IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

Jan / Feb, 2021 **Common to CE & ECE**

Seventh Semester **Automobile Engineering**

Time: Three Hours **Maximum:**60 Marks

1 A) A few representative types of combustion chambers of which there are many more here are many more Variations Variationsare enumerated and discussed bel are enumerated and discussed bel are enumerated and discussed below:

1. T-head combustion chamber. head combustion chamber. head combustion chamber.
2. L-head combustion chamber. head combustion chamber. head combustion chamber.
3. I-head (or overhead valve) combustion chamber. head (or overhead valve) combustion chamber. head (or overhead valve) combustion chamber.
4. F-head combustion chamber. head combustion chamber. head combustion chamber.

B) We can **classify internal combustion** reciprocating **engines** according to the **number of strokes** of the piston in one complete working cycle. ... Thus, we can speak of two-**stroke engines** and four-**stroke engines**.

C) A **muffler** (North American English) or silencer (British English) is a device for reducing the noise emitted by the exhaust of an internal combustion engine—especially a noise-deadening device forming part of the exhaust system of an automobile.

d) What is the function of a starting motor?

The **function** of the starter **motor** is to start up the combustion engine. An electric **motor** forms the basis of the starter **motor**. When the starter switch is turned on, the starter relay turns on the electric **motor**. This **motor** drives the starter gear ring via the pinion gear.

e) What is the purpose of lubrication in engine?

The job of the **lubrication** system is to distribute oil to the moving parts to reduce friction between surfaces which rub against each other.

f) Explain the purpose of cooling in an engine.

The **cooling** system serves three important functions. First, it removes excess heat from the **engine**; second, it maintains the **engine** operating temperature where it works most

efficiently; and finally, it brings the **engine** up to the right operating temperature as quickly as possible

g) Explain about the chassis

Chassis is the main support structure of the vehicle which is also known as 'Frame'. It bears all the stresses on the vehicle in both static and dynamic conditions. In a vehicle, it is analogous to the skeleton in living organisms. ... Every vehicle whether it is a two-wheeler or a car or a truck has a **chassis**-frame

h) List the differences between wet and dry clutch?

Dry Clutch	**Wet Clutch**
A dry clutch is a clutch which does not have oil present between the clutch plates	Physical oil is present between the plates of the clutch
The sound in dry clutch is more as compared to wet clutch and goes on increasing as the clutch goes on wearing out	The sound level is net clutch is less as compared to dry clutch or it is taken up by the oil present between the plates
Wear and tear is more in dry clutch	Wear and tear is more in dry clutch
Maintenance cost is high	Maintenance cost is low
The life is less as compared to wet clutch	The life is high as compared to wet clutch
The dust which is collected by wear and tear of the plates is in the cover of the clutch casing.	The dust is removed by the oil filter present in the clutch casing

i) Enlist any four types of gear boxes.
ii) (A.) Sliding mesh **gear** box:
iii) (B.) Constant mesh **gear** box:
iv) (C.) Synchromesh **gear** box:
v) (D.) Epicyclic **gear** box:
vi) (E) Hydraulic torque converter:

J) What is the need of the suspension system?
Your car's **suspension system** is responsible for smoothing out the ride and keeping the car in control. Specifically, the **suspension system** maximizes the friction between the tires and the road to provide steering stability and good handling

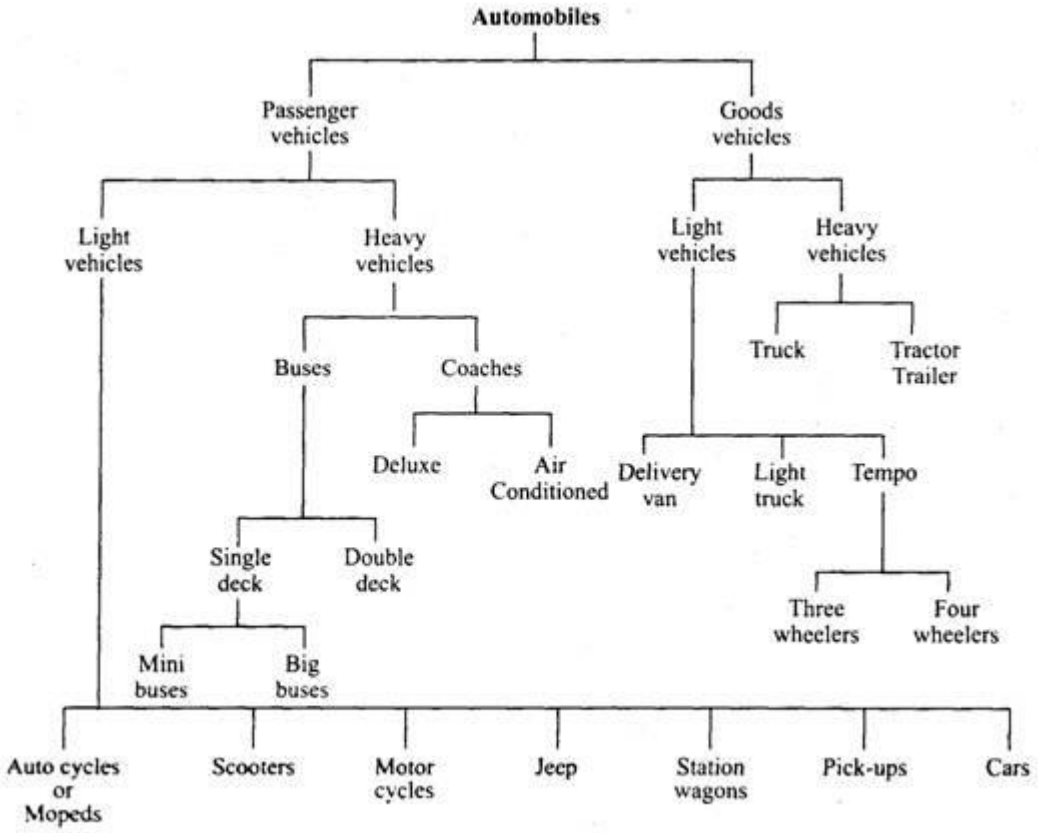
K) Distinguish between Toe-in and Toe-out.
Toe is the side-to-side difference in distance **between** the front and rear of the front tires. If the distance is closer at the front, it's called **toe**-in. If the difference is closer at the rear, it's called **toe**-**out**.

I) What are the requirements of a brake fluid?
The main requirements for brake fluids are high operation temperatures, good low-**temperature** and viscosity-**temperature** properties, physical and chemical stability, protection of metals from corrosion, inactivity with respect to mechanical rubber articles, and lubricating effect

2 a) classify automobile vehicles

1.2. General Classification of Automobiles
The different types of automobiles found on roads are presented in Chart 1.1 in a comprehensive manner. There are in general three main classifications of the various types of vehicle. They are:
(i) The single-unit vehicles or load carriers.
(ii) The articulated vehicles.
{Hi) The heavy tractor vehicles.

Chart 1.1. Classification of vehicles.



1.2.1. The Single-unit Vehicles or Load Carriers

These vehicles are conventional four-wheel types with two-axle design in which the front axle is a steering non-driving axle and the rear axle is the driving axle. With the advancement, many changes have been incorporated in the number of axles as well as the driving system.

1.2.2. The Articulated Vehicles

A larger powered three-wheeler with single steering wheel in front and a conventional rear-driving axle falls in this category. It can be turned about its own tail due to the three-wheel construction and has a greater handling ability in unusual places. The coupling mechanism between semi-trailer and tractor in most of these vehicles is designed for automatic connection and coupling up. A lever is provided within the driver's approachTor coupling operation. A pair of retractable wheels in front can be raised or lowered automatically along with the coupling and uncoupling operation.

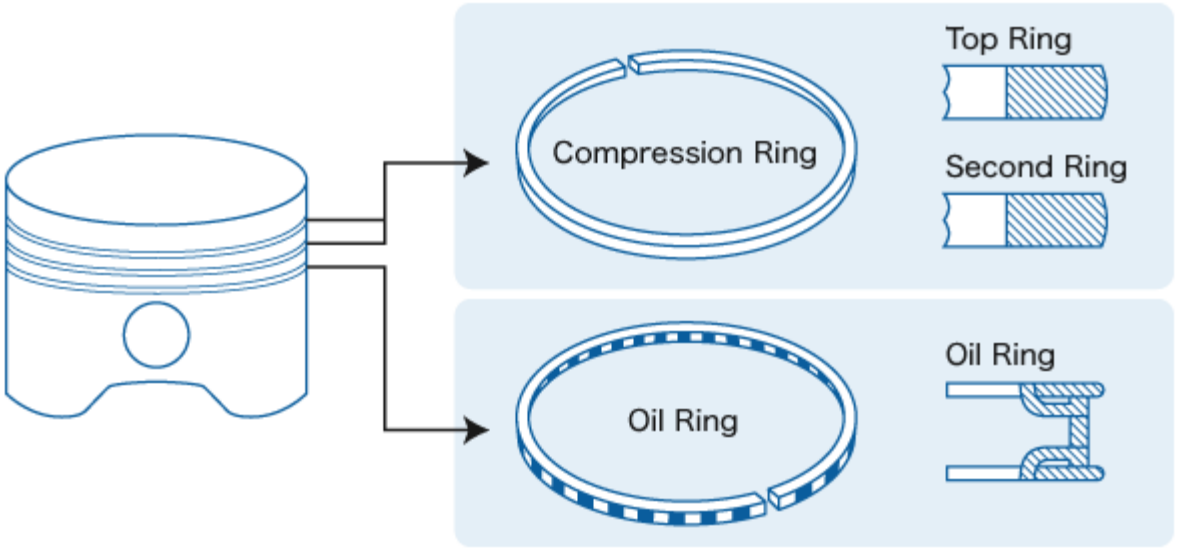
1.2.3. The Heavy-tractor Vehicles

To move heavy loads tractor or independent tractor vehicles are used. They commonly

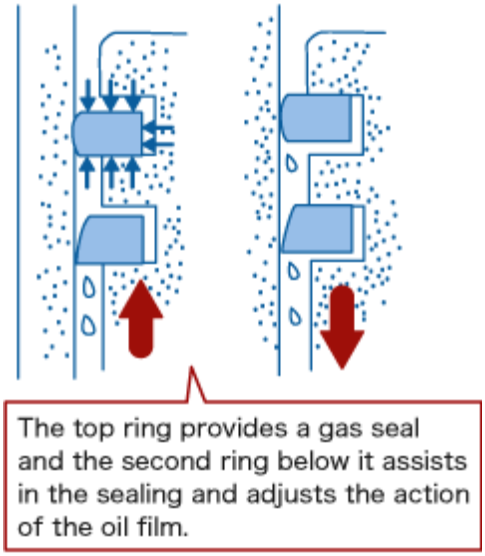
operate in pair either in tendon or as puller or pusher. The latter arrangement provides stability while descending appreciable gradients.
The digital figures like 4×2, 4×4, 6×4 etc. are commonly used in the classification of vehicles, where the first figure represents the total number of wheels and the second figure the number of driving wheels. By increasing the number of axles, the load per axle can be reduced, which protects the tyres from overloading and the road surface from damage. Wheel axles are called "live" if drive and called "dead" if non-drive. A live axle supports the payload and provides
driving tractive effort, whereas a dead axle just supports the load.
2

2b) What are the functions of piston rings? Explain different types of piston rings with neat sketches.

Piston rings maintain **gas compression** between the piston and the cylinder wall. Piston rings seal the cylinder so that combustion **gas** generated at the time of ignition does not leak into the opening between the piston and the cylinder.

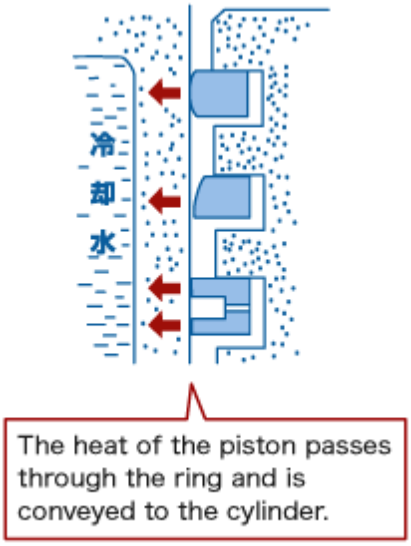


Gas Seal Function



This means that the combustion chamber must be made as gas-tight as possible, so that the pressure generated by the quickly burning combustion gases will move the piston in the cylinder causing the crankshaft to turn, making power available. Not only important for the combustion/expansion stroke, gas-tightness is also very important for the intake, compression and exhaust strokes as well. This general function can be simply called "gas sealing".

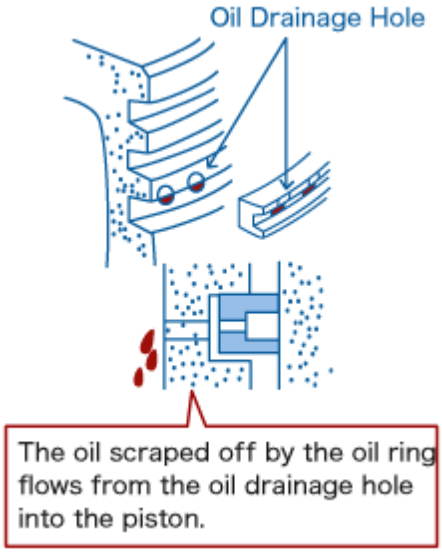
Heat transfer Function



The piston rings act to carry heat away from the hot piston into the cooled cylinder wall/block of the engine. Heat energy flows from the piston groove into the piston ring and then into the cylinder wall, where it eventually will be transferred into the engine coolant. This heat transfer

function is very important to maintaining acceptable temperatures and stability in the piston and piston rings, so that sealing ability is not impaired.

Oil Controll Function



The piston rings require some oil for lubrication, however it is desirable to keep this amount to a minimum. The rings act in a scraping manner, keeping excess oil out of the combustion chamber. In this way, oil consumption is held at an acceptable level and harmful emissions are reduced.

3 A) What is Supercharging, Explain with neat sketch about anyone of the supercharger.

A supercharger is an air compressor that increases the pressure or density of air supplied to an internal combustion engine. This gives each intake cycle of the engine more oxygen, letting it burn more fuel and do more work, thus increasing power. Power for the supercharger can be provided mechanically by means of a belt, gear, shaft, or chain connected to the engine's crankshaft.

Roots Supercharger: The roots supercharger is among the oldest designs for pumping air. First implemented in early 1900, it was used as an industrial air-moving device. In the past thirty years however, it has been used on many vehicles as a supercharger. "The roots type supercharger is two counter-rotating meshed lobed rotors. The two rotors trap air in the gaps between rotors and push it against the compressor housing as they rotate towards the outlet/discharge port. During each rotation, a specific fixed amount of air is trapped and moved to the outlet port where it is compressed, which is why the roots type supercharger falls under the broader category of fixed-displacement superchargers (like the twin screw supercharger). As with all positive displacement blowers, boost is directly related to the speed of the lobes. The roots supercharger is known for its high levels of low-rpm boost. Used often in high torque applications such as towing, the roots blower has also seen much use in top-fuel dragsters. The simplicity and low-rpm of the design make it a very reliable compressor Advantages & Disadvantages of Root's Blower Super

Chargers 1. Simple design, low capital and maintenance cost 2. The volumetric efficiency is high and better balancing is possible at high speeds. 3. Chances of leakage are more, air supply is not regular due to pulsed delivery 4. As pressure increases, volumetric efficiency of the super charger decreases

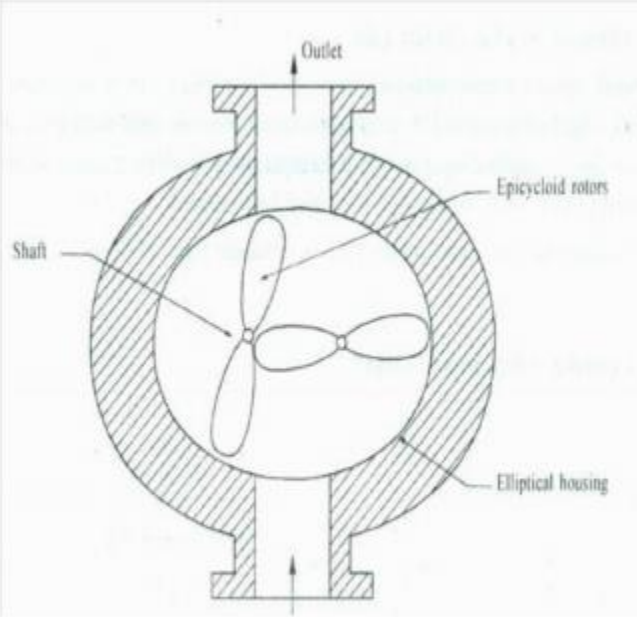
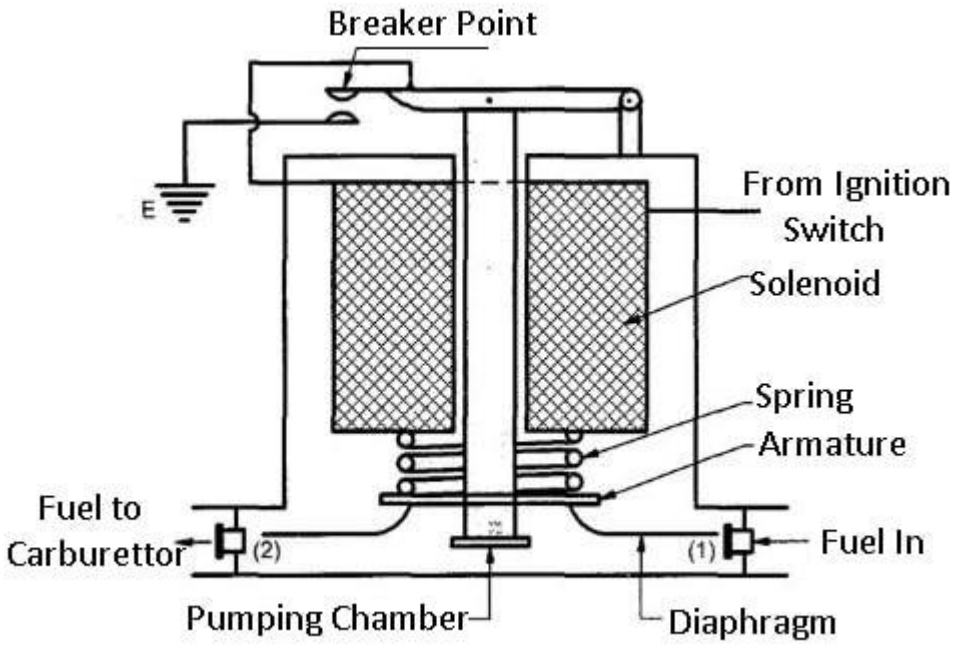


Fig. Root's Supercharger

3b) With neat sketches, explain the working of the electrical fuel pump.

Electric Fuel Pump

The electrical fuel pump is mounted in the fuel tank. It contains an impeller which is driven by an electric motor. This pushes the fuel through the fuel line to the carburettor. Another type of electric fuel pump is mounted in the engine compartment.



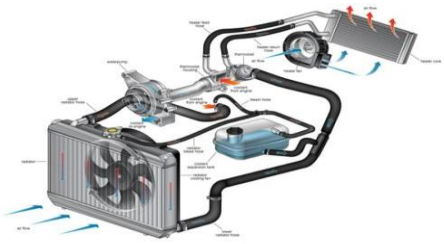
ELECTRIC FUEL PUMP

The figure shows an S.U.elcetric fuel pump. It also consists of a diaphragm, but it is operated electrically. But turning on the ignition switch, the solenoid winding generates magnetic flux, which pulls the armature and the diaphragm moves up.

The upward movement of the diaphragm creates suction, and the fuel is drawn into the chamber through the inlet valve. But as soon as the armature moves up it disconnects the electric supply, the magnetic flux dies and the armature falls down, causing the cases the outlet valve to open and inlet valve to close.

The fuel goes out to the carburettor. The downward movement of the armature again sets electric supply to the solenoid, and the same process is repeated, the pump continues to operate until the ignition switch is turned off.

4 a) With a neat sketch explain the air cooling system and write the advantages and disadvantages of the air cooling system



AIR COOLING SYSTEM In this type of cooling system, the heat, which is conducted to the outer parts of the engine, is radiated and conducted away by the stream of air, which is obtained from the atmosphere. In order to have efficient cooling by means of air, providing fins around the cylinder and cylinder head increases the contact area. The fins are metallic ridges, which are formed during the casting of the cylinder and cylinder head

The amount of heat carried off by the air-cooling depends upon the following factors:

(i)The total area of the fin surfaces,
(ii) The velocity and amount of the cooling air and

(iii) The temperature of the fins and of the cooling air. Air-cooling is mostly tractors of less horsepower, motorcycles, scooters, small cars and small aircraft engines where the forward motion of the machine gives good velocity to cool the engine. Air-cooling is also provided in some small industrial engines. In this system, individual cylinders are generally employed to provide ample cooling area by providing fins. A blower is used to provide air.

Advantages of Air Cooled Engines Air cooled engines have the following advantages:

1. Its design of air-cooled engine is simple.

2. It is lighter in weight than water-cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.

3. It is cheaper to manufacture.

4. It needs less care and maintenance.

5. This system of cooling is particularly advantageous where there are extreme climatic conditions in the arctic or where there is scarcity of water as in deserts.

6. No risk of damage from frost, such as cracking of cylinder jackets or radiator water tubes.

4 b) what are the advantages of liquid cooling system and what are its limitations

ADVANTAGES: LIQUID COOLING VERSUS AIR COOLING

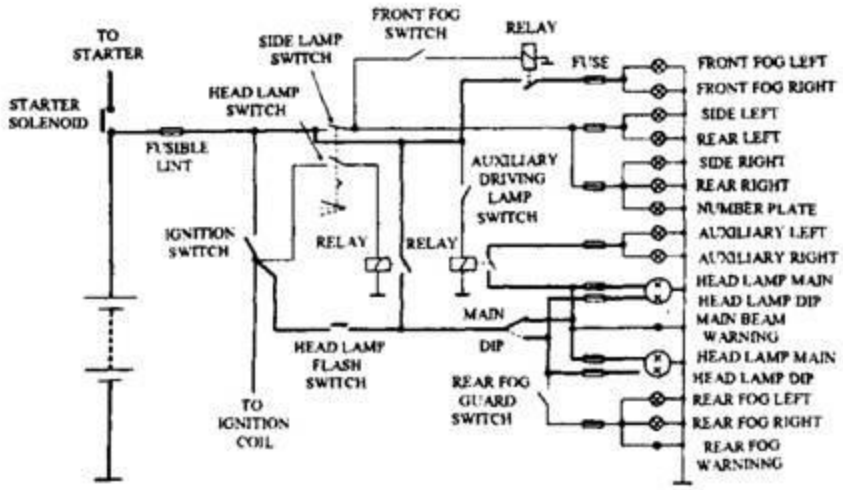
1. **Less clutter and more space:**Traditional air cooling uses fans. A typical air-cooled PC has several fans installed inside the PC case. These include fans for drawing air inside and outside the case, specific fans for the graphic card, and other specific fans for the CPU or processor.

2. **Noise-free operation:**Fans generate noise that becomes more audible when the PC is overworked. The PC becomes noisier with too much fans. Another one of the advantages of a liquid cooling system over air cooling system is that it does not generate the same noise. It is actually relatively silent.
3. **Better overclocking potential:**Overclocking a CPU or raising the frequency of the processor chip beyond the stock frequency is popular among computer hobbyists and builders. However, doing so results in too much power consumption and heat generation.
4. **Cooling specific components:**A higher degree of cooling specification is another one of the benefits of liquid cooling. This means cooling specific components of the computer to a greater degree than in traditional air cooling.

DISADVANTAGES: LIQUID COOLING VERSUS AIR COOLING

1. **More costly or expensive:**One notable disadvantage of liquid cooling over air cooling is that it is considerable costly to set up. Fans are prevalent in the market and this overabundance of supply means they are cheap.
2. **Complex to install:**Setting up a liquid cooling system from scratch can be tricky because it requires a certain degree of understanding in the fields of electronics and thermodynamics. This is another considerable disadvantage, especially for newbies. Take note that a good liquid cooling system should remove excess heat effectively and immediately.
3. **Susceptibility to leaks:**Poorly implemented liquid cooling system is likely to result in leaks. Note that water or liquid coolant can accelerate the corrosion of metal parts and damage electronic components. Pressure inside tubes can also build up due to too much heat absorbed by the liquid resulting in leaks.

5 a) with a neat sketch explain about the lighting system



The lamps in this parallel circuit are controlled by three switches. Switch 1 operates the side and rear lamps. It also supplies power. Switch 2 operates the headlamps and supplies power.
Switch 3 distributes the current to either the main beam or the dip-beam head lamp bulbs. 29.2.2. Circuit Protection and Extra Features
If a single fuse is installed along with in the external lighting supply cable, then all lights go out when the fuse fails. This is a dangerous situation when the vehicle is travelling at speed along a dark road. To eliminate such a situation manufacturers either fit separate fuses for each light system, or refrain from fusing the headlamp circuit altogether (Fig. 29.2). The circuit in Fig. 29.2 also incorporates extra features.

Headlamp Flash Switch.
This switch enables the driver to signal to other drivers during daylight avoiding the use of the main light switches. This is a spring-loaded switch and hence operates only when the lever is held in the 'on' position.

Ignition-controlled Headlamps.
As per the regulations the headlamps should not be used when the engine and vehicle are stationary. To accomplish this ignition switch controls the feed to the headlamps. Additionally a relay is installed to minimize the current load on the switch.

Auxiliary Driving Lamps.
These long range auxiliary lamps (spot lamps) are utilized when the headlamps are set to main beam. But these lamps should not be in operation when other vehicles are approach and to achieve this the auxiliary lamps are connected to the main beam branch of the circuit. Since the power consumed by these lamps is considerable, a relay is used to control these lamps.

Front Fog Lamps.
During fog the main headlamps cause glare. This problem is minimized by using low mounted fog lamps. These twin lamps can be used in place of headlamps and hence feed is taken from the side lamp branch of the circuit.

Rear Fog Guard.
These high intensity fog lamps highly illuminate the rear of the vehicle, and hence they must be used only in conditions of poor visibility to guard the rear. To prevent illegal use of these lights the supply is taken from either the dipped beam or the front fog lamps. A warning light must indicate the operation of the rear fog guard lamps.

Lamp Failure indicator.
Many manufacturers also incorporate a warning system to indicate the driver the nonfunctioning of a light. Often the lamp signal indicator on the instrument panel glows either when the lights are operating normally, or as a signal to warn the driver that a light is out. Most graphical display systems provide full illumination for a few seconds after switching-on the ignition. This feature permits checking of the lights in the graphical display and indicates that they are functioning correctly.

In addition to this graphical display unit, a module (sometimes called a bulb outage module) is installed to monitor when a particular section of the circuit does not consume the rated current. When an open-circuit condition happens the module triggers a light on the instrument panel to indicate the driver the lamp which is out. Each branch of the circuit passes through the module for monitoring the system. However, this feature complicates the circuit and increases the length of cable needed for the lighting system. But, it is still in use on the grounds of safety.

Dim-dip Lighting Devices.

Some regulations compel for fitting dim-dip lighting system in vehicle. This system does not permit the vehicle to be driven on side lights alone, because the side lights can be operated only when the ignition is switched off so they may be regarded as parking lights. Headlamps can be operated in two dip modes. A dim-dip light is of low power, which is used without dazzling other road users in well-lit streets at night or dull weather at twilight. Whereas the dip beams of standard intensity is used for normal night driving in out-of-town areas. As per the regulation one pair of headlamps should incorporate a dim-dip device. Compared with the normal dipped beam, the dim-dip light intensity should be 10% for halogen lamps or 15% for normal filament lamps.

5 b) what are requirements of an ignition system? Explain in detail.

GENERAL DESIGN REQUIREMENTS Following is a number of design criteria to be considered in the design of ignition systems.

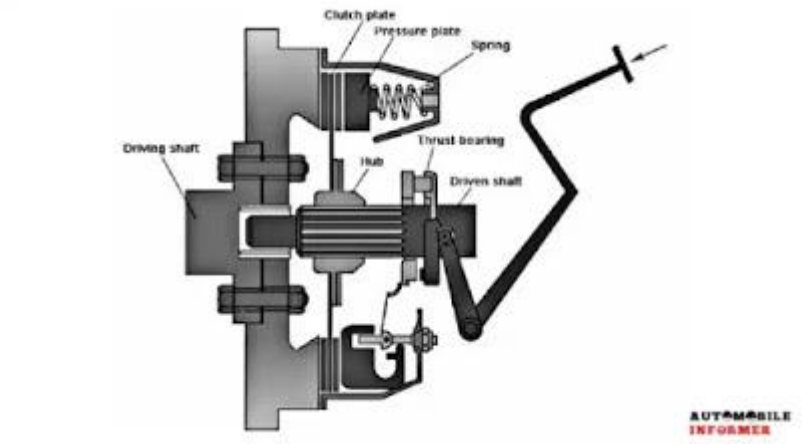
1. Use as short a voltage rise time as practical, not necessarily as short as possible. With a sufficiently short rise time, an ignition system can more readily fire fouled plugs. In selecting the upper limit on rise time, capacitance loading, corona loss, and Insulation failure become of paramount Importance.
2. A new ignition system must be more reliable than the system it replaces. Reliability includes the time and cost of maintenance.
3. If the system is not original equipment, installation should require a minimal change in components or wiring.
4. Input power should vary as engine speed.
5. Use energy levels only sufficient for operation.
6. Gains should be made by well known ignition practices related to voltage, namely:

a. Keep the cppacitance of the ignition leads as low as possible by keeping them away from metal parts. b. Reduce secondary series resistance to that required for radio suppression. c. Use short leads. d. Reduce corona losses, and hysteresis of coils and capacitors. e. Develop only sufficient voltage to assure that an arc can be produced at all engine load and operating conditions. A small voltage reserve may be applied, but should not be overdone.

7. If the system is designed to replace an existing one, leave the original system intact so thlA it may be readily reconnected in case the new system fails.

8. Be able to operate at temperatures in the engine compartment, preferably as high as 2500 F., to permit installation directly on the fire wall.

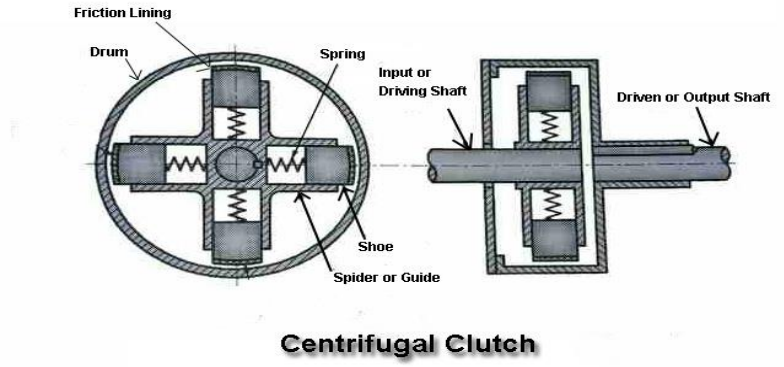
6 a) With neat sketch explain the working of single plate clutch.



WORKING OF SINGLE PLATE CLUTCH

- In the Clutch the three parts needs. These are the engine flywheel, a friction disc or a clutch plate and a pressure plate.
- Some springs give axial force to stay the clutch in the engaged position. When the engine is running and therefore the flywheel is rotating, the pressure plate also rotates because the pressure plate attaches to the flywheel. The friction disc is located between the flywheel and the pressure plate.
- When the driving force has pushed down the clutch is released. This action forces the pressure plate to move away from the friction disc against the force of pressure springs. With this movement of the pressure plate, the friction plate is released, and therefore the clutch disengaged.
- When your foot is off the pedal, the springs push the pressure plate against the clutch disc, which successively presses against the flywheel. This locks up the engine to the transmission input shaft, causing them to spin at the same speed.
- The quantity of force the clutch can hold depends on the friction between the clutch plate and the flywheel, and in this way, much force the spring puts on the pressure plate.
- When the clutch presses, the piston pushes on the release fork, which presses the throw-out bearing against the center of the diaphragm spring. As the middle of the diaphragm spring pushes in, a series of pins near the outside surface of the spring causes the spring to pull the pressure plate away from the clutch plate. This releases the clutch from the spinning engine.

6 b) Enumerate advantages and disadvantages of centrifugal clutch



Centrifugal Clutch

Working of Centrifugal Clutch:

- When the driving shaft or input shaft revolves, it exerts a radially outward centrifugal force on the shoe, magnitude of which depends upon the speed of the shaft.
- Here when the input shaft is rotated the power is transmitted from the input shaft. As the speed of the shaft increases, the centrifugal force experienced by the shoes of the centrifugal clutch increases.
- When the speed of the input shaft reaches a particular speed then the centrifugal force exerted on the shoe exceeds the binding force of spring and the shoes start moving in radially outward direction.
- When the shoes reach the drum, the friction lining gets pressurized on the inner surface of the drum. The inner surface of the drum also has some sort of friction lining.
- As soon as the inner surface of the drum gets in contact with the friction lining of the shoe, the drum also starts rotating and the torque is transmitted.

Advantages of centrifugal clutch:

1 It is easier for the driver since the operation becomes simpler.
2) It is low in price.
3) It requires very little maintenance.
4) It is safer for both the user and the system since huge loads won't stall the engine and letting the throttle free disengages the driving shaft almost immediately.
5) The engaging speed can be preciously controlled by selecting springs.

6) If optimized in conjunction with a particular engine, the overall operation can become extremely efficient and effective.

Disadvantages of Centrifugal clutch:

1 Power transmission is limited due to slippage.
2) Overheating problem due to friction between the drum and shoes. If taken too far due to bad driving/usage habits, permanent damage may completely destroy the clutch.
3) There is a need for frequent oiling of centrifugal clutch arrangement so as to keep the temperature at a safe level.
4) It can not be used to transmit a high amount of torque.
5) The power transmission is totally dependent on controlling speed.
6) There will be always a power loss due to friction and slipping.

7A) discuss the construction and working of a constant mesh gearbox

Constant Mesh Gearbox was invented to overcome the limitations of the sliding mesh gearbox. In this gearbox, all the gears are always in mesh. The gear remains fixed and not slide like the sliding mesh gearbox.

In this gearbox, the sliding mesh was replaced with constantly meshed pairs of gears and the new shifting devices named dog clutches were introduced.

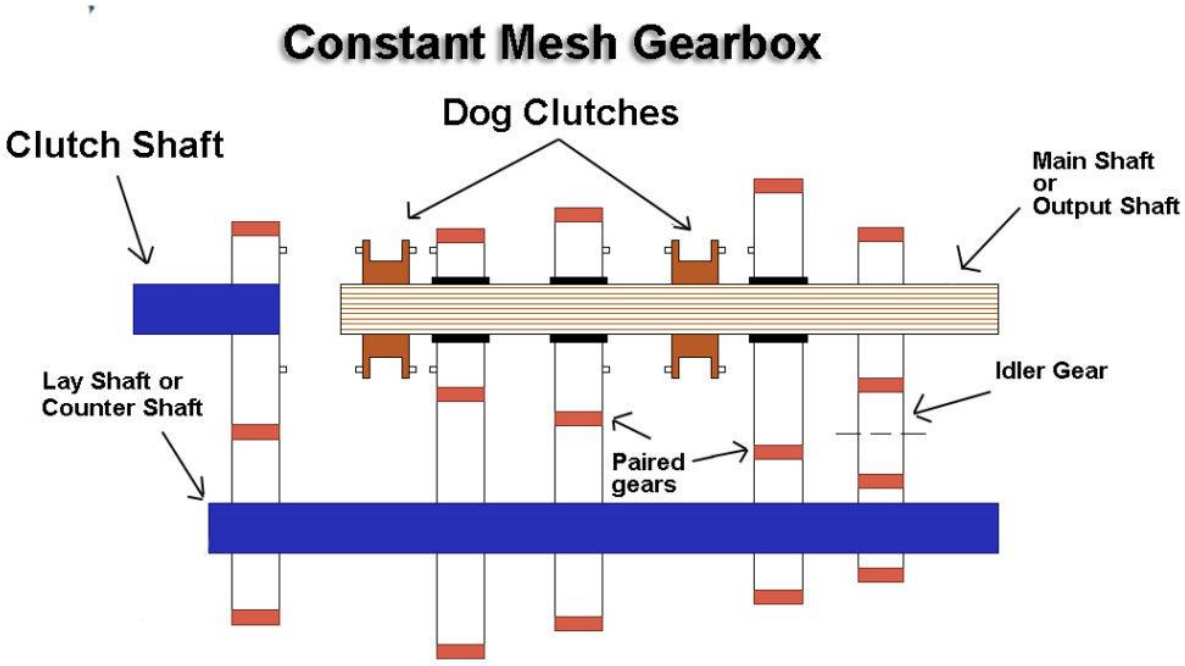
A constant mesh gearbox usually comes with 4-speed 1-reverse manual transmission configuration.

This gearbox has different parts like counter shaft, main shaft, clutch shaft, gears and dog clutch. Gears on the couter shaft are fixed to it and the gears on the main shaft are free to rotate. Helical and herringbone gears are usually used in this gearbox, so it is quiter than sliding mesh gearbox which uses spur gears.

In this gearbox all the gears in the main shaft and the counter shaft are always engaged with each other . Different transmission ratio or speed ratio are obtained by using the **dog cluth** .
Dog clutches engage with gears on the main shaft to obtain desired speed or torque.

Working of Constant Mesh Gearbox:

- When the **dog clutch** is engaged with different gears of main shaft different gear ratios are obtained as gears of main shaft are always paired with gears of counter shaft to form different gear ratios.
- If the dog clutch is not in contact with any gear of main shaft the gears of main shaft rotates freely and does not rotates the main shaft as they are connected with main shaft using bearings.
- The main shaft rotates only when one of the dog clutch is engaged with any of the gear of the main shaft.
- Reverse gear is obtained in this gearbox using the same technique that was in sliding gearbox i.e using the idle gear between main shaft gear and counter shaft gear.



7b) Explain the differential of an automobile with a neat sketch

Differential gear, in automotive mechanics, gear arrangement that permits power from the engine to be transmitted to a pair of driving

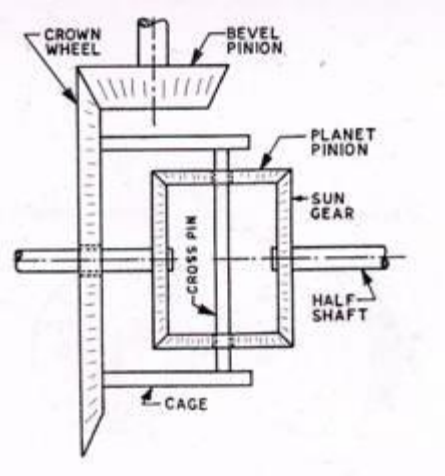
wheels, dividing the force equally between them but permitting them to follow paths of different lengths, as when turning a corner or traversing an uneven road. On a straight road the wheels rotate at the same speed; when turning a corner the outside wheel has farther to go and will turn faster than the inner wheel if unrestrained.

The elements of the Pecqueur differential are shown in the Figure. The power from the transmission is delivered to the bevel ring gear by the

drive-shaft pinion, both of which are held in bearings (not shown) in the rear-axle housing. The case is an open boxlike structure that is bolted to the ring gear and contains bearings to support one or two pairs of diametrically opposite differential bevel pinions. Each wheel axle is attached to a differential side gear, which meshes with the differential pinions. On a straight road the wheels and the side gears rotate at the same speed, there is no relative motion between the differential side gears and pinions, and they all rotate as a unit with the case and ring gear. If the vehicle turns to the left, the right-hand wheel will be forced to rotate faster than the left-hand wheel, and the side gears and the pinions will rotate relative to one another. The ring gear rotates at a speed that is equal to the mean speed of the left and right wheels. If the wheels are jacked up

with the transmission in neutral and one of the wheels is turned, the opposite wheel will turn in the opposite direction at the same speed.

The torque (turning moment) transmitted to the two wheels with the Pecqueur differential is the same. Consequently, if one wheel slips, as in ice or mud, the torque to the other wheel is reduced. This disadvantage can be overcome somewhat by the use of a limited-slip differential. In one version a clutch connects one of the axles and the ring gear. When one wheel encounters low traction, its tendency to spin is resisted by the clutch, thus providing greater torque for the other wheel.



8a) What are the objects of suspension system? With a neat sketch explain about torsion bar in suspension system.

Your car's suspension system is responsible for smoothing out the ride and keeping the car in control. Specifically, the suspension system maximizes the friction between the tires and the road to provide steering stability and good handling. The suspension system also provides comfort for passengers to limiting the impact of particular road conditions to not only the car, but the passengers riding inside.

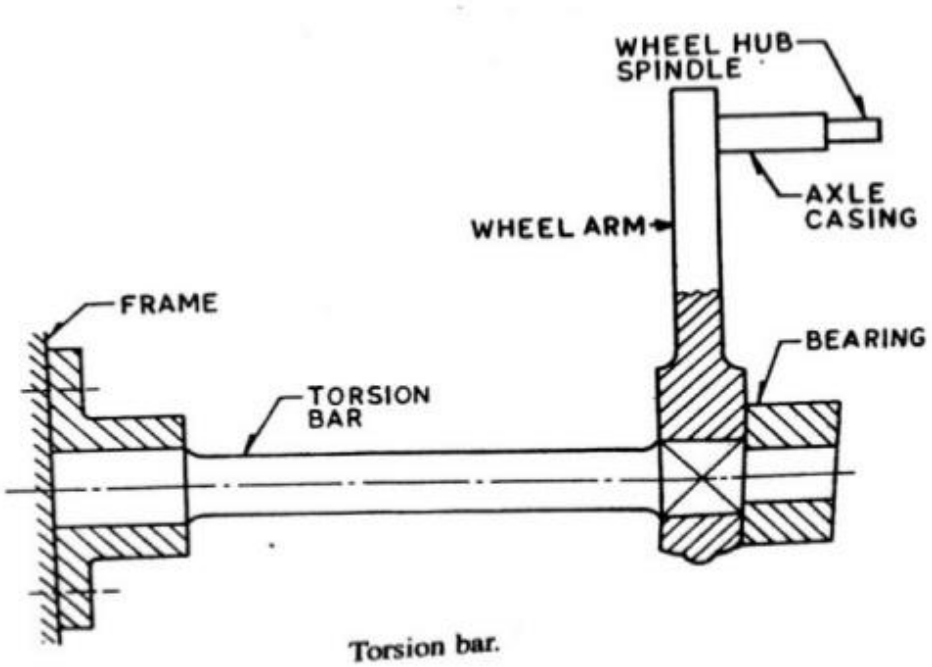
- Provide consistent handling and braking
- Prevent premature tire wear
- Help keep the tires in contact with the road
- Maintain dynamic wheel alignment

- Control vehicle bounce, roll, sway, drive, and acceleration squat
- Reduce wear on other vehicle systems
- Promote even and balanced tire and brake wear

WORKING OF TORSION BAR

Torsion bars use the twisting properties of a steel bar to offer coil-spring-like functions. One end of a bar is fixed rigidly to the vehicle frame. The further end is fastened to a wishbone, which acts like a lever that travels perpendicular to the torsion bar. When the wheel hits at a stone or projections, vertical motion is shifted to the wishbone and then, through the levering act, to the torsion bar. The torsion bar then twists sideways its axis to offer the spring force. European car manufacturers used this system widely, as did Packard and Chrysler in the United States, through the 1950s and 1960s.

TORSION BAR



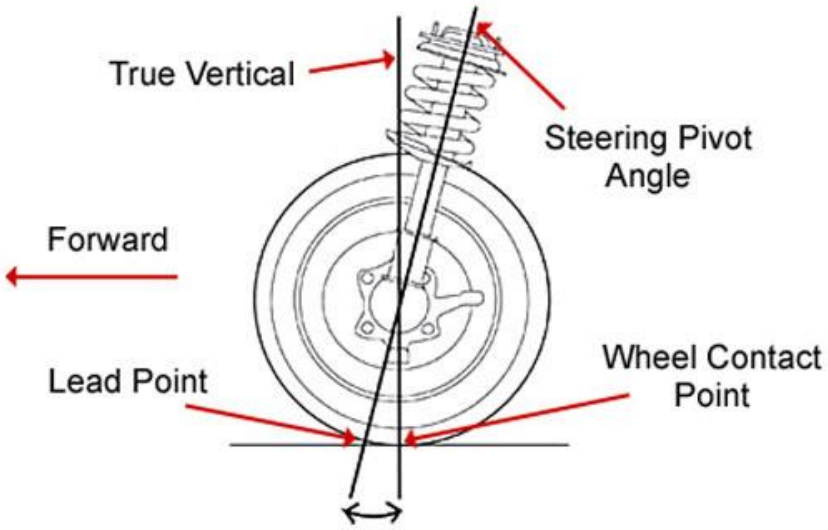
Torsion bar.

ADVANTAGES OF TORSION BAR SUSPENSION SYSTEM

In this system there are several key advantages. The design of the torsion bar suspension takes up less area than other suspension systems. This makes the vehicle designers to create a more spacious passenger compartment. The elevation of the bars can also be varied more easily than other suspension systems. They are also extremely durable and habitually have a long service life.

8 b) Generalize the purpose of caster and camber

Caster is the measure of how far forward or behind the steering axis is to the vertical axis, viewed from the side. This is measured by drawing a line between the top and bottom pivot points of the front upright. The angle between the drawn line and vertical is the caster angle.



Positive Caster

Positive caster is when the top upright mounting point is more rearward of the car than the bottom mounting point when looking at the side view.

Another way to get positive caster is when the two mounting points are on the same vertical line as each other but are both infront of the centre line of the wheel. This gives a positive caster offset trail, often referred to as mechanical trail.

Neutral Caster

Neutral caster is when the upright mounting points are on the same vertical plane as each other as well as being on the same vertical plane as the centre line of the hub and wheel.

Negative Caster

Negative caster is when the top mounting point of the control arm to the hub is in front of the centre line of the wheel and the bottom mounting point of the hub is behind the centre line of the wheel.

Another way to obtain negative caster is for both mounting points to be on the same vertical line as each other but behind the centre line of the wheel.

Camber

When the word “camber” is used in relation to automobiles, it refers to the angle of a vehicle’s wheels and their vertical position as they sit on the surface of the ground or road.

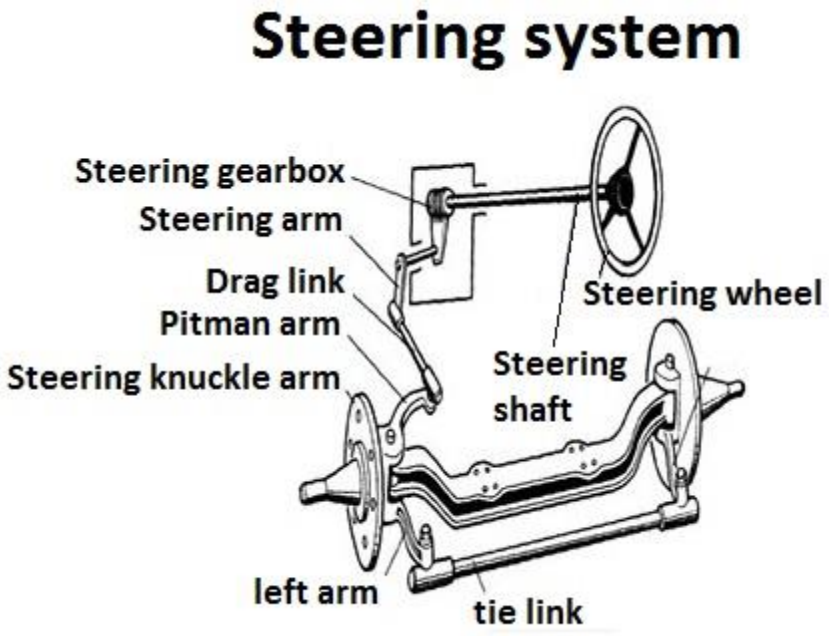
If the wheels have a negative camber, it means the tops of the front wheels are inclining to the side toward the center of the vehicle’s frame. If the wheels have a positive camber, it means the tops of the front wheels are inclining toward the outside and away from the center of the chassis.

The importance of the camber angle has to do with how stable it makes the vehicle on the road, particularly when making turns around corners. The general consensus is that a positive camber is good for keeping a recreational vehicle stable, while a negative camber is better for allowing high-performance vehicles to turn corners faster and more accurately.

You use degrees to measure the camber angle when figuring out the distance that the wheels will incline from the vertical axis.

9a) Draw a neat sketch of a steering system, mark all important parts on it and explain how the system works.

Steering is the group of components and linkages, which allows any car to follow the desired course. The purpose of steering system is to allow the driver to guide the car. Each car have a steering gear, which used for controlling the direction by turning usually front wheels of a car.



The steering system is worm gear or screw gear, and rack and pinion or steering box intended to converts the rotation of the steering wheel into a movement of the road wheels. The steering system also provides a driver to use light force to steer a heavy car. The steering effort transmits to the wheels through a system of pivoted joints.

Pivoted joints are allow the wheels to move up and down with the suspension without changing the steering angle. Pivoted joints adjusting must be very precisely, because even a little loneness can be a reason of a dangerous situation on the road.

There are two main steering systems in use:

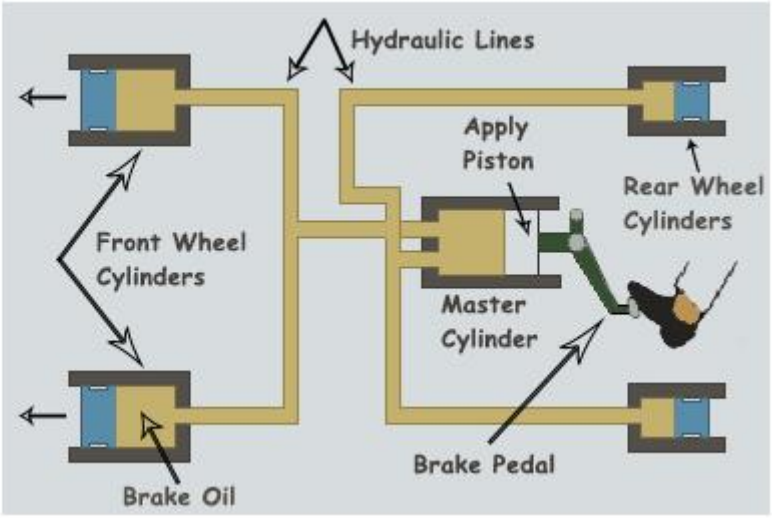
- rack and pinion;
- Steering box.
  - The trucks have heavier steering, so these have a system of power assisted to reduce the effort on the steering wheel needed to move the vehicle.

  - **The rack-and-pinion system construction**
  - There is a small gear wheel inside a housing at the base of the steering column. Turning of the gear wheel makes the rack move from side to side.

  - The ends of the rack couples to the road wheels by track rods.

  - **The steering-box system**
  - There is a worm gear inside the box at the base of steering. Worm gear is a threaded cylinder. When a bolt is turning which holding a nut – the nut move along the bolt. In the same way worm gear are working. The steering system with worm gear has achieved wide distribution.

9 b) With a neat sketch, explain the working of hydraulic braking system.



Without a proper braking system, it is impossible to operate an automobile. Braking systems allows a vehicle to stop or slow down by applying only a small force on the brake pedal. Whatever it is, from bicycles to aeroplane, every vehicle we use must have a proper braking system. The electromagnetic braking system, servo braking system, mechanical braking system, hydraulic braking system, **ABS brakes**, etc.. are some braking system categories that are in use. Recently, most of the automobiles have brakes on its 4 wheels to ensure safety while driving. Among the four, brakes located on the front wheels play an important role in stopping the car.

Here, we can discuss more details on the **hydraulic braking system** that are commonly used in cars or automobiles.

The hydraulic braking system uses hydraulic fluid(commonly brake oils containing glycol ethers or diethylene glycol) to transmit the force applied on the brake pedal to the final drum shoes or disc calliper to stop the moving vehicle. The major components in the hydraulic brake system circuit are connected fluid-filled master cylinder and slave cylinders. When the driver applies force on the brake pedal, the fluid in the master cylinder is pushed to the slave cylinder through the connected brake lines. When fluid enters into the slave cylinder, the piston rod will move outwards and create the friction that makes the wheels to stop. This is the principle of hydraulic brake working.

Brake Pedal: To slow down or stop the movement of a vehicle, the driver will apply force on a pedal. This component where the driver presses with his/her foot is called the brake pedal. It is connected to the master cylinder through a mechanical cord or linking rod.

Master Cylinder: An important unit of every braking system that converts the applied force on the pedal to hydraulic pressure. The basic functions of master cylinder include developing

pressure, equalizing the required pressure for braking, preventing contaminants like air and water, etc… Master cylinder components are housing, reservoir, piston, rubber cup, pressure check valve and more.

Wheel cylinder: Wheel cylinders are responsible for converting hydraulic pressure to mechanical pressure used for pushing brake shoes towards the drum. The stepped wheel cylinder and the single-piston wheel cylinder are the two major categories of wheel cylinders.

Brake Lines & Hoses: Brake lines or hoses are used for transferring high-pressure fluid between different components. In these two, brake lines are rigid and are constructed using double-wall steel tubings. Whereas the brake hoses are flexible that can be moved.

Brake Fluid: Brake fluids are the medium that transfer pressure to the wheel cylinders. Low freezing point, water tolerance, lubrication, non-corrosiveness, proper viscosity and high boiling point are the required properties for hydraulic brake fluids.

Drum Brake: It is a small round drum containing a set of brake shoes inside it. The brake shoes are supported on a back-plate that is bolted to the axle-casing. This will rotate along with the wheels and when the driver applies the brake, the shoes will come closer to the drum and will resist the rotation of wheel.

Disk Brake: It contains a disc-shaped metal rotor bolted to the wheel hub. So, this metal rotor will spin within the wheel. While pressing the brake pedal, the brake pads will be squeezed against the disk and slow down the vehicle.