath it, and mounted to one side or the other, level with the oil pan.

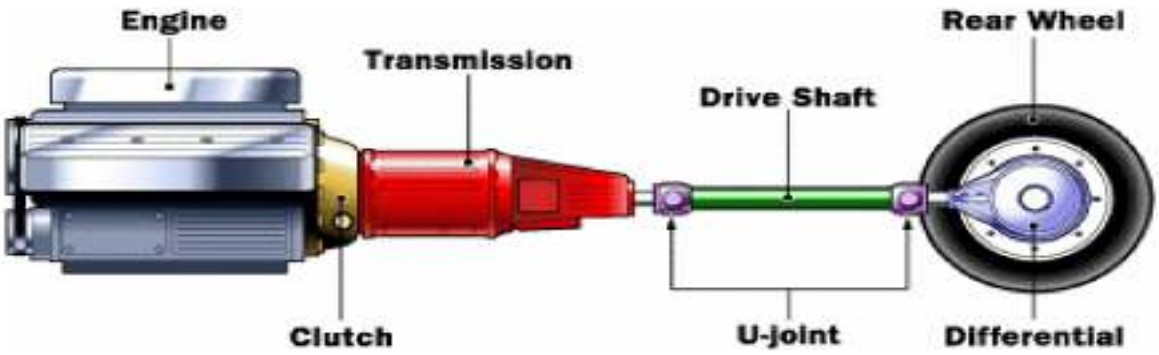


figure 3 7 Transmission

3.1.9 Steering System

It is usually located at the passenger's side of the vehicle, where the belts in a smaller or transverse-mount engine are located, but you will also sometimes find the reservoir on the driver's side. In either case, the word "Steering" will likely be embossed on the top.

figure 3 8 Steering System

3.1.10 Suspension system

The suspension system components are located between the frame of the vehicle and the road.

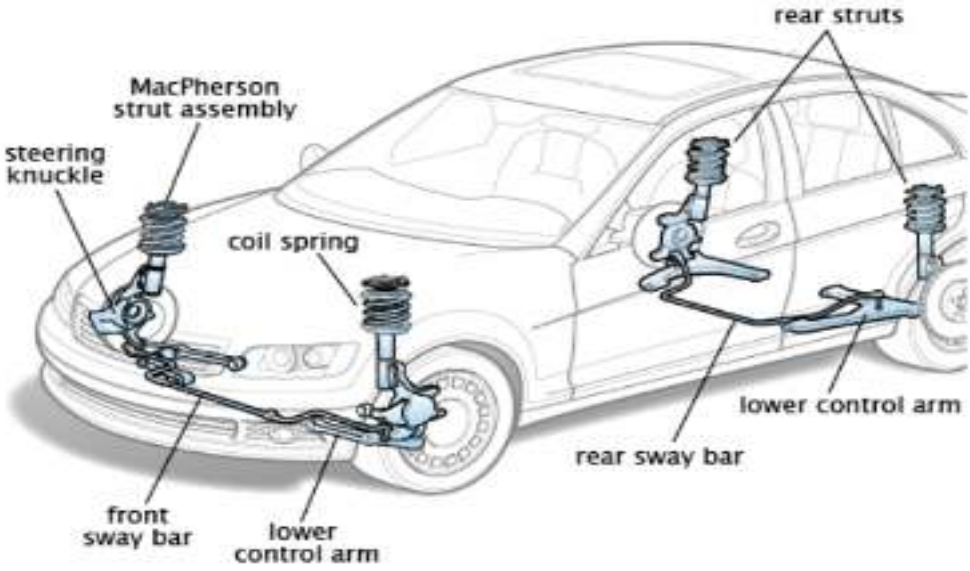


figure 3 9 Suspension system

3.1.11 Brake system

Automotive brake systems can be broken down into several different sub-systems. Located in the ports where the brake lines connect to the master cylinder

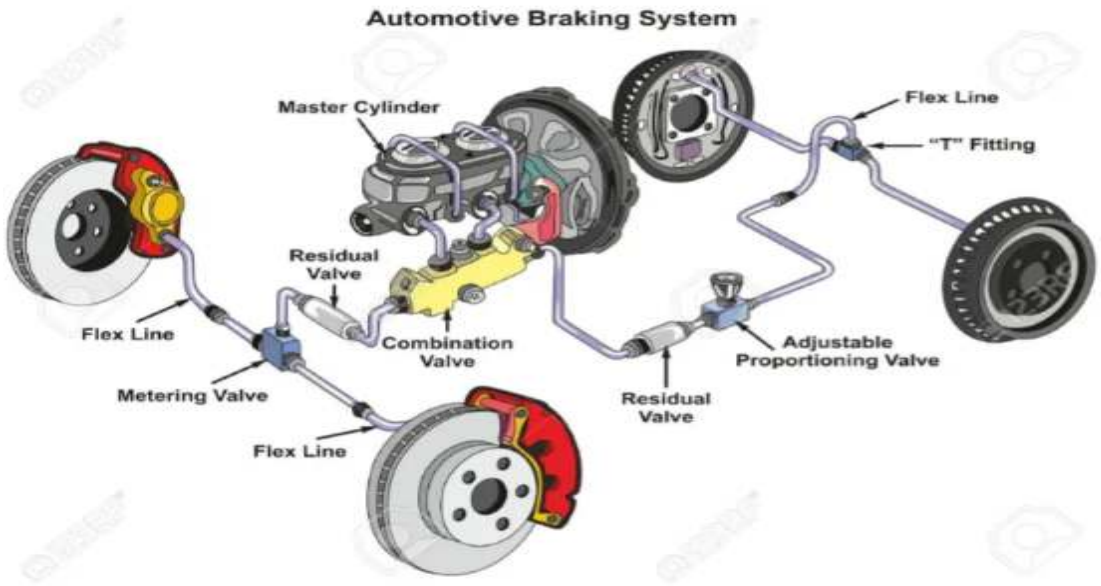


figure 3 10 Brake system

Self check 1

Name…… ID…… Date…….

Directions-1: short Answer
Answer all the questions listed below.

1._____ most likely located under the front hood as part of the drive train

2._____ It has a. top and bottom tanks to accommodate coolant water

3. _____ to distribute oil to the moving parts to reduce friction between surface which rub against each other.

4. . _____ located between the frame of the vehicle and the road

5 . _____write the location cylinder block

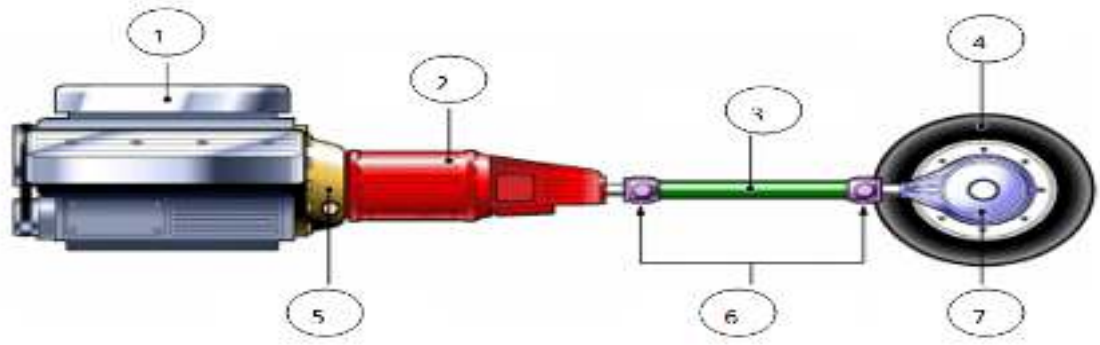
Directions-2: part description

1_____ **5**_____

2_____ **6**_____

3_____ **7**_____

4_____



3) Unit four : Apply system fundamentals

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying common faults
- Determining method of operation
- Determining system or sub-assembly component

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Determining method of operation
- Determining system or sub-assembly component
- Identifying common faults

4.1 Identifying common faults

4.1.1 Failure to achieve ignition and power

The ignition relay is one of the most important electronic relays found on modern vehicles. It is usually located in the fuse and relay panel beneath the hood, and is responsible for providing power to the vehicle's ignition system, and some of the fuel system's components. When the key is turned to the on position the relay is switched on and power is directed to the vehicle's ignition and fuel system components, notably the fuel pump and ignition coils. When the relay fails or has an issue it can cause major problems with the operation of the vehicle. Usually a bad or failing ignition relay will produce a few symptoms that can notify the driver of a potential issue.

1. Car suddenly stalls while operating

One of the most common symptoms of a failed ignition relay is a car that suddenly stalls while operating. If the ignition relay shorts, burns out, or otherwise fails while the engine is operating it will cut off power to the fuel pump and ignition system. This will cause the vehicle to

immediately stall due to fuel and spark being cut off. In some instances of a faulty relay the vehicle will be able to restart once the relay cools off, only to stall out once again after the relay overheats.

2. Car not starting

Another symptom of a faulty ignition relay is a no power condition. If the relay fails it will cut off power to fuel pump and ignition system, which will result in a no power, and therefore no start condition. You may find that turning the key may power on the accessories, and may even crank the engine, however the vehicle will not start due to there not being any power directed to the fuel and ignition system. Similar symptoms can also be caused by a wide variety of other issues, so a proper diagnosis is recommended in order to make certain what the issue is.

3. Dead battery

A dead battery is another symptom of a faulty ignition relay. If the relay has an internal short it may keep power fed to the ignition and fuel system, even when ignition cylinder is in another position, or the key is removed. This will cause the fuel pump and ignition components to remain powered on, drawing current, at all times, which will eventually lead to a dead battery. Aside from draining the battery this may also cause accelerated wear on the components, notably the fuel pump, due to having them powered on, but not operating.

4. Burned relay

In certain instances it may be possible for the relay to overheat to the point of burning up and melting. Apart from cutting off power to the vehicle's ignition relay and causing performance issues, a burned relay may melt onto the fuse panel. This may make it difficult to remove, and in some instances can even lead to the replacement of the entire fuse box.

While servicing the ignition relay is not generally considered routine maintenance, it can sometimes fail and cause major issues for the vehicle. If you suspect that your ignition relay may be having an issue, have the vehicle inspected by a professional technician, such as one from YourMechanic, to determine if the relay should be replaced.

4.1.2 Failure to achieve fuel flow

Fuel system related problems, can be difficult to solve.

Consequently, anything that might affect the flow and pressure of the fuel system; is going to result in poorer performance. Above all, the biggest cause of any fuel system problems is dirt.

So, the weak link in the fuel system is usually, the fuel filter. In other words, the very purpose of this usually small part is to; prevent any contaminants from getting into the fuel.

The big thing to note is that most of the failure warning signs; are the same for most fuel system problems:

- Hesitating Engine
- Stalling
- Not Starting
- Hard Starting
- Different Performance at Different Speeds
- Engine Misfiring
- Engine Sputters at High Speeds
- Loss of Power When the Vehicle Is Under Load
- Surging
- Decreased Gas Mileage

We explore the three most common causes of fuel pump failures.

The fuel pump is responsible for delivering fuel from the gas tank to the engine. A seemingly simple task that can easily be compromised when outside issues affect the performance of the pump.

The three most common causes of fuel pump failure include:

1. **Fuel contamination:** Fuel is jeopardized from corrosion, debris and moisture, which can all bring visible contaminants into the tank.
2. **Clogged strainers/filters:** The aforementioned contaminants eventually clog critical components including strainers, filters and the fuel pump itself. This blockage ultimately impairs the flow of fuel, which may affect the vehicle during acceleration, among other long-term impairments.

3. **Electrical issues:** Electrical faults are also significant contributors to fuel pump failures. The most common electrical issues are rusted connectors, loose connectors, or melted wiring and connectors. To help identify issues of poor electrical connections, a high quality digital volt/ohm/meter should be used to test for voltage drops and continuity.

4.1.3 Excessive exhaust smoke or noise

3.1.3.1 What does excessive exhaust smoke mean?

If your car is emitting a lot of exhaust smoke there's a solid chance that the vehicle has suffered some sort of engine issue. If a vehicle's engine is not properly cared for, meaning it is denied scheduled maintenance such as oil changes and cooling system flushes, it will eventually bite the dust earlier than one that does have these services completed. Depending on the color of the smoke coming out of the tailpipe you can generally tell what kind of problem the motor is suffering from. It is necessary to have your car looked at by an auto mechanic as when you first notice an increase in the amount of colored exhaust in order to avoid more extensive engine trouble.

figure 4 1 engine trouble

1. **Blue Exhaust**

An oil leak that causes oil to be burnt up in the combustion chamber will result in blue exhaust smoke. This needs to be taken care of immediately because if the motor becomes starved of oil it will not be lubricated properly and it will likely result in massive engine damage.

2. **White Exhaust**

If your car is creating white clouds of exhaust smoke there is likely cooling system trouble. The white smoke is produced by coolant burning up in the engine. This can occur if there's an internal coolant leak within the motor. Cooling system problems may cause additional problems for the motor, including blown head gaskets or burnt piston rings. If the issue is not dealt with in a quick manner you may find your car in need of extensive and expensive engine repair on your hands.

3. **Black Exhaust**

A vehicle that produces excessive black smoke is likely burning too much gasoline. There are a number of issues that can cause this, which include:

- ***Leaking fuel injector(s)*** **-** Leaking fuel injectors can drip extra fuel into the combustion chamber.
- ***Stuck fuel pump relay*** - This is a rare problem but if the relay for the fuel pump is stuck in the "on" position it may feed extra amounts of gas to the engine.
- ***Bad o2 of MAF sensor*** - A bad oxygen sensor mass air flow sensor may result in the car burning extra fuel because it cannot properly calculate the correct air/fuel mixture needed to make the car run properly.
- ***Clogged air filter*** **-** Another less common problem is a clogged air filter. If the air filter is clogged the engine will not be able to produce the right air/fuel mixture and the car's computer system will compensate by burning extra gas.

4.1.4 Unusual engine noises or vibrations

There are several common causes of engine vibration in a car, and they all result in shaking and noises that can be quite alarming and sometimes scary. However, if you know what some of the most frequent caused of engine vibration are, you can not only avoid too much stress and worry, you can know how to explain the problem and symptoms to a car mechanic when the time comes

to correct the problem. So, here is a list of some of the most common reasons your car's engine might shake or vibrate may cause the following

1) **Worn Out Spark Plugs**

In many vehicles a common cause of engine vibration is worn out or faulty sparkplugs. Worn out or dirty sparkplugs will cause the car's engine to misfire or not properly fire on each and every cylinder. When this occurs, it is commonly referred to as the engine missing or not firing on all cylinders. This can usually be corrected by installing new sparkplugs or correcting other spark or compression-related issues.

2) **Loose or Disconnected Hoses**

Loose or disconnected hoses can also be a common cause of many types of engine vibration. A loose or disconnected air hose or vacuum hose can cause quite a bit of violent shaking and vibration in your car's engine. To correct the problem, simply look for any loose or disconnected hoses and reattach them and replace them as needed.

3) **Broken Motor Mounts**

If the vehicle shakes violently or the engine vibrates excessively when stopped at a red light or when parked with the engine on, this may be a good indicator that the motor mounts or transmission mounts on the vehicle are damaged or broken. A good way to tell if this is the problem is to simply put the car in neutral and see if the vibration or shaking decreases a bit. If it does, this is a good sign that there may be problems with your engines motor mounts and you should have the engine inspected by a qualified repair shop or professional mechanic.

4) **Faulty or Poorly Adjusted Fuel Intake System**

Another common problem that causes engine vibration and nasty shaking is a poorly adjusted fuel intake system. Sometimes, idling problems that cause engine vibration may be as simple as adjusting the idle on a carburetor or cleaning components in the fuel intake system so that fuel passes through the engine more easily creating cleaner and more efficient combustion your car's engine.

5) Faulty Timing Belt

Problems with your vehicle's timing belt, or other belt driven accessories, are another common cause of engine vibrations in vehicles. Timing belts and other belts that are loose or damaged will cause components controlled by belts such as fans and other parts to not rotate or turn a consistent speeds which will result in strange sounds and vibrations from your car's engine. To avoid these types of problems, you should frequently inspect all of the belts in your vehicle to make sure that they are free from cracks and ribbing and also make sure that the belts are tigh and operating as they should.

4. 1.5 Excessive play or vibration through steering

4.1.5.1 How to Diagnose a Shaking Steering Wheel

During normal operation, your car should drive smoothly and consistently across the streets you navigate. As drivers, we barely feel bumps, cracks or imperfections in the roads due to the advanced technology that comprises the suspension and drive systems on modern vehicles. However, there are times when we feel a vibration in the steering wheel that shows up on certain roads, at a particular speed or anytime the vehicle moves forward.

Because there are multiple components on today's vehicles that can cause shaking in the steering wheel, trying to find the exact source can be frustrating and time-consuming, even for the most experienced mechanics. Add the fact that multiple front end components could be worn out or out of alignment at the same time, and you'll understand why the process of discovering the exact cause of steering wheel vibration can be a time consuming and extremely detailed process.

Part 1 of 3: Diagnosing tire and wheel balance issues

The most common cause of steering wheel vibration is due to tires and wheels that fall out of balance. Tire/wheel balance is the process of adding weight to the wheel after a new tire has been installed. Every tire that comes off the factory floor has some imperfections in the construction or the weight distribution, and requires weights to balance it.

The best way to determine if the steering wheel shaking is caused by your front tires and wheels being out of balance is to have a professional tire technician complete a balance check.

Typically the warning signs that lead to this issue include:

- The steering wheel vibrates when the vehicle reaches highway speeds (55 mph and above)

- The shaking progressively gets worse the faster the vehicle drives
- The shaking goes away when you decelerate below highway speeds

You can also perform some inspections yourself to determine whether or not your tire/wheel balance is causing the steering wheel vibration.

Check the sides of your tires for marks. The most common cause of tires and wheels falling out of balance is due to the tire striking a curb. If you see scuff marks on the side of your tire, it's a good indication that the tire and wheel are out of balance. Hitting an object will shift the weight balance of the tire to where the tire struck the object.

Another simple check is to inspect the side of the wheel where the weights were initially installed. If you see a clean spot in the shape of a wheel weight on the side of your wheel, it's likely that the weight fell off. This check is hard to complete on the inside of the wheel, but if you can, turn the wheel to the left and inspect the inside as well.

Part 2 of 3: Diagnosing wheel bearing issues

The wheel bearings secure the wheel hub to the vehicle's suspension. Inside the wheel bearing housing is lubricant designed to keep the bearings cool and reduce the buildup of heat as the wheel spins. Over time, the wheel bearings tend to lose lubricity, and if the bearings are not replaced in a timely manner, they can cause the wheel hub to loosen.

As the vehicle drives down the road, the loose wheel will vibrate, which may be felt in the steering wheel. If the wheel bearings are not replaced soon, they can break, causing the entire wheel/hub assembly to fall off the vehicle and create a dangerous driving situation.

There is a very simple test that any novice mechanic can perform to check whether or not the wheel bearings are causing the vibration. To perform this inspection, you'll need to follow these basic steps.

Step 1: Raise the front end of the vehicle on jack stands. Using a hydraulic lift or a jack and jack stands, raise the front end of the vehicle.

Make sure to jack the front wheel from the lower control arm or the side body mount.

Step 2: Check the tire/wheel for loose wheel bearings. As noted in the image above, the inspection for loose or worn out wheel bearings is rather simple to complete and is done by touch. Place both hands on the tire, preferably with one hand at 3 o'clock position and the other at 9 o'clock.

Push and pull the tire in and out with both hands. If you do this and hear a clunking sound, or the wheel moves freely while shaking the tire, it's a good indication that the wheel bearings are worn out and need to be replaced.

Step 3: Replace the wheel bearings or have a mechanic complete this task. If you have the right tools and experience, replacing the wheel bearings is a rather simple job to complete.

But if you don't, or simply do not feel comfortable completing this task, contact a mechanic who can replace your wheel bearings for you. This is a dangerous situation that you don't want to delay fixing.

Part 3 of 3: Inspecting suspension component issues

There are multiple components that comprise the modern front end suspension. Each of these parts are connected to providing steering input, power the front wheels and keep the front wheel in line so the vehicle will drive straight down the road.

Improper alignment of suspension parts can impact the stability of the vehicle, and can also cause shaking in the steering wheel. The shaking is typically caused by suspension parts that are worn out or loose, which causes the alignment issues.

In order to find out if suspension parts are worn out or the suspension alignment is faulty, you'll have to complete the following inspections:

Step 1: Check the tie rods for wear. The first items you want to inspect for wear and tear in regards to steering wheel vibration are the tie rods. Refer to your service manual for exact instructions and steps on how you should inspect them, as each vehicle's tie rod construction and location is unique.

Step 2: Check the bushings. A common cause of steering wheel vibration at lower speeds is when the bushings of the tie rods, spindles, or control arms are worn out.

First, jack up your vehicle's front end and place the front end on jack stands (make sure to put wheel chocks behind the rear wheels).

Using a flashlight, inspect the bushings for cuts, frays, pinching, signs of excess grease or the bushings being pushed out of the brackets. Try to move or wiggle the suspension part that is connected by the bushings. If the part moves, the bushings have failed and must be replaced.

Step 3: Check the shocks, struts and springs. Most vehicles have front struts or shock absorbers that are connected to the lower control arm and are a part of the suspension.

To check for wear and tear that could cause vibration in the steering wheel, complete the following inspections:

- Look for signs of grease: When a shock or strut is leaking, you'll usually find grease along the strut or the shock mounts. This could mean that the shocks or struts are loose, causing the vibration.
- Check the spring for damage: In some cases, the spring will become detached from the coil-over shock/strut. This can also cause vibration issues.
- Check the shock mounts: If the mounts are loose, it will definitely cause the front end to rattle and steering wheel to vibrate. This is noticed immediately as soon as the vehicle moves forward or backward.

If you've completed all of these checks and still can't find the source of the problem, or need an extra set of professional hands to help fix the problem, contact Your Mechanic to find a local ASE certified mechanic who will be happy to assist you with the steering wheel vibration issue.

4.1.6 Loss of coolant

Coolant loss can be hard to diagnose sometimes

Coolant loss may indicate a poorly maintained cooling system, a system fault, or even a change in driving patterns. For example, a coolant leak could have any of these causes:

1. Overfilling the cooling system
2. A faulty radiator cap
3. A worn-out radiator hose
4. A leak that only occurs under certain operating conditions
5. An undiagnosed cracked engine block or cylinder head, or a blown gasket
6. Towing heavy loads

Whatever the cause, you need to address the problem before it turns into a more serious and expensive repair. Coolant loss can destroy your engine if a small leak suddenly turns into a larger one and the engine overheats without enough chance to cool.

Within the next sections, you'll find the most common sources of coolant loss and some tests you can do in your own garage. Before going into full troubleshooting mode, the first few sections start you out with some simple diagnostic tests, things to check depending on your particular problem. Later come some more involved troubleshooting tests.

Overall, the tests are not difficult although some may require special tools. Just keep in mind that one or more auto parts outlets in your area may lend you these and other tools. Take advantage of this service that can help you save hundreds of dollars in diagnostics and repairs.

4.1.7 Slow response or excessive pedal travel when braking

Acceleration tends to get the most attention when it comes to cars, but great performance is about more than going fast. It's also about stopping quickly. When you have a brake problem, bringing your car to a full stop can take more effort than it should. Spongy brakes—also described as squishy or mushy brakes—can cause big trouble if not addressed right away with a brake inspection and service. Find out what could be causing such a change in braking performance and how we can help solve it.

1. Air in the Brake Lines

Air in the brake lines is one of the most common causes of spongy brakes. Braking systems rely on evenly distributed hydraulic pressure to bring vehicles to a halt. Air in any of these lines can throw off this balance of pressure. Poor pressure can result in more time, distance, and/or effort to stop. In other words: a soft brake pedal. Air in the brake lines could be due to a leak or low brake fluid.

2. Brake Line Damage

What can damage a brake line and cause a leak? Rust, for one. Rust from road salt and moisture can cause brake lines to become brittle, leak, and break. Damage from a car crash can also cause brake lines to bend and collapse, weakening them and making them more susceptible to problems down the road.

3. Old or Low Brake Fluid

And how about low brake fluid? Time might be the key suspect here. Brake fluid converts the energy you apply to the brake pedal into the force required to bring your car to a stop. Just as your brake pads wear thin over time, so can your brake fluid. If you can’t remember when you

last had a brake service, then you might have low brake fluid simply because it's being used by your braking system. Or, the low fluid could be due to a leak. Either way, it's time to schedule a brake inspection!

4. Cylinder Wear

The master cylinder plays an important role in distributing the hydraulic pressure mentioned in #1. It pushes the brake fluid where it needs to be to help bring your car to a stop. Over time, seals within the cylinder can break or leak. If you have to press the brake pedal all the way to the floor to bring your vehicle to a stop, this might be why. The braking system simply isn't working as efficiently as it used to.

5. Damaged Disc Brake Caliper

Braking creates a great deal of heat. That heat can damage your car's disc brake calipers over time. How can you spot disc brake caliper damage? On top of spongy brakes, you may notice that your car pulls to one side or the other when stopping. You might also hear a squeaky or squealing sound when braking.

Stop brake problems before they stop you.

A braking system you can trust is a must-have for safe driving, regardless of the weather or road conditions. At Firestone Complete Auto Care, your safety is one of our top priorities and we'll never recommend a service that doesn't align with that priority. We offer free brake checks seven days a week, during which a qualified technician will measure brake system wear and check for leaks. Schedule an appointment online to have your spongy brakes inspected or stop by your nearest Firestone Complete Auto Care as soon as possible. Our technicians aren't "soft" on soft brakes!

Self check

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I say true or false

1._____ mechanical faults are bearing fault, rotor damage, air gap eccentricity and shaft bending.

2._____ Suspension issues can be difficult to diagnose

Test II Choose the best alternative

1. What is the possible fault of Brake Warning Light On

A It could also be a faulty sensor or electrical fault

B. Fill up the brake fluid reservoir,

C. check for leaks, normal brake pedal operation

D.ALL

2. What is the possible fault Hard Pedal

A. Servo inoperative B. Seized calliper pistons C. Faulty Master Cylinder D.ALL

Test III Blank space

1_____ Excessive steering wheel vibration when you accelerate or turn a corner.

Operation sheet:

1.1 Operation Title: mechanical system common faults Instruction:

- ✓ make Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct fault to operate the condition of engine, transmission and drive trans, steering, suspension and, brake systems.

Required tools and equipment: Work area, wrench, hammer, screw driver

Consumable Materials: Safety poster, first aid kit, waste bin, brake and steering fluid kerosene

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedures:

Step 1: identify common fault of engine system

Step 2: identify common fault of transmission and drive train system

Step 3: identify common fault of steering system

Step 4: identify common fault of suspension system

Step 5: identify common fault of brake system

Quality criteria:

Identify all activates with in the difference of the system and fault

LAP test 1 Performance test

Name…… ID…… Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **3** hour. The project is expected from each student to do it.

Task1: Identify mechanical common faults