

SCHEME OF EVALUATION
(Scoring indicators)

Rev:2015
Course: Automobile Engineering

Course code:4022

PART A

- I.1. Air-fuel ratio is the mass ratio of air to solid, liquid or gaseous fuel present in a combustion process.
- I.2. Engine, Clutch, Gear box, Universal joint, Propeller shaft, Differential and rear axle.
- I.3. This is the backward tilt of the king pin from the axle at the top. The main purpose of the caster angle is to make the driver to have maximum steering, to have directional stability to travel straight ahead.
- I.4. The purpose of the air bag is to provide the occupants a soft cushioning and restranit during crash event. It can reduce injuries between the flailing occupant and the interior of the vehicle.
- I.5. The function of fuel filter is to clean the fuel by eliminating dirt and abrasive particles from it. Leaning of fuel prevents the damage of engine surface and valves.

(5x2 =10 Marks)

PART B

II.1. The purpose of governor is to keep the engine running at a desired speed regardless of the changes in the load carried by the engine. If the load on the engine decreases, the speed of the engine will begin to increase, if the fuel supply is not decreased. As the speed of the engine increases, the centrifugal force on the rotating weights of the governor also increases and moves the control sleeve, together with the fuel regulating mechanism; in the direction of less fuel supply thereby the speed is brought to the rated value. (6 Marks)

II.2.

1. To lubricate engine parts
2. Lubricants will occupy the clearance between moving parts through the capillary force, thus sealing the clearance. This effect can be used to seal pistons and shafts.
3. Lubricant circulation systems have the benefit of carrying away internally generated debris and external contaminants that get introduced into the system to a filter where they can be removed.
4. To cool the engine parts. (6 Marks)

II.3.

1. Gradual engagement
2. Torque transmission
3. Heat dissipation

4. Vibration damping
5. Dynamic balancing
6. Free pedal play
7. Ease of operation.

(6 Marks)

II.4

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. To facilitate smooth change of gears in varying the speed of transmission.

Gear box: To Change the speed of the vehicle. To reverse the vehicle. To overcome the low torque at low speed.

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. To transmit power to the road wheels at varied lengths and varied angles.

Universal joint: To enable the drive shaft to transmit power at different angles.

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.

Rear axle: To rotate the two rear wheels.

FUNCTION OF ELEMENTS OF TRANSMISSION :

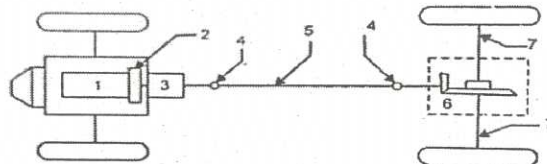


Fig. 3.1 Elements of Transmission System

- | | | | |
|--------------------|-----------------|---------------|--------------------|
| 1. Engine | 2. Clutch | 3. Gear box | 4. Universal Joint |
| 5. Propeller Shaft | 6. Differential | 7. Rear Axles | |

(6 Marks)

II.5.

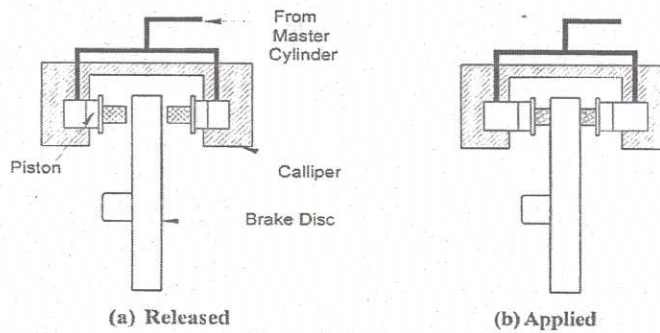
1. The supply of air is unlimited, so the brake system can never run out of its operating fluid, as hydraulic brakes can. Minor leaks do not result in brake failures.
2. Air line couplings are easier to attach and detach than hydraulic lines; the risk of air getting into hydraulic fluid is eliminated, as is the need to bleed brakes when they are serviced. Air brake circuits on trailers can be easily attached and removed.
3. Air not only serves as a fluid for transmission of force, but also stores potential energy as it is compressed, so it can serve to control the force applied; hydraulic fluid is nearly incompressible.

Air brake systems include an air tank that stores sufficient energy to stop the vehicle if the compressor fails.

Air brakes are effective even with considerable leakage, so an air brake system can be designed with sufficient "fail-safe" capacity to stop the vehicle safely even when leaking. (6 Marks)

II.6

- Cast iron Disc bolted to wheel hub and stationary housing called the caliper.
- Caliper is connected to some stationary part of vehicle like axle casing or the stub axle.
- Caliper consists of two parts, each part contains a piston.
- In between the piston and the disc, friction pads are placed.
- Passages are drilled in the caliper for fluid to enter or leave each housing.
- Hydraulically actuated pistons move the friction pads to bring them in contact with disc applying equal and opposite forces on the disc.
- On releasing brakes piston and friction pads retract them away from disc.



(6 Marks)

II.7.

Cars can be fitted with an electronic locking system which is connected to the car's alarm system. To lock the car from the inside, the driver uses the key to lock one of the front doors and all the doors lock automatically. The driver can lock or unlock all doors by locking or unlocking the driver's side door lock manually or by pressing the lock and unlock buttons on the key fob or dashboard.

Other than being a hugely convenient system, it is a very important safety feature. Every key has a unique code which is matched with the code in the alarm system. Once the key is used to lock the car, an immobiliser goes off in the engine. Only when the onboard computer detects the same code from the car key will it unlock the immobiliser in the engine. When the immobiliser is on the engine of the car will not start.

Central locking systems evolved to systems that could be operated with a remote. That had buttons on a remote attached to the key. The car can be locked or unlocked with the remote. Some remotes have a button to set off the car alarm. Car remotes are extremely useful for locating your car in a car park. People lock and unlock their cars with the remote and the sound and blinking lights help you locate your car. These remote locking systems work on the principle of radio waves. (6 Marks)

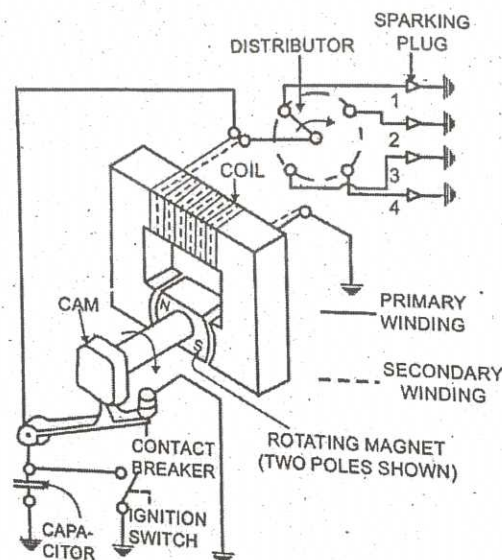
PART C

Module I

III.(a) Magneto Ignition System:

The magneto ignition system consists of magneto; ignition switch, breaker points, condenser, distributor and spark plug. It is similar in principle to the battery system except that the battery of ignition system is replaced by a rotating permanent magnet. It has a stationary coil which carries primary and secondary windings.

As the magnet turns, the direction of the magnetic flux of the coil reverses direction i.e, magnetic field produced varies from a positive maximum to a negative maximum and back again. Due to this voltage is induced in the primary and secondary windings. But the change of flux is not rapid to induce required voltage to overcome the resistance of the air gap in the spark plug. The high voltage is induced in secondary winding with the help of breaker points and condenser. When the breaker points are opened by the cam, the condenser is charged. This is followed by rapid discharged of the condenser which causes very rapid break down of magnetic flux. This induces high voltage in the secondary winding which is led to the spark plug by the distributor.



Magneto ignition system used in racing cars, scooters and motor cycles.

Advantages.

1. No battery is required and as such no maintenance problems.
2. Compact and occupy less space.

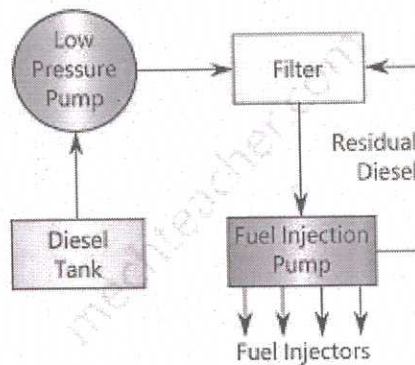
3. Efficiency improves as the engine speed increases.

Disadvantages

1. During starting, quality of spark is poor due to low speed.
2. Suitable only for small capacity engines.

(8 Marks)

III.b.



The fuel injection system lies at the very heart of the diesel engine. By pressurising and injecting the fuel, the system forces it into air that has been compressed to high pressure in the combustion chamber.

The diesel fuel injection system consists of:

- **fuel injection pump** - pressurises fuel to high pressure
- **high-pressure pipe** - sends fuel to the injection nozzle
- **injection nozzle** - injects the fuel into the cylinder
- **feed pump** – sucks fuel from the fuel tank
- **fuel filter** - filtrates the fuel

Some types of fuel tanks also have a fuel sedimentor at the bottom of the filter to separate water content from the fuel.

Functions of the system

The diesel fuel injection system has four main functions:

Feeding fuel

Pump elements such as the cylinder and plunger are built into the injection pump body. The fuel is compressed to high pressure when the cam lifts the plunger, and is then sent to the injector.

Adjusting fuel quantity

In diesel engines the intake of air is almost constant, irrespective of the rotating speed and load. If the injection quantity is changed with the engine speed and the injection timing is constant, the output and fuel consumption change. Since the engine output is almost proportional to the injection quantity, this is adjusted by the accelerator pedal.

Adjusting injection timing

Ignition delay is the period of time between the point when the fuel is injected, ignited and combusted and when maximum combustion pressure is reached. As this period of time is almost constant, irrespective of engine speed, a timer is used to adjust and change injection timing – enabling optimum combustion to be achieved.

Atomising fuel

When fuel is pressurised by the injection pump and then atomised from the injection nozzle, it mixes thoroughly with air, thus improving ignition. The result is complete combustion.

(7 Marks)

IV.a.

Simple Carburettor

The main functions of carburettor are

- To maintain a small reserve of petrol at a constant level in float chamber.
- To atomise the liquid fuel (petrol) and to mix it with air.
- To supply air-fuel vapour mixture at correct ratio according to engine requirements.

The operation of simple carburettor is shown figure. It consists of float chamber, venture (choke) tube, fuel jet and throttle valve. Fuel jet is placed in the throat (smallest section of venture) at a slightly higher level than the level of the petrol in the float chamber. A vent hole is provided on float chamber, to maintain atmospheric pressure in the float chamber.

Fuel is delivered to the float chamber by gravity or by a pump. Float and needle valve maintain a constant fuel (petrol) level in the float chamber. As the float chamber is filled with fuel, the float rises and actuates the needle to close the valve. When the desired level is reached the valve closes completely so that no additional fuel can enter. When the fuel level drops, the float descends to open the valve, allowing more fuel to enter the float chamber. During suction stroke, a partial vacuum is created in the engine cylinder and carburettor. Due to this air flows into the carburettor. At the narrow section (throat) of venturi tube velocity of air increases and air pressure is correspondingly reduced. A pressure difference is thus produced between float chamber and the venturi, which causes fuel to flow out of fuel jet in the form of spray. The fuel delivered by the jet into the air stream is finely atomized, mixed with air and vaporized to form homogeneous air-fuel mixture which is admitted to the engine cylinder.

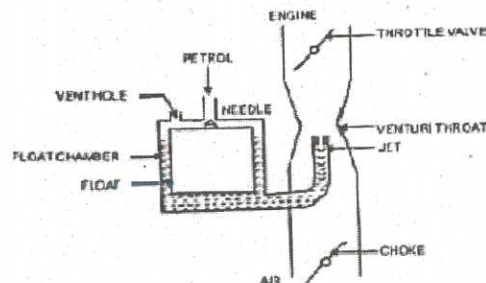


Fig. 2.11 Simple Carburettor

(8 Marks)

IV.b Fuel feed pump

Fuel feed pump serves to deliver fuel to the fuel injection pump. The fuel feed pump must deliver adequate amount of fuel to the fuel injection pump at a pressure about 1.2 bar.

It consists of a barrel, a plunger and two valves. The plunger is actuated by spring and cam. Plunger requires two strokes to deliver fuel to the injection pump. Due to rotation of the cam, the plunger moves upwards against the spring action. At the same time the inlet valve is closed and the fuel is forced through outlet valve. At the initial lift position of the cam the spring forces the plunger to move downwards. The downward movement of the piston creates low pressure above the plunger (i.e, in the fuel chamber) and fuel enters into the pump (chamber) through the open inlet valve. As the cam continues to rotate, the plunger moves upwards and the pressure above the plunger increases. This pressure causes inlet valve to close and outlet valve to open, and fuel is expelled from the pump.

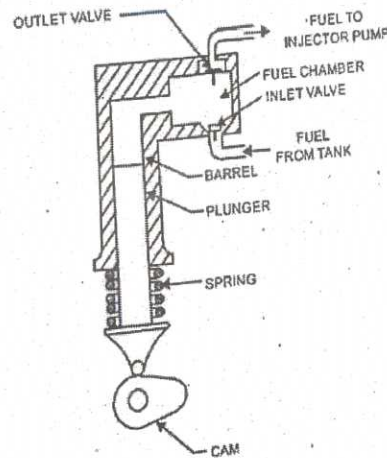


Fig. 2.2 Fuel Feed Pump

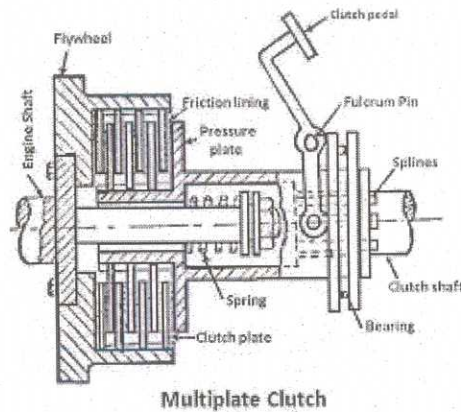
(7 Marks)

Module II

Multi plate clutch

A clutch having more than three disc is called a multi plate clutch. This multi plate clutch is used where the space is limited, consist of a number of clutch plates, instead of only one clutch plate, as in the case of single plate clutch. The increased number of the clutch plates obviously increases the capacity of the clutch to transmit more torque. Due to this, these clutch plates are used in heavy duty commercial vehicles, racing cars, special purpose military vehicles etc. These may be dry or wet. When the clutch of this type is operated in a oil bath, is called a wet clutch. The oil acts as a cushion to provide a smooth engagement. The energy released as heat is also carried away by the oil. This reduces the operating temperature and prolongs life. The dry clutch is used without oil having driving plates lined on each side with a frictional material .The function of dry clutch is similar to wet clutch.

In multi plate clutch as inner drum which is coupled to the gearbox shaft has a number of plates splined as its outer periphery .Another drum is bolted to the flywheel and carries a number of plates splined at its inner circumference. The plates revolve with the drum but can slide axially. A spring keeps the outer and inner plates are pressed together so that the driving number transmits the power to driven number. The clutch is disengaged by pulling the inner drum against the pressure spring.



(8 Marks)

V.b Fluid coupling or fluid clutch

- Used in cars employing automatic transmissions.
- It consists of two members, the driving and driven as shown in figure.
- Driving member is attached to engine flywheel, driven member to transmission shaft.
- Two members do not have any direct contact with each other.
- Driven member is free to slide on splines on the transmission shaft.
- Two rotors are always filled with fluid of suitable viscosity.

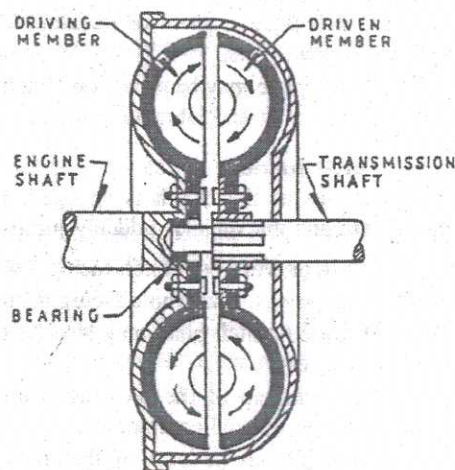


Fig : Fluid coupling or fluid clutch

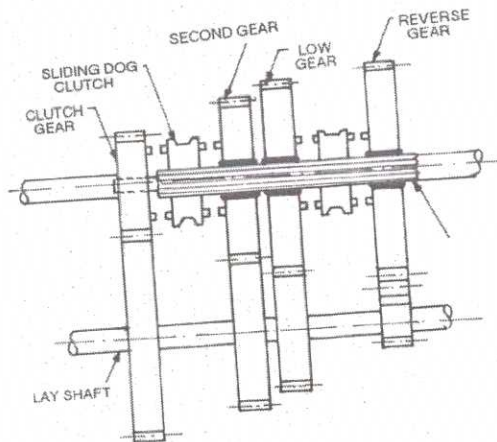
Advantages:

1. No wear on moving parts.
2. No adjustment to be made.
3. No maintenance necessary except oil level.
4. Simple design.
5. No jerk on transmission when the gear engages.
6. No skill required for operate it.
7. Car can stop in gear and move also by pressing accelerator pedal only.

Disadvantage:

There is a drag on gear box shaft even when the percentage slip is 100. This makes the gear changing difficult with ordinary gear box. Fluid flywheel is suitable for epicyclic gear box. (7 Marks)

VI.a Constant Mesh Gear Box

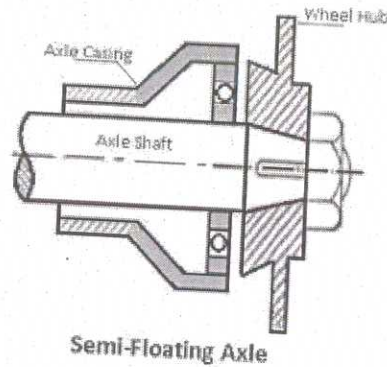


- In this type all the gears are in constant mesh with the corresponding gears on the lay shaft.
- The gears on the main shaft which is splined, are free. The dog clutches are provided which are free to slide on the main shaft.
- Gears on the lay shaft are fixed.
- When the left dog clutch is slide to the left by means of the selector mechanism, its teeth are engaged with those on the clutch gear and we get the direct gear.
- The same dog clutch, when slide to right makes contact with the second gear and second gear is obtained.
- The movement of right dog clutch to the left results in low gear and towards right in reverse gear. (8 Marks)

VI.b

The semi-floating axle setup is commonly used on half-ton and lighter 4x4 trucks in the rear. This setup allows the axle shaft to be the means of propulsion, and also support the weight of the

vehicle. The main difference between the full- and semi-floating axle setups is the number of bearings. The semi-floating axle features only one bearing, while the full-floating assembly has bearings in both wheel hubs. The other difference is about the axle removal. To remove the semi-floating axle, one has to remove a wheel first. And, if such axle breaks, the wheel is most likely to come off the vehicle. The semi-floating design is found under most 1/2-ton and lighter trucks and SUVs and rear-wheel-drive passenger cars, usually being smaller or less expensive models.



Module III

(7 Marks)

VII.a

Recirculating Ball Type Steering Gear

This type of gear was perhaps the most widely used steering gear at one time in India, it is used in the Tata, Dodge/Fargo, Standard 20 vehicles. It consists of a worm at the end of the steering rod (Fig. 4.9). A nut is mounted on the worm with two sets of balls in the grooves of the worm, in between the nut and the worm. The balls reduce the friction during the movement of the nut on the worm. The nut has a number of teeth on the outside, which mesh with the teeth on a worm wheel sector, on which is further mounted the drop arm, which steers the road wheels through the link rod and the steering arms.

When the steering wheel is turned, the balls in the worm roll in the grooves and cause the nut to travel along the length of the worm. The balls, which are in 2 sets, are reticulated through the guides, as shown in the figure. The movement of the nut causes the wheel sector to turn at an angle and actuate the link rod through the drop arm resulting in the desired steering of the wheels. The end play of the worm can be adjusted by means of the adjuster nut provided. To compensate for the wear of the teeth on the nut and the worm, the two have to be brought nearer bodily. To achieve this the teeth on the nut are made tapered in the plane perpendicular to the plane of Fig. 4.9. A screw is also provided by means of which the drop arm, and hence, the wheel sector can be positioned along its axis. When the wheel sector has to be moved bodily closer to the nut to eliminate backlash due to wear, the screw is turned which slides the wheel sector in a direction in which the tapered teeth on the nut are narrower, till the required adjustment is achieved.

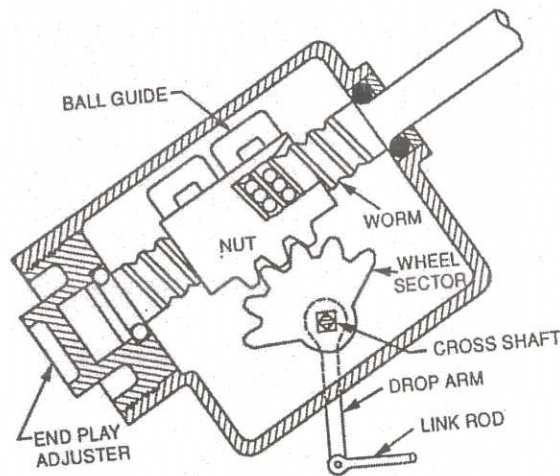


Fig. 4.9: Recirculating Ball type Steering Gear.

(8 Marks)

VII.b

The tyre is a cover for the tube and provides protection. These are placed around the rims of the wheel as a cushion between the wheel and the road.

The casing is made up of a number of fabric layers. The casing resists expansion of the tube when road shocks are experienced. Rubberized cards are used to form sheets of the layers. Each sheet is placed at an inclination to the adjacent layer so that a strong casing is formed. The tyre casing is made of Rayon and Nylon materials to form a strong, flexible and heat resisting tyre. A number of hoops of steel wire are used in the bead of the tyre to place the tyre on the rim. The tyres are made of natural or synthetic rubber. These are compounded with chemicals.

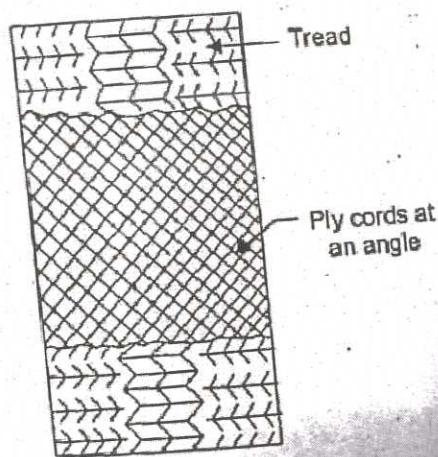


Fig. 6.10 Cross Ply Tyre

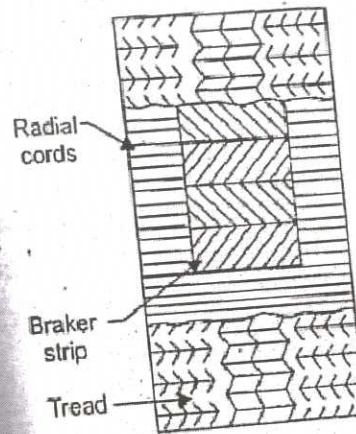


Fig. 6.11 Radial Ply Tyre

Cross ply tyre: In this skeleton work the plycords are woven at an angle in the opposite direction. This type of tyre has bad wear and heating characteristics.

Radial ply tyre:

A radial tire (more properly, a radial-ply tire) is a particular design of vehicular tire. In this design, the cord plies are arranged at 90 degrees to the direction of travel, or radially (from the center of the tire). Radial tires have different characteristics of springiness from those of bias-ply tires, and a different degree of slip while steering. A benefit was that cars could now be made lighter because they would not have to make up for the deficiencies of bias-ply tires. (7 Marks)

VIII.(a)

- Cast iron Disc bolted to wheel hub and stationary housing called the caliper.
- Caliper is connected to some stationary part of vehicle like axle casing or the stub axle.
- Caliper consists of two parts, each part contains a piston.
- In between the piston and the disc, friction pads are placed.
- Passages are drilled in the caliper for fluid to enter or leave each housing.
- Hydraulically actuated pistons move the friction pads to bring them in contact with disc applying equal and opposite forces on the disc.
- On releasing brakes piston and friction pads retract them away from disc.

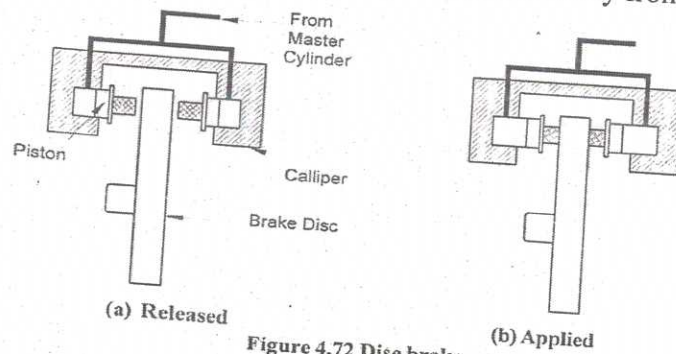


Figure 4.72 Disc brake

(8 Marks)

VIII.(b)

1. To safe guard the passengers and goods against road shocks.
2. To prevent the road shock from getting transmitted to the vehicle body.
3. To preserve the stability of the vehicles while in motion.
4. To provide proper road hold when driving cornering and braking.
5. To maintain proper steering geometry.
6. To keep the body perfectly in proper level while traveling on a uneven path.
7. To bear the torque and braking reaction.

(7 Marks)

IX.(a)

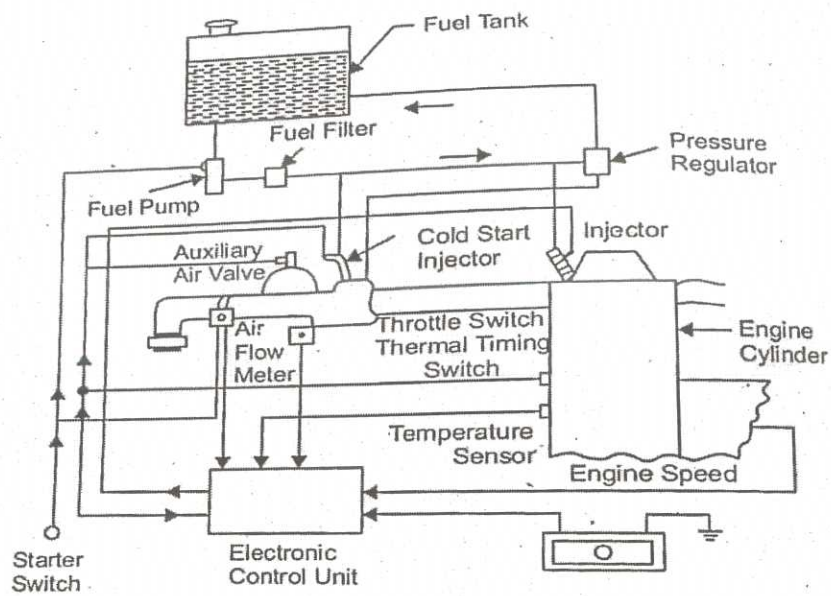


Fig. 2.31 Electronic Fuel Injection System

1. Fuel Delivery system: It consists of an electrically driven fuel pump which draws fuel from a fuel tank. The pump forces the fuel through a filter into a line at the end of which is situated a pressure regulator which in turn is connected to intake manifold. The pressure regulator keeps the pressure difference between the fuel pressure and the manifold pressure constant, so that the quantity of fuel injected is dependent on the injector open time only.

2. Air Induction System: After passing the air filter, the incoming air flows through an air flow meter, which generates a voltage signal (depending on the quantity of air flow). Just behind the throttle valve is fitted a cold start magnetic injection valve, which injects additional fuel for cold start. This valve also supplies the extra fuel needed during warm-up period. An auxiliary valve (which by-passes the throttle valve) supplies the extra air required for idling (in addition to rich air fuel mixture). This extra air increases the engine speed after cold start to acceptable idling speed. To the throttle valve is attached a throttle switch equipped with a set of contacts which generate a sequence of voltage signals during the opening of throttle valve. The voltage signals result in injection of additional fuel required for acceleration.

3. Electronic Control Unit: The sensors are incorporated to measure the operating data at different locations. The data measured by the sensors are transmitted to the electronic control unit which computes the amount of fuel injected during each engine cycle. Thus amount of fuel injected is varied by varying the injector opening time only. The sensors used are :

- (i) Manifold pressure
- (ii) Engine speed
- (iii) Temperature at the intake manifold.

4. Injection Time: For every revolution of the cam shaft the fuel is injected twice, each injection contributing half of a fuel quantity required for engine cycle. The injectors at different phases of the operating cycle, are operated simultaneously. (8 Marks)

IX.(b).

An emission control programme aims at reducing the concentration of CO, HC and NOX in the exhaust. The main approaches which have been used for this purpose are:

1. Engine design modification,
2. Treatment of exhaust gas, and
3. Fuel modification.

Engine design modification: The engine modification approach for improving the exhaust emission is aimed at following:

1. Use of leaner air-fuel ratios
2. Retarding ignition timing
3. Modification of combustion chamber configuration to reduce quenches areas.
4. Modification of combustion chamber
5. Reduced valve overlap
6. Alternation in induction system

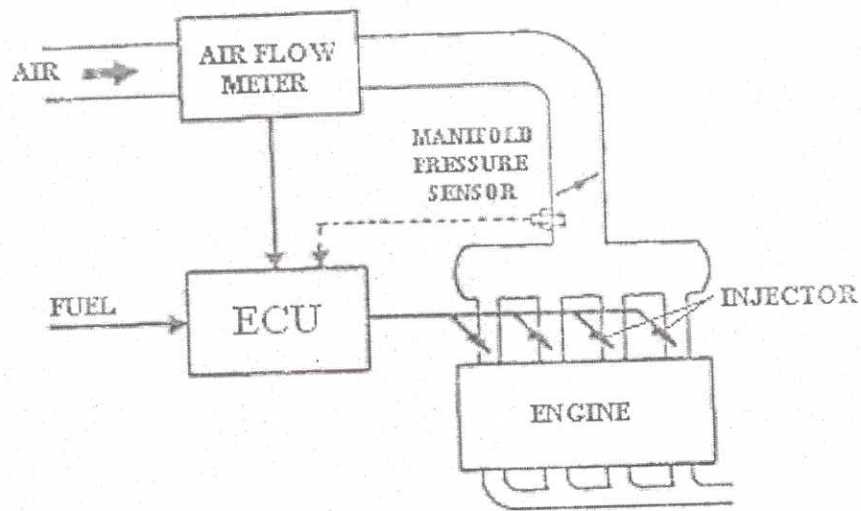
There are three basic methods of emission control using this approach: (i) thermal reactors, which rely on homogeneous oxidation to control CO and HC; and (ii) oxidation catalysts for CO and HC; and (iii) dual catalyst systems, which incorporate in series a reduction catalyst for NOx and an oxidation catalyst for CO and HC. Where NOx control is needed with the first two methods, exhaust gas recirculation (EGR) is added to the system. (7 Marks)

X.(a)

MPFI

- Technology used in petrol engines.
- Use of modern computer system (ECU). ie. Intelligent way of controlling the engine.
- Improve power, fuel economy, efficiency and other performances and reduce harmful emissions, noise, vibrations.
- In MPFI, each cylinder has one injector which is controlled by ECU.
- Timing and amount of fuel injection are controlled by ECU.
- ECU works with input signals from multiple sensors.
- Timing and amount of fuel injection based on these signals.
- In MPFI, each cylinder is treated independently.

MULTI POINT FUEL INJECTION (MPFI)



Advantages of MPFI

1. Improve power and torque.
2. Improve performance.
3. Improve efficiency.
4. Improve fuel economy.
5. Reduce noise and vibrations.
6. Reduce emissions.
7. Superior pick up.
8. It helps to overcome the difficulty in Cold starting.

Disadvantages of MPFI

1. Initial cost high.
2. Costly spare parts.
3. More maintenance.
4. High maintenance cost.

(8 Marks)

X.(b)

Air pollution can be defined as addition to our atmosphere of any material which will have a deleterious effect on life upon our planet. The main pollutants contributed by automobiles are carbon monoxide (CO), unburned hydrocarbons (UBHC), oxides of nitrogen (NOx) and lead and other particulate emissions. Automobiles are not the only source of air pollution, other sources

such as electric power generating stations (which mainly emit sulphur oxides, nitrogen oxides, and particulates), industrial and domestic fuel consumption, refuse burning, industrial processing etc., also contribute heavily to contamination of our environments.

1. Evaporative loss : 15 to 25% of HC
2. Crankcase blowby: 20 to 35% of HC
3. Tail pipe exhaust: 50 to 60% of HC and almost all CO and NO_x

CO: Carbon monoxide occurs only in engine exhaust. It is a product of incomplete combustion due to insufficient amount of air in the air-fuel mixture or insufficient time in the cycle for completion of combustion.

Hydrocarbons: Unburnt hydrocarbon emissions are the direct result of incomplete combustion. The pattern of hydrocarbon emissions is closely related to many design and operating variables. Two of the important design variables are induction system design and combustion chamber design, while main operating variables are air-fuel ratio, speed, load and mode of operation. Maintenance is also an important factor.

Particulate matter and partial oxidation product. Organic and inorganic compounds of higher molecular weights and lead compounds resulting from the use of TEL are exhausted in the form of very small size particles of the order of 0.02 to 0.06 micron. About 75 per cent of the lead burned in the engine is exhausted into the atmosphere in this form and rest is deposited on engine parts. Some traces of products of partial oxidation are also present in the exhaust gas, of which formaldehyde and acetaldehyde are important. Other constituents are phenols, acids, ketones, ethers etc. These are essentially products of incomplete combustion of the fuel.

Oxides of Nitrogen (NO_x). Oxides of nitrogen which also occur only in the engine exhaust are a combination of nitric oxide (NO) and nitrogen dioxide (NO₂). Nitrogen and oxygen react at relatively high temperatures. Therefore, high temperatures and availability of oxygen are the two main reasons for the formation of NO_x. When the proper amount of oxygen is available the higher the peak combustion temperature the more is the NO_x formed. The NO_x is formed in the atmosphere as NO oxidizes. The combination of HC and NO_x in the presence of sunlight and certain atmospheric conditions produce photochemical smog. (7 Marks)