

## SIXTH SEMESTER DIPLOMA EXAMINATION IN MECHANICAL ENGINEERING—OCTOBER,2013

**AUTOMOBILE ENGINEERING**

(Maximum marks : 100) [Time : 3 hours]

**PART—A** (Maximum marks : 10)

I. Answer all questions in one or two sentences. Each question carries two marks.

**1. What do you mean by Air-fuel ratio.**

**Ans:** Air–fuel ratio (AFR) is the mass ratio of air to fuel present in a combustion process such as in an internal combustion engine or industrial furnace. If exactly enough air is provided to completely burn all of the fuel, the ratio is known as the stoichiometric mixture, often abbreviated to stoic. For precise AFR calculations, the oxygen content of combustion air should be specified because of possible dilution by ambient water vapour, or enrichment by oxygen additions. The AFR is an important measure for anti-pollution and performance-tuning reasons.

**2. List any two sources of noise in an automobile.****Ans:**

- Piston slap which is generated when the piston moves from side to side during the engine cycle.
- Timing gear rattle which is generated when the teeth of the gears impact.

**3. What is a CV joint.**

**Ans:** All front-wheel drive cars have *Constant Velocity joints* or *CV joints* on both ends of the drive shafts (half shafts). Inner CV joints connect the drive shafts to the transmission, while the outer CV joints connect the drive shafts to the wheels. The CV joints are needed to transfer the torque from the transmission to the drive wheels at a constant speed, while accommodating the up-and-down motion of the suspension.

**4. Define king pin inclination.**

**Ans:** This is the inward tilt of the king pin as from the vertical plane. This tilting tends to keep the wheels straight ahead, and makes the wheels return to the straight position, after completion of a turn; it also reduces steering effort.

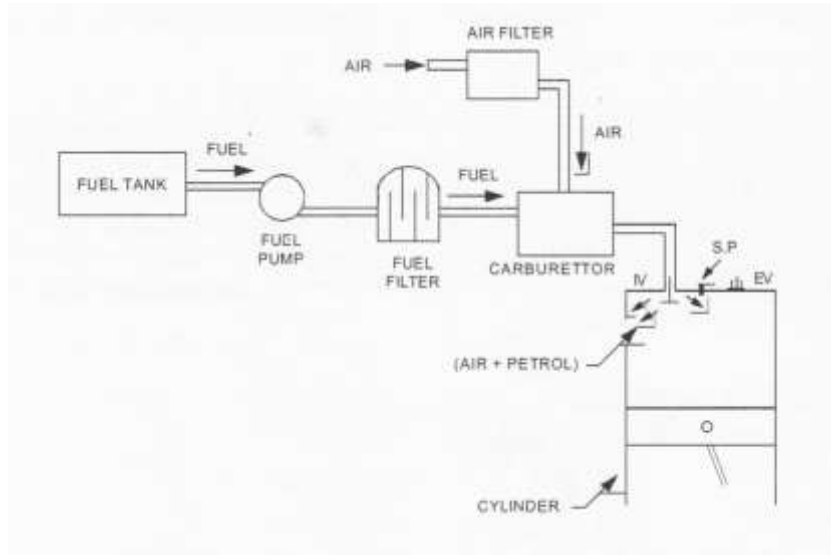
**5. What is a spoked wheel.**

**Ans:** A spoke is one of some number of rods radiating from the center of a wheel (the hub where the axle connects), connecting the hub with the round traction surface. Moreover the diameter of the wheel is very quick as only one unit is to be loosened. The internal splines are provided in the hub to mount on the axle shaft. The spokes are correct length and cross tension to hold the rim centrally. The initial tension of the spokes can be adjusted by means of screw nipples.

**PART—B** (Maximum marks : 30)

I. Answer Any five questions. Each question carries 6 marks.

**1. Draw a neat layout of fuel injection system of a diesel engine.****Ans:**Fuel injection system



The main components of fuel injection system are,

- a. Fuel tank
- b. Fuel feed pump
- c. Filter
- d. Injection pump
- e. Injector.

During the operation, the fuel from the tank enters the fuel feed pump. In feed pump the pressure of fuel is risen slightly. Then the fuel is drawn into the filter where all the dust particles are removed. From the filter the fuel enters into the injection pump where the pressure of fuel is increased above the pressure of air in the cylinder at the end of combustion. At this high pressure fuel is sprayed into the engine cylinder by means of fuel injector. Any spill over fuel in the injector is returned to the filter.

**2. What are the exhaust pollutants emitted by petrol or diesel vehicle.**

**Ans: Hydrocarbons:**

Hydrocarbon emission result when fuel molecules in the engine do not burn or burn only partially. Hydrocarbon reacts in the presence of nitrogen oxides and sunlight to form ground level ozone, a major component of smog.

**Nitrogen oxide:**

Under the high pressure and temperature condition in an engine, nitrogen and oxygen atoms in the air react to form various nitrogen oxides, collectively known as NOx.

**Carbon monoxide:**

Carbon monoxide is a product of incomplete combustion and occurs when carbon in the fuel is partially oxidized rather than fully oxidized to carbon dioxide.

**Carbon dioxide:**

In recent years, the US environmental protection agency has started to view carbon dioxide, a product of perfect combustion, as a pollution concern. Carbon dioxide does not directly impair human health, but it is a green house gas that traps the earth's heat and contributes to the potential for global warming.

**3. Write any six requirements of a clutch.**

**Ans:**

- Gradual engagement.
- Torque transmission.
- Heat dissipation.
- Vibration damping.
- Dynamic balancing.
- Free pedal play.

**4. Explain the working principle of epicyclic gear box.**

**Ans:** This is also known as planetary gear train. One shaft is called sun gearshaft and other shaft is called planet carrier shall.

The central gear is known as sun gear which is in constant mesh with two or three gears called planet gears. The sun gear will rotate only on its own axis. But the planet gears, apart from rotating about their own axes.

The sun gear shaft is rotated by the engine crank shaft. To obtain different speed ratios only one of the above units is made stationary by means of a brake band. For example ring gear is locked, the sun gear causes the planet gear to rotate. First, let the ring gear be locked. Due to rotation of the sun gear, the planet gears will rotate. But the planet gear is in mesh with the internal teeth of the ring gear also. Since the ring gear is held stationary, the planet gears will be forced to climb over it, and walk around the ring gear internally. So, ring gear acts as the track for the planet gears to move over.

The driven shaft which is connected to the planet carrier is made to rotate. When the ring gear is released it will also rotate with the planet gears. Hence, there is no movement of the planet carrier shaft. So : the driven shaft will remain stationary.

#### 5. Explain leaf spring suspension.

**Ans:** Leaf springs are formed by bending. They are made up of long flat strips of spring steel. A number of strips are placed one above the other, and held together with the help of centre U bolt and clamps. Each strip is named as a leaf. The longest leaf extends and consists of eyes or loops at both ends. These loops or eyes provide facilities to connect the frame. The other leaves are shorter. The progressive leaf spring is bent in the form of an elliptical shape. Its curvature and camber are pre-determined during manufacturing itself. Normally, the longer leaf is secured to the front hanger by a bolt at one end and by a spring shackle at the other end. Both hangers are bolted to the frame. The spring will get elongated during compression and shortened during expansion. Any change in length of spring is compensated by the shackle. Some rebound clips are located at the intermediate positioning of the spring. These clips are loose enough to permit the leaves together to slide and tight enough to get closer when the spring rebounds. The eyes or loops at the ends are provided with bushings or with some anti-friction material like bronze or rubber. In this leaf spring arrangement the spring weight is made as light as possible. The front eye of the leaf spring is attached to the frame. The rear eye is connected to a spring shackle.

#### 6. How mechanical brakes are operated.

**Ans:** Mechanical brakes are obsolete now as service brakes. However, these are still used on rear wheels in many cars, as parking or energy brakes. There are two main types of mechanical brakes are, Drum brakes and Disc brakes.

There are brake shoes which come in contact with the rotating drums during braking operation. At each wheel, there are two shoes used. The shoes are provided with lining on their surfaces. An anchor is used to lift the brake shoes at one end. The other end is connected by some method so as to make the brake shoes come in contact with the brake drums. After the operation of braking, the brake shoes should return to their original position. For this purpose, retracting springs are fitted. These springs also keep the shoes even when the brakes are not in operation. So, in general the braking system includes brake shoes, drum plate acting as means to fasten cam and the brake shoes with an enclosure to keep the entire mechanism is shown in figure.

Normally a cam toggle or toggle lever is used to operate the shoes and mechanical linkages are provided which are operated by the driver's foot.

#### 7. Write short notes in central locking system.

**Ans:** The central locking system is controlled by an electric device called the central locking control unit that is basically a relay. There are normally 4 wires that go to each door. Two of the wires connect to the lock mechanism and tell the central locking control unit whether the doors are locked or not. The other two wires connect to the actuator which can either take the form of a motor or an electro magnet. The central locking control unit connects these wires in one direction to lock and the opposite direction to unlock the doors. Most modern cars also have a remote key fob. This sends a radio or IR signal to a detector which then connects to the central locking control unit to tell the car to lock or unlock. This uses a coded signal that is unique to that particular key fob.

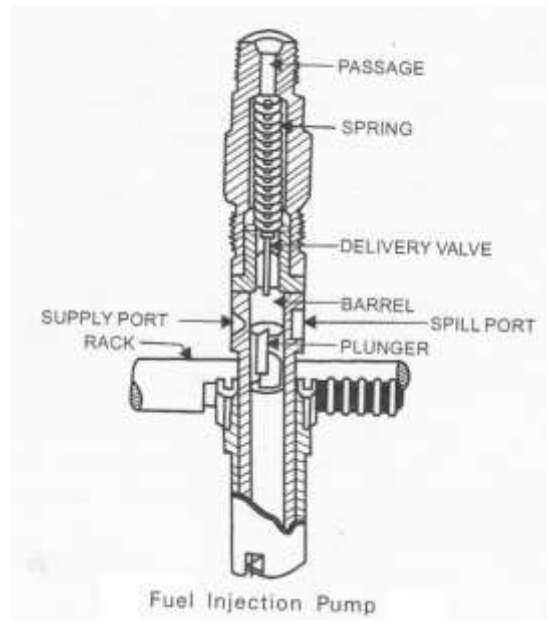
**PART—C** (Maximum marks : 60)

II. Answer one full question from each unit. Each question carries 15 marks.

#### UNIT – I

III. Explain with neat sketch the working principle of fuel injection pump.

**Ans:** Fuel injection pump



The fuel injection pump serves the supply of metered quantity of fuel into engine cylinder. It comprises plunger reciprocating in a barrel. Barrel is a cylindrical one with two diametrically opposite ports, one is inlet and other spill port. Fuel injection pump is connected to fuel injector through delivery valve which opens under fuel pressure against the spring action. The plunger is turned by means of control sleeve which is driven by rack and teathed segment.

As the plunger moves up, it closes the inlet port and spill port of the barrel and pressurise the fuel in the barrel. The fuel pressure increases causing delivery valve to open and allow the fuel to enter into the fuel injector at high pressure. With further rise of the plunger, at a certain moment, the spill port is connected to the edge of helical groove. As soon as spill port uncovers, the fuel passes through the vertical groove and annular helical groove to the spill port, thus reducing the pressure of the fuel above the plunger. As result the delivery valve is closed by the spring action. The quantity of fuel delivered is controlled by the turning of the plunger.

OR

IV. (a) Briefly explain any two methods of governing of IC engine.

Ans: (b) With the help of sketch explain the working of AC mechanical pump.

#### AC mechanical pump

1) Hit and Miss method of governing:

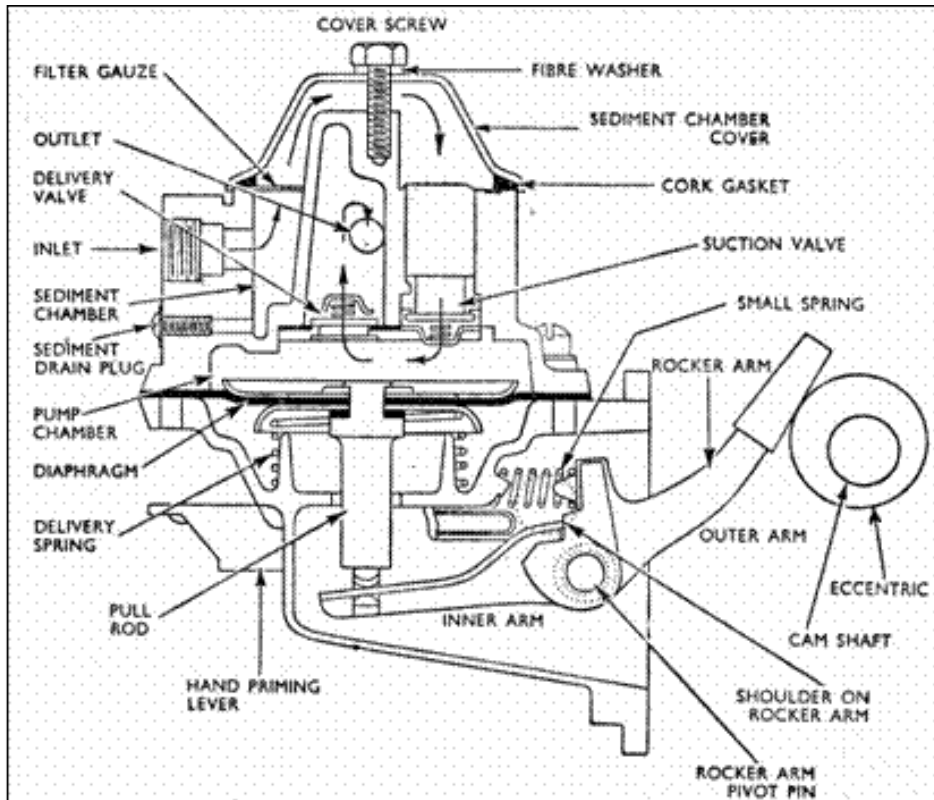
In this method, the supply of fuel is stopped for one or more cycles when the speed of engine increases. Once the supply is cut off, engine performs idle cycles which will reduce the engine speed.

It is simple, but the large fluctuation of speed takes place in the idle cycle which needs a heavy flywheel. This method is suitable for small gas or oil engines.

2) Quality governing:

This method is employed for high speed diesel engines (CI engines). In this method the quality of fuel supplied is varied by altering the air fuel ratio. For quality governing the amount of air drawn into cylinder is constant, but the supply of fuel varies. Thus the quality of the mixture is varied.

The pump is usually bolted to the crankcase of the engine and operated directly by an eccentric on the camshaft, or by push rod. As the camshaft rotates, the eccentric lifts the rocker-arm which pulls the connecting rod, together with the diaphragm, downward against the pressure of the return spring, thus creating a vacuum in the pump chamber. Fuel from the tank is then sucked through the inlet connection, into the sediment chamber, through the gauze filter and inlet valve into the pump chamber. On the return stroke the pressure of the return spring pushes the diaphragm upward forcing fuel from the pump chamber through the outlet or delivery valve and outlet connection to the carburettor.



When the correct level in the carburettor float chamber is reached, the needle valve will close, thus creating a back pressure in the pump chamber. This pressure will hold the diaphragm downward against the return spring and it will remain in this position until the carburettor requires more fuel and the float chamber needle valve opens.

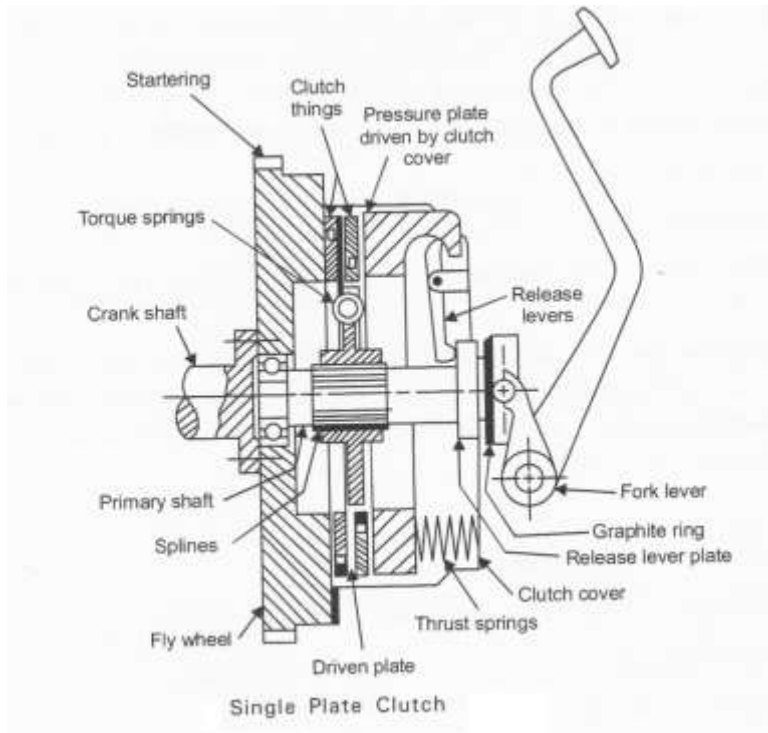
When the fuel pump is subjected to a back pressure the diaphragm connecting rod forces the interior, pivoted portion or lever of the two-piece rocker arm to the bottom of its stroke. As the outer part of the rocker arm, which is in direct contact with the eccentric cam, is also secured to the same pivot centre as the lever, the rocker arm will cease to operate the lever until the diaphragm is returned to its initial position. The small spring at the rocker arm shoulder is intended to keep the rocker arm in constant contact with the eccentric, to eliminate noise.

## UNIT – II

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

**Ans:** The single plate clutch consists of following parts :

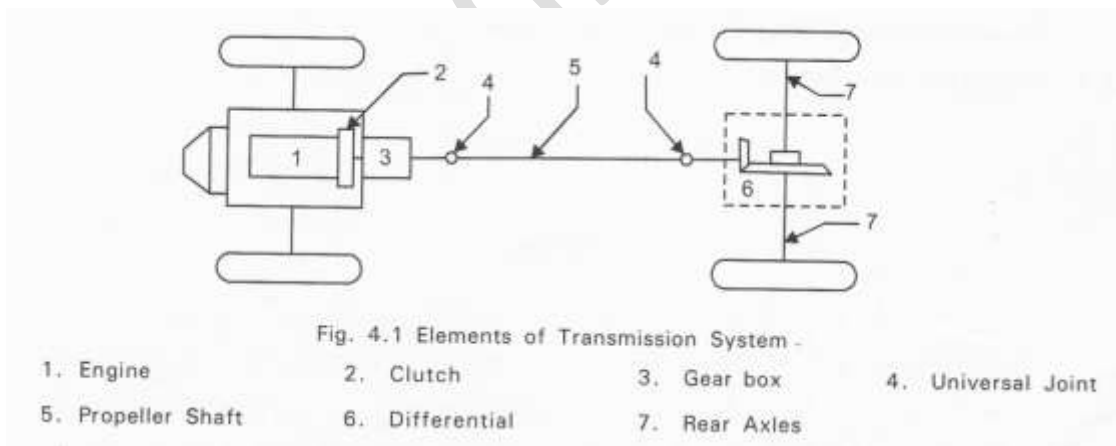
- Driving plate.
- Driven plate.
- Pressure plate.



When pressure is applied to the foot pedal, the pressure is transmitted through the release finger, fork and release bearing. Then, the springs are compressed and it moves back the pressure disc thus releasing the clutch plate. Now the clutch is said to be disengaged. At this stage, the pressure plate and fly wheel are free to rotate while the clutch plate remains stationary. Similarly, when the clutch pedal is released, spring pressure is fully applied on the clutch plate. It is held between the fly wheel and the pressure plate and rotates as a single unit. Thus the clutch is said to be engaged.

**(b) With block diagram explain how the power is transmitted from engine to rear axle.**

**Ans:**



**1. Clutch:**

- To connect the fast running engine to the stationary transmission in a progressive manner to effect smooth take off from rest.
- To engage or disengage the engine from transmission.

**2. Gear Box:**

- To change the speed of the vehicle.
- To reverse the vehicle.
- To overcome the low torque at low speed.

**3. Propeller shaft:**

- To transmit power from the gear box to the differential and at last to the final drive.

- To enable the driving wheels to move back and forth due to fixing of road springs.

4. Universal joint:

- To enable the drive shaft to transmit power at different angle.

5. Differential:

- To bring down the speed of propeller shaft to that of the road wheels.
- To provide different rotational speeds to the road wheels when the vehicle negotiates curved paths.

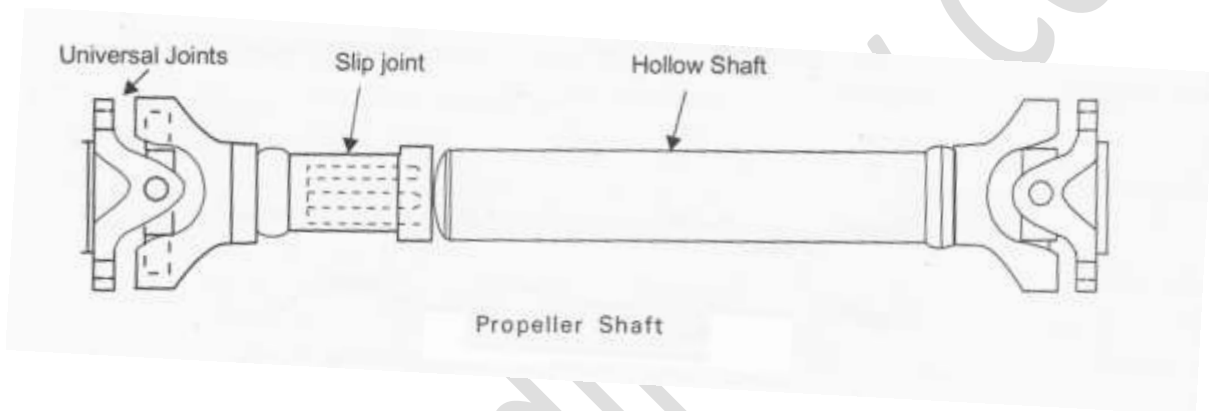
6. Rear axle:

- To rotate the two rear wheels.

OR

VI. (a) With neat sketch explain the construction and working of propeller shaft.

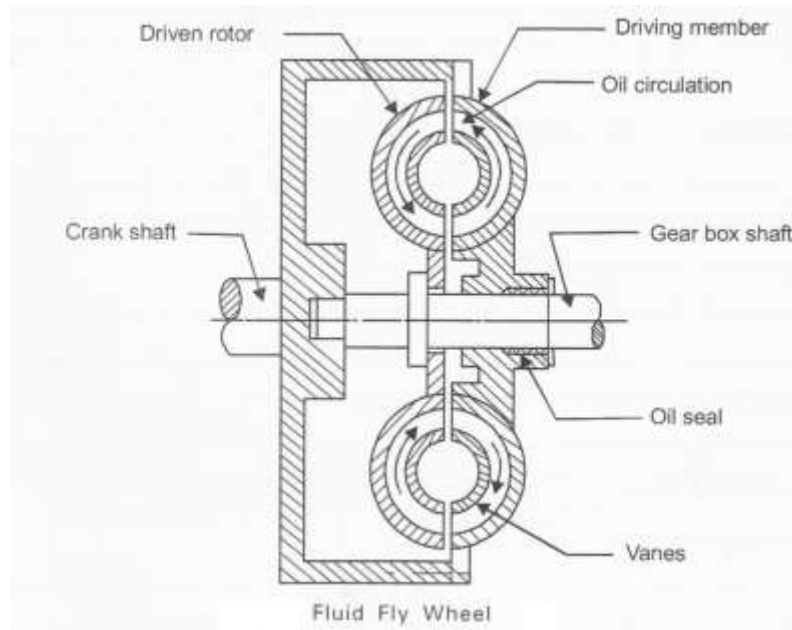
Ans:



This is an important shaft in the transmission system, by means of which drive is transmitted to the driving axle. The shaft power is to be transmitted to the rear wheels at different lengths and different angles. This shaft connects the transmission with the driving axle by means of universal joints. This shaft also contains a slip joint which enables the shaft to vary its length. Thus the propeller shaft has to transmit the power from the engine end to the driven end in different vertical and horizontal planes. The propeller shaft is to withstand torsional stresses, therefore, it must be well balanced. It should not whip when rotating at high speeds. This is made of a strong steel tube or shaft.

(b) Explain the working of fluid fly wheel with figure.

Fluid fly wheel



This is a liquid coupling used to transmit the engine turning force to a clutch. This assembly consists mainly two members.

- a) Driving member. And
- b) Driven member.

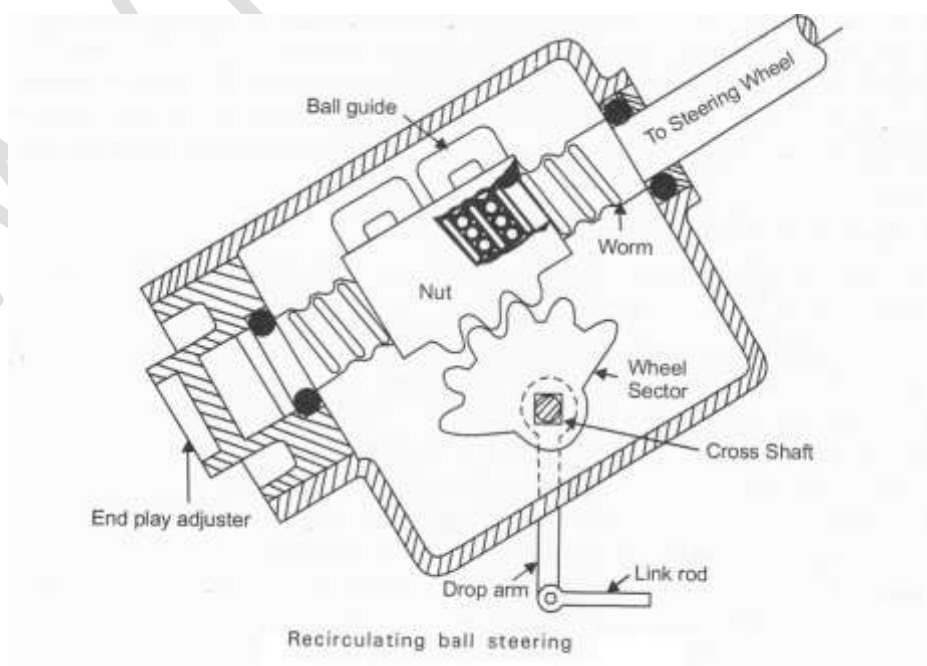
When the engine is started, the oil from the driving member is forced outward radially because of the centrifugal force. The oil moves generally in two directions at the same time. A rotary flow at right angles to the shaft and also in a vortex flow because of circulation between the impeller and the runner. The rotary flow initiates the movement of the runner. The vortex flow is at right angles to the rotary flow.

The oil is thrown out against the curved interior surface because of centrifugal force. Then, it is directed across, to the runner and returned to the impeller. When the efficiency of the coupling is highest, under best operating conditions, runner speed almost equal to the impeller. The lagging of the driven unit behind the driving unit is known as slip.

### UNIT – III

#### VII. (a) Sketch and explain the working of recirculating ball type steering gear box.

Ans:





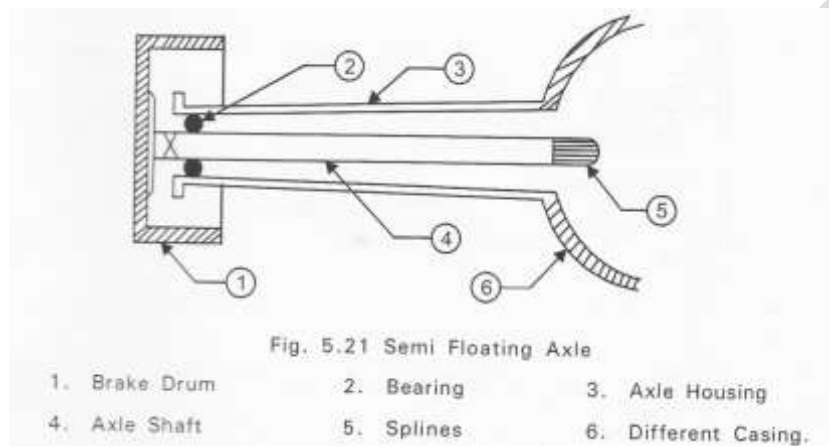
A recirculating ball gear has a driving gear and a driven gear. The driving gear is a worm gear with spiral threads. The driven gear is a sector gear, connected to the pitman arm.

This is a screw and nut type of steering gear box. The lowest end of the steering shaft carries a screw and a screw nut. The outer surface of the nut is provided with a threaded portion engaged with the sector wheel. The sector wheel is connected to the drop arm through cross shaft. The inner threads of the nut and the thread form of the screw are shaped as semi-circular grooves or a recirculating ball race is provided between the nut and the screw.

By turning the steering wheel, the balls in the worm, roll along the grooves. This movement causes the nut to travel along the worm. The balls are recirculated through the return guides shown. The up and down movement of the ball nut causes the wheel sector to turn to the required angle. The wheel sector actuates the drop arm and thereby the link rod. This results in the steering of the front wheels.

**(b) Draw and explain semi floating axle.**

**Ans:**



It is splined on the differential end and uses this end for driving purpose only. This end floats and carries no weight. A bearing is placed between the axle shaft and the housing at the outer end to carry the weight of the vehicle. The shaft is held in position by a lock on the differential end or by a bearing on the outer end.

**OR**

**VIII. (a) Write short notes on Camber, Caster, Toe in and Toe out.**

**Ans:** Camber:

This is the outward tilt of the front wheels from the vertical plane at the top. This tilting is called 'positive camber'. In case of negative camber, the load is allowed to act through king pin directly down thereby relieving any bending action of the pivots. The purpose of camber is to bring the road contact of the tyre more nearly at or under the point of the load. And to provide easy steering by allowing the vehicle weight to be carried by the inner wheel bearing and spindle.

Caster:

To obtain directional control of the vehicle by making the front wheels to maintain straight-ahead position or return to straight ahead position out of a turn.

The main purpose of the caster angle is to make the driver to have maximum steering, to have directional stability to travel straight ahead. This is achieved by the fact that the projected axis of the king pin strikes the road ahead of the contact point of the tyre. This arrangement has a tendency to drag the wheel behind it providing the vehicle directional stability. The back ward tilt from the vertical is called positive caster and in contrast, the forward tilt in the same plane is called negative caster.

Toe-in:

The toe in refers to as the turning in of the front wheels from the straight ahead position. It is clearly seen that the distance between the front wheels is lesser at A than B. This amount should not exceed 3 milli-meters. Because of this, the wheels will have the tendency to move perfectly straight ahead. The main purpose of the toe-in arrangement is to stabilize steering during running, to prevent side slip and excessive wear on tyres.

Toe-out:

Toe-out on steering geometry refers to the difference between the front wheels and the chassis frame during turning. The difference in the angles of the wheels during turning is obtained by setting the steering arms obliquely so that they point inward to the central line of the car thus providing toe-out. The inner wheel must toe-out, more than the outer wheel.

**(b) State advantages of front independent suspension system.**

**Ans:**

✓ Better Handling and Cornering:

While cornering, a centrifugal force gets created in sprung vehicles. This leads to the formation of a roll couple that tilts the vehicle's body outwards. This body-roll is countered by the resisting couple produced by the suspension springs. The magnitude of this resisting couple is given by the product of the spring's reaction forces and the effective distance between them.

In the beam-axle type suspension system, the maximum distance between the springs depends on the width of the chassis where the supporting shackles are attached. However, in the case of independent suspension, which uses a transverse-arm linkage, the effective distance is equal to the wheel track of the vehicle, which is typically greater than the width of the chassis. This allows softer springs to be used without affecting the body roll. The soft springs react to even minute road deformations, cushioning the shock, which improves the ride quality of the vehicle.

✓ Better Stability and Steering:

In rigid suspension, since both the springs are interconnected, when one wheel jogs or bounces, the entire axle tilts. This causes the opposing wheel to either tilt inwards or outwards, preventing it from continuing to roll in a straight line. This effect is termed as 'bump steer', and it can cause imbalance and decrease steering control. Furthermore, rigid axles are also less responsive during cornering, especially in heavy vehicles, leading to instability caused by forces transferred from wheel to wheel via the axle. Both these problems are taken care of by the design of an independent front suspension (IFS), as it imparts freedom to each wheel on the same axle, allowing it to respond independently to the road surface.

✓ More Ride Comfort:

Ride comfort is a measure of how good a car feels to drive. It is a combination of a lot of different factors, including vibration level, noise, smoothness of the steering, etc. But most importantly, it depends on the degree to which the undulations of the road surface get transferred to the car's body, and therefore to the passengers. Unlike the rigid axle suspension, the independent suspension system is able to perform well on most of these counts, thanks to the front wheel decoupling. This creates isolation between the suspension and the chassis, thereby improving the overall stability of the vehicle.

✓ Lower Weight:

The rigid axle suspension is a solid design, which is known for its simplicity and high strength. However, its strength comes at the cost of a larger size and higher mass. For the heavier, cruiser type vehicles of the 1940s, the rigid axle design was the perfect choice, and it still finds applications in big vehicles like trucks. However, it is no longer practical in the smaller and lighter vehicles of today, in which the IFS system is able to impart greater stability, manoeuvrability, and responsiveness.

**UNIT – IV**

**IX. (a) Explain the working of master cylinder of hydraulic brake system.**

**Ans:** The master cylinder is the fluid reservoir for the brake and is operated by the brake pedal. Master cylinder connects the individual wheel cylinder. To understand in detail what is actually happening in the master cylinder during the application of the brakes, assume that, brake pedal is applied slightly. This braking effort through linkages moves the piston, and rubber cup towards the outlet. As soon as the compensating port is covered by the rubber cup, pressure is built up in the cylinder. This pressure makes the fluid to pass through a check valve into the system. The cylinder pressure is proportional to the pressure exerted.

Similarly, when the brake pedal is released slowly, the rubber cup returns to the position in the released direction. Due to the release of pressure, the fluid returns from the wheel cylinder in to the main cylinder. This makes the outlet check valve to push back off its seat. Again, the oil may be passed into the receiver.

**(b) Explain leading and trailing brakes.**

**Ans:** The end of the brake shoes are named as 'Leading or Trailing' shoes with respect to the direction of rotation of the wheels. The brake shoe which is ahead of the wheel, rotating forward is called 'lead' primary or 'Leading' brake shoe. The shoe after or behind the wheel cylinder is called 'Secondary' or 'Trailing' shoe.

Leading shoe:

In this case, the shoe tip is dragged along the drums and produces more force against the brake drum. So an equal braking effect is produced.

Trailing shoe:

This end to move away from the drum during braking. This is opposing the rotation of the drum.

**OR**

**X. (a) Briefly explain about common rail diesel injection system.**

**Ans:** Common rail diesel injection system

Common rail direct injection (CRDI) is an advanced fuel injection system that uses a common rail or tube to inject pressurized fuel directly into the car engine whilst maintaining constant high pressure. The pressure in the engine ensure that the fuel breaks into small particles during injection and evenly mixes with the air, eventually reducing automotive pollution. When the air and fuel is evenly mixed, the amount of unburnt fuel is reduced that further reduces the amount of harmful emissions from the vehicle.

Working:

In common rail engine system, the high pressure fuel pump stores a reservoir of fuel at a pressure of at about 29,000 psi in a common rail. This common rail is actually a tube which branches off to computer controlled fuel injector valves that comprise a precision-machined nozzle and a plunger driven by a solenoid valve. The fuel reservoir then pumps out the fuel to multiple injectors that are electronically controlled by the engine control unit. Under the control of an on-board computer, the engine regulates the fuel quantity and pressure. It also controls the precise moment when the actual process of fuel injection occurs and also increased the pressure at which fuel is injected. This in turn results in better fuel atomization and combustion, eventually leading to lower exhaust emissions, lower fuel consumption, and increased fuel efficiency.

**(b) Explain about Tube less tyres.**

**Ans:** Tube less tyres

In this type, there is not separate tube. The air under pressure in the tyre itself serves this purpose. A non-return valve is fitted to the rim. The construction of the tyre is the same as that of a tubed tyre. But a special air retaining liner is provided and the amount of the air pressure required depends upon the tyre. 1.5 kg/cm<sup>2</sup> for passenger cars, and 7kg/cm<sup>2</sup> for heavy duty tyres and transport buses. These tyres are lighter and run cooler. The main advantage in this case is that, if any hole is caused in the tyre, repairing can be done by plugging. Tubeless tyre retains air pressure for a long period even when punctured. So, tyre bursting is reduced. The puncture sealing is provided by a soft inner liner. In this, the valve is a separate unit and is fitted in a hole in the rim.