TED (15) - 4022

(REVISION — 2015)

Reg. No. ....

Signature ....

DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — APRIL, 2019

AUTOMOBILE ENGINEERING

[*Time* : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. What is carburation ?
2. Write any two functions of lubrication.
3. What is the function of a universal joint ?
4. What is camber angle ?
5. What is wheel alignment ? (5×2 = 10)

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. Explain the thermo syphon cooling system.
2. What are the different properties of lubricant ?
3. Briefly describe about propeller shaft.
4. Draw a neat sketch of single plate clutch and mark the parts.
5. Explain the working of rack and pinion steering gear box.
6. Explain different types of wheels.
7. Briefly describe about Emission standards. (5×6 = 30)

Marks

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

Unit — I

III (a) Briefly describe about battery ignition system. 8

(b) Explain the fuel system of diesel engine. 7

Or

IV (a) Briefly describe about different methods of lubrication system. 8

(b) Draw the line diagram of fuel injection pump and mark the components. 7

Unit — II

V (a) Explain the working principle of constant mesh gear box. 8

(b) Explain the working principle of a centrifugal clutch. 7

Or

VI (a) Explain the working principle of Differential unit. 8

(b) Briefly describe about semi floating rear axle. 7

Unit — III

VII (a) Draw the neat sketches of different types of stubaxles. 8

(b) Explain the steering system of an automobile. 7

Or

VIII (a) Briefly describe about tubed tyre and tubeless tyre. 8

(b) Explain the working of hydraulic brake system. 7

Unit — IV

IX (a) Briefly describe about common rail direct injection system. 8

(b) Explain the working of power steering. 7

Or

X (a) Briefly describe about air suspension system. 8

(b) What are the different air pollutants from automobiles and its effects ? 7

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FOURTH SEMESTER DIPLOMA EXAMINATION IN MECHANICAL ENGINEERING—APRIL,2019

AUTOMOBILE ENGINEERING

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

PART—A
(Maximum marks : 10)

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

1. What is carburetion?
Ans: The homogeneous mixture of air and fuel is prepared outside the engine cylinder. The air-fuel mixture is supplied into the engine cylinder during suction stroke. The process of preparation the charge for SI engines is called Carburetion.

2. Write any two function of lubrication.
Ans: The function of lubrication system are given below,

- To decrease the power required to overcome the friction, thereby increasing the power output.
- To reduce the wear between rubbing and bearing surfaces so that the engine service life is increased..
- To reduce the noise.

3. What is the function of a universal joint.
Ans: The universal joint is used for the power transmission when the input and output shaft are not on the same line, is one of the main components of the vehicle transmission system. To enable the drive shaft to transmit power at different angle.

4. What is camber angle ?
Ans: 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.

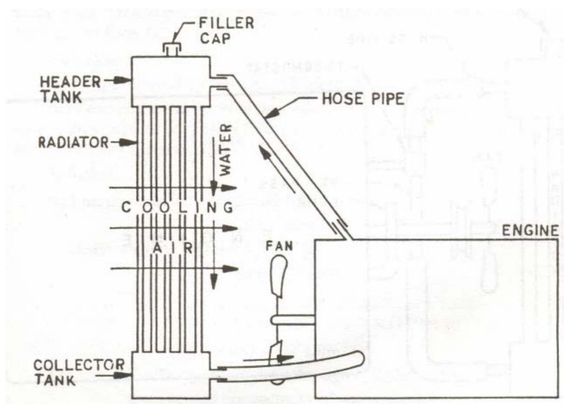
5. What is wheel alignment ?
Ans: Wheel alignment is referred to as breaking or tracking, is part of standard automobile maintenance that consists of adjusting the angles of wheels to the car manufacturer specifications. Wheel alignment refers to the proper setting of the axle geometry as well as tracking of all axles on a vehicle.

PART—B
(**Maximum marks : 30)**

II. Answer Any five qustions. Each qustion carries 6 marks.

1. Explain the thermo syphon cooling system.

Ans: This system works on the principle that hot water being lighter rises up and the cold water being heavier goes down. In this system the radiator is placed at a higher level than the engine for the easy flow of water towards the engine. Heat is conducted to the water jackets from where it is taken away due to convection by the circulating water. As the water jacket becomes hot, it rises to the top of the radiator. Cold water from the radiator takes the place of the rising hot water and in this way a circulation of water is set up m the system. This helps in keeping the engine at working temperature.



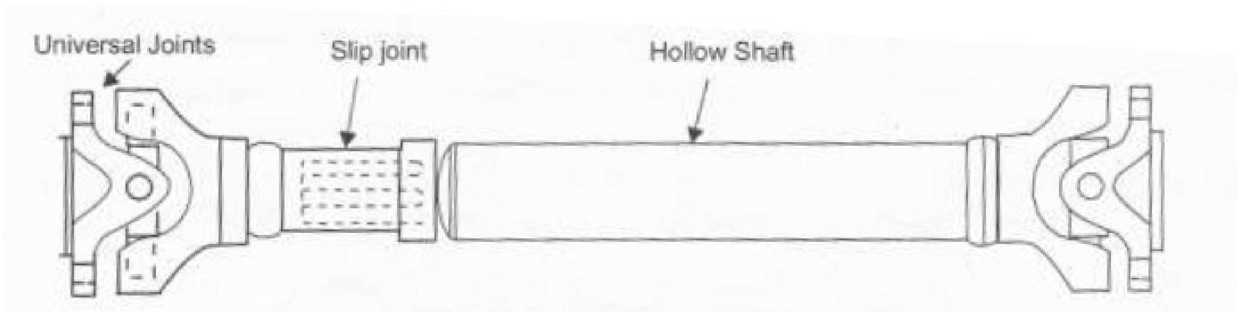
2. What are the different properties of lubricants?

Ans: Properties of Lubricants:

- Viscosity
- Flash Point
- Cloud point and pour point
- Aniline point
- Corrosion resistance.
- physical stability.
- Fire Point

3. Briefly describe about propeller shaft.

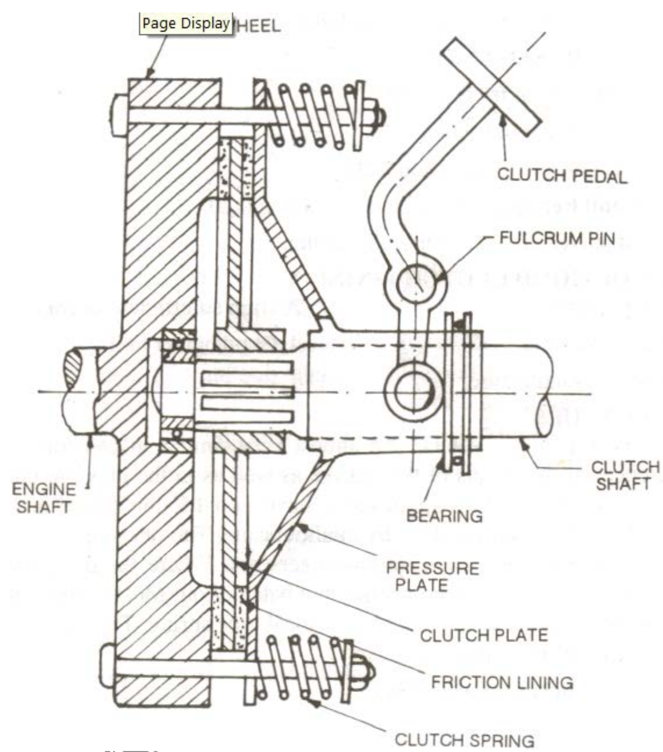
Ans: This is an important shaft in the transmission system, by means of which drive is transmitted to the driving axle. The shaft power is to be transmitted to the rear wheels at different lengths and different angles. This shaft connects the transmission with the driving axle by means of universal joints. 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 which when rotating at high speeds. This is made of a strong steel tube or shaft.



Propeller Shaft

4. Draw a neat sketch of single plate clutch and mark the parts.

Ans:

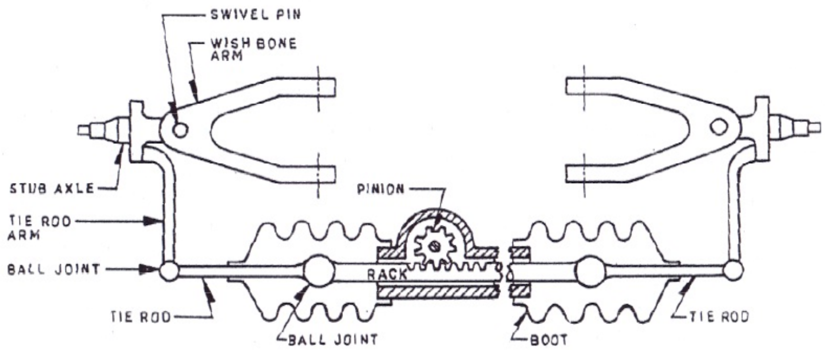


5. Explain the working of rack and pinion steering gear box.

Ans: In this design, a pinion is employed at the steering shaft in place of worm (or) cam. The pinion always remains in mesh with the rack. A rack is operated by the pinion resulting in change in the rotary motion of steering shaft to straight line motion of the rack.

The rack has ball joints at each end to allow for the rise and fall of the wheels. The ball joints are further connected to the stub axles by rods.

In the modern design, the rack is connected in the centre by two halves of the tie rod'. It is simple and light. It occupies very small space and uses lesser number of linkage components compared to the other type of gear box. When the steering wheel is rotated the pinion also rotates and the rack moves left (or) right causing the wheels to turn. This types of steering gear provides sufficiently low gear reduction for cars and it is quite suitable even for heavier motor vehicles assisted with power. Rack and pinion type steering gear is used in Ambasador and maruthi 800 cars.



6. Explain different types of wheels.

Ans: Different types of wheels

1. Pressed steel disc wheel

-- most commonly used

-- simple, robust construction, lower cost and ease in cleaning

-- require negligible maintenance and are easy to produce

2. Wire wheel

-- used in bikes and vintage cars

-- lighter, better heat dissipation, can fitted and removed very easly

-- difficult to clean

3. Alloy wheels

-- cast or forged as a single unit

-- aluminium or magnesium alloy

-- casted wheels are used in cars

-- forged wheels are used in heavy vehicles

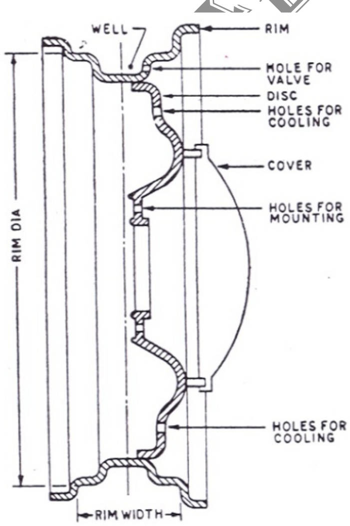
-- light weight as compared to disc wheels

-- high heat dissipation capacity

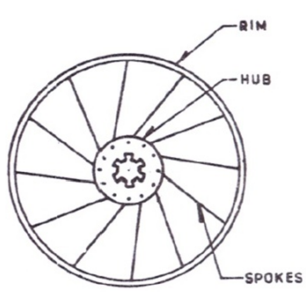
-- wider rims are possible

-- magnesium alloys:- high impact & fatigue strength(ie. Can stand vibrations and shock loading), chance of corrosion

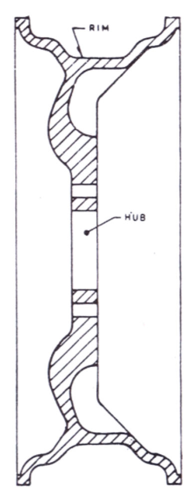
-- Aluminium alloys:- less chance of corrosion, easy to cast & forge, do not high resistance to vibration and shock



Pressed steel disc wheel



Wire wheel



Alloy wheels

7. Briefly describe about Emission Standards.

Ans:

PART—C

(Maximum marks : 60)

(Answer one full questions from each unit. Each full question carries 15 marks.)

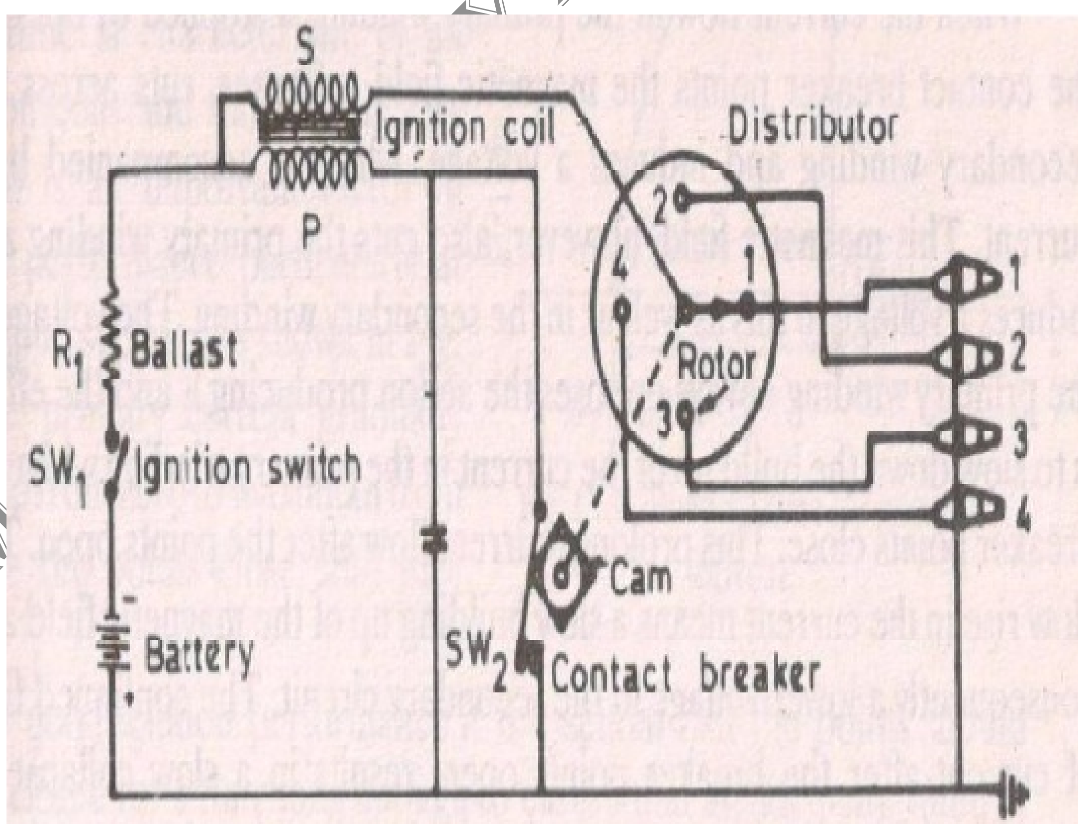
UNIT – I

III. (a) Briefly describe about battery ignition system.

Ans: Working:

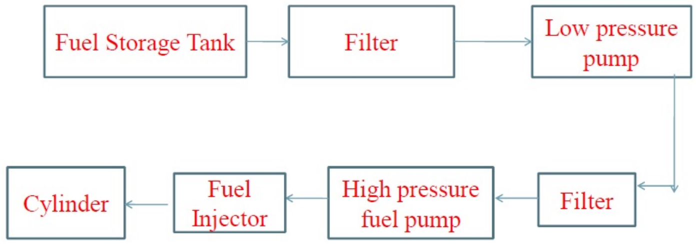
When the ignition switch is closed and engine in cranked, as soon as the contact breaker closes, a low voltage current will flow through the primary winding. It is also to be noted that the contact beaker cam opens and closes the circuit 4-times (for 4 cylinders) in one revolution. When the contact breaker opens the contact, the magnetic field begins to collapse. Because of this collapsing magnetic field, current will be induced in the secondary winding. And because of more turns (@ 21000 turns of secondary, voltage goes unto 28000-30000 volts. This high voltage current is brought to centre of the distributor rotor. Distributor rotor rotates and supplies this high voltage current to proper stark plug depending upon the engine firing order. When the high voltage current jumps the spark plug gap, it produces the spark and the charge is ignited-combustion starts-products of combustion expand and produce power.

The Function of the capacitor is to reduce arcing at the contact breaker (CB) points. Also when the CB opens the magnetic field in the primary winding begins to collapse. When the magnetic field is collapsing capacitor gets fully charged and then its tarts discharging and helps in building up of voltage in secondary winding. Contact breaker cam and distributor rotor are mounted on the same shaft.



III. (b) Explain the fuel system of diesel engine.

Ans:



The main components of fuel system are,

1. Fuel tank
2. Fuel feed pump
3. Filter
4. Injection pump
5. Injector.

During the operation, the fuel from the tank enters the fuel feed pump. In feed pump the pressure of fuel is rised 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.

IV (a) Briefly describe about different methods of lubrication system.

Ans: Lubrication system: various lubrication system used for IC engines are,

(a) Mist lubrication system

(b) Wet sump lubrication system

(c) Dry sump lubrication system

(a) Mist lubrication system:

-Used where crankcase lubrication is not suitable

- Generally adopted in two stroke petrol engine line scooter and motor cycle. It is the simplest form of lubricating system.

- It is the simplest form of lubricating system. It does not consist of any separate part like oil pump for the purpose of lubrication.

- In this system the lubricating oil is mixed into the fuel (petrol) while filling in the petrol tank of the vehicle in a specified ratio (ratio of fuel and lubricating oil is from 12:1 to 50:10 as per manufacturers specifications or recommendations.

- When the fuel goes into the crank chamber during the engine operation, the oil particles go deep into the bearing surfaces due to gravity and lubricate then. The piston rings, cylinder walls, piston pin etc. are lubricated in the same way.

-If the engine is allowed to remain unused for a considerable time, the lubricating oil separates oil from petrol & leads to clogging (blocking) of passages in the carburettor, results in the engine starting trouble. This is the main disadvantage of this system.

-It causes heavy exhaust smoke due to burning of lubricating oil partially or fully

-Increase deposits on piston crown and exhaust ports which affect engine efficiency
-Corrosion of bearing surfaces due to acids formation
-thorough mixing can fetch effective lubrication
-Engine suffers insufficient lubrication during closed throttle i.e. vehicle moving down the hill.

(b) Wet sump lubrication system:

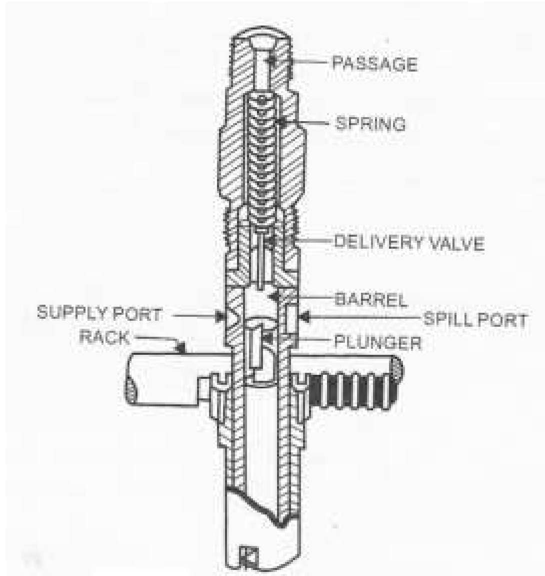
Bottom of the crankcase contains oil pan or sump from which the lubricating oil is pumped to various engine components by a pump. After lubrication, oil flows back to the sump by gravity. Three types of wet sump lubrication system,
(i) Splash system
(ii) Splash and pressure system
(iii) Pressure feed system
(i) Splash system:
-In this system of lubrication the lubricating oil is stored in an oil sump. A scoop or dipper is made in the lower part of the connecting rod. When the engine runs, the dipper dips in the oil once in every revolution of the crank shaft, the oil is splashed on the cylinder wall. Due to this action engine walls, piston ring, crank shaft bearings are lubricated.
-It is used for light duty engine
(ii) Splash and pressure system:
Lubricating oil is supplied under pressure to main, camshaft bearings and pipes which direct a stream of oil against the dippers on the big end of connecting rod bearing cup and thus crankpin bearings are lubricated by the splash or spray of oil thrown up by the dipper.
(iii) Pressure feed system:
In this system of lubrication, the engine parts are lubricated under pressure feed. The lubricating oil is stored in a separate tank (in case of dry sump system) or in the sump (in case of wet sump system), from where an oil pump (gear pump) delivers the oil to the main oil gallery at a pressure of 2-4 kg/cm2 through an oil filter. The oil from the main gallery goes to main bearing, from where some of it falls back to the sump after lubricating the main bearing and some is splashed to lubricate the cylinder walls and remaining goes through a hole to the crank pin. From the crank pin the lubricating oil goes to the piston pin through a hole in the connecting rod, where it lubricates the piston rings. For lubricating cam shaft and gears the oil is led through a separate oil line from the oil gallery. The oil pressure gauge used in the system indicates the oil pressure in the system. Oil filter & strainer in the system clear off the oil from dust, metal particles and other harmful particles.

(c) Dry sump lubrication system:

-Supply of oil is carried in external tank
-Oil pump draws oil from the supply tank and circulates it under pressure to various bearings of the engine
- Oil dripping from the cylinders and bearings into the sump is removed by a scavenging pump and again return to supply tank through the filter
-The capacity of scavenging pump is greater than the oil pump
-Separate oil cooler to remove heat from oil is used which is either cooled by air or water

IV (a) Draw the diagram of fuel injection pump and mark the components.

Ans:

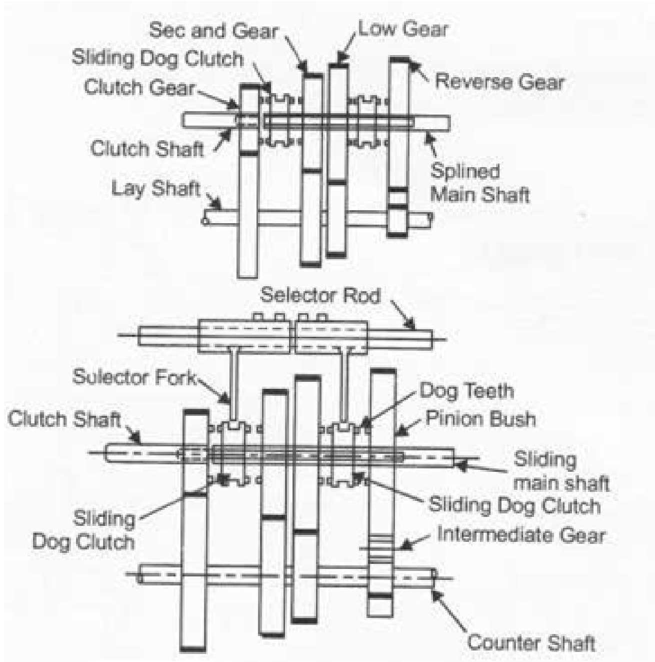


Fuel Injection Pump

UNIT – II

V (a) Explain the working principle of constant mesh gear box.

Ans: Figure shows the simple arrangement of the constant mesh gear box. It has three shafts namely primary shall, main shaft and lay shaft. The clutch shaft gear is in mesh with the biggest gear of the counter shaft and the other gears of the counter shaft are also in constant mesh with the corresponding gears on the main shaft. The gears on the counter shaft rotate along with the shaft but the main shaft gears are free rotate bushes. The main shaft is splined shaft. Dog clutches are provided which are free to slide on the main shaft. Selector forks are also provided to move the dog clutches to engage with the other set of dog clutches. The gear blanks are also provided with dog teeth on their faces. The power flow is the same as in the sliding mesh gear box.



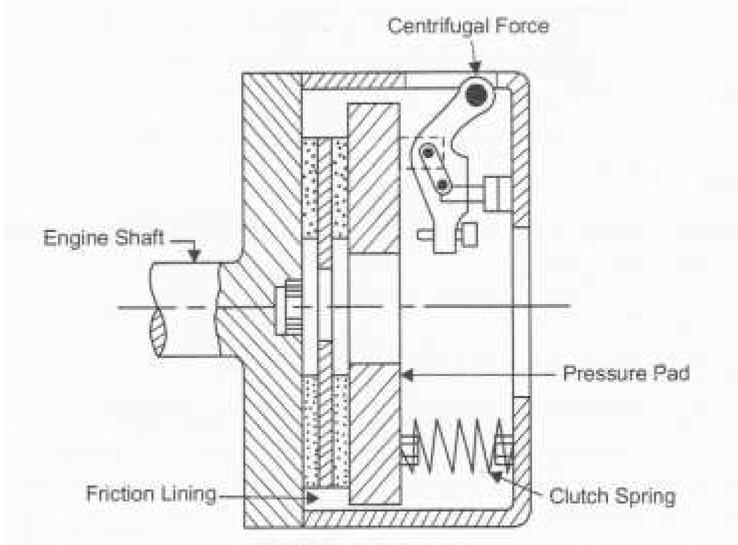
Constant Mesh Gear Box

When the second dog clutch is slide to the right side, it engages the larger gear on the main shaft to the smallest on the counter shaft, to rotate as a single unit. So, now the power flow is through the clutch shaft to the largest gear on the lay shaft and then through the above unit it comes out from the splines to the main shaft. Similarly when the second dog clutch is slide to the left and gets engaged, second gear is obtained. When the first dog clutch is slide towards left, the clutch directly engages with the clutch shaft, and power is directly transmitted as in sliding mesh gear box

V. (b) Explain the working principle of a centrifugal clutch.

Ans:

In this arrangement the centrifugal action of flyweights is made use of for engaging and disengaging the pressure plate. The functioning of the clutch is automatic and depends upon the engine speed. In this arrangement, there is no need for specific operation to disengage the clutch. The vehicle can also be stopped with gear load, without stalling the engine. The vehicle is controlled by the accelarator pressure and gear transmission at the starting only. The arrangement makes the driving operation very easy and convenient.

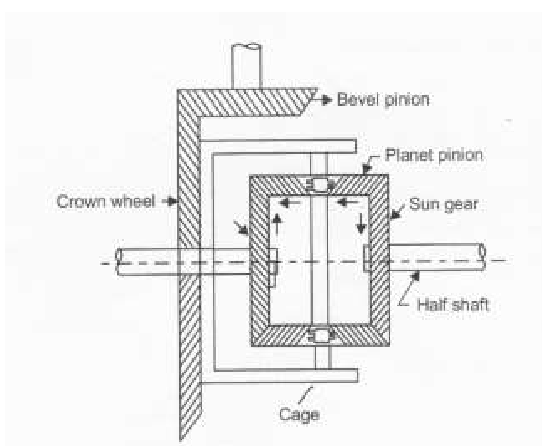


Centrifugal Clutch

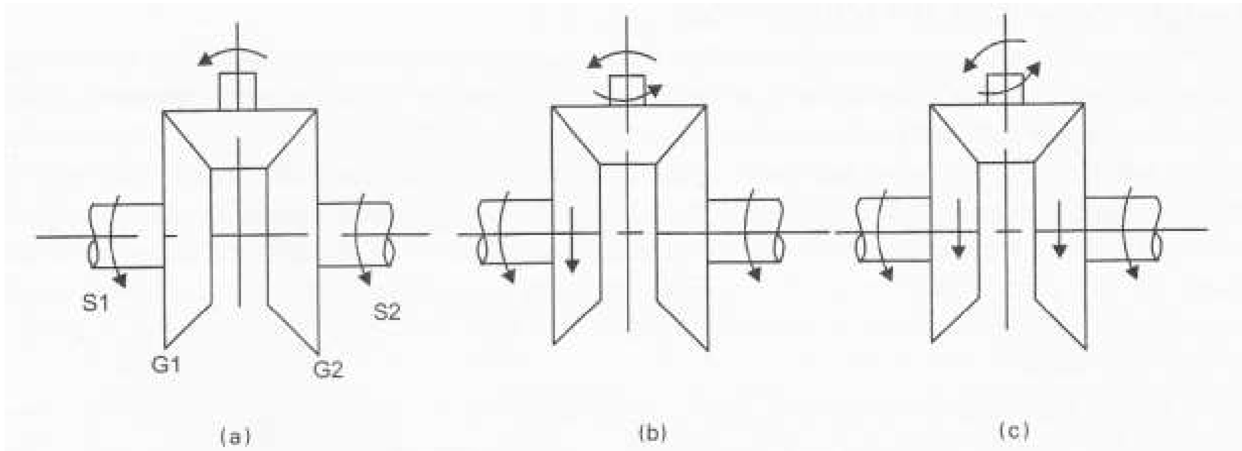
As the speed increases, the fly weights move outwards due to centrifugal force. This movement operates a bell crank lever and presses the floating plate. There are helical springs between the floating plate and pressure plate. Through the springs. The pressure plate containing the friction lining presses the clutch. There is one more set of springs on the back side of the pressure plate shown in figure to keep the clutch is disengaged position at low speed. A projection or a strip called stop is also provided to limit the movement of the fly-weights and the amount of the centrifugal force. Even if the speed is in beyond this limit, the pressure on the plates will remain constant.

VI. (a) Explain the working principle of Differential unit.

Ans: The figure will explain the functioning of differential. When the shaft is moved in a stright ahead position, the bevel gears along with the shaft shall revolve at the same speed in the same direction, irrespective of the speed of the shall. If s-2, is held, stationary, then the right side bevel gear will nut rotate. In this case , if the main shaft is assumed to move forward, the pinion rotates about its own axis and the left side bevel gear rotates faster, then in the previous case. Because in this case the left side bevel gear recieves two different motions due to,



Differential



Principles of Differential

- Forward pulling of the shaft as before.
- Rotation of the pinion about its own axis which is in constant mesh with the bevel gear.

Suppose the right side bevel is allowed to slip on pinion wheel, then the left side bevel gear shall rotate at a lower speed than in the previous case.

VI (b). Briefly describe about semi floating rear axle.

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 plannet gears, aprt from rotating about their own axes.

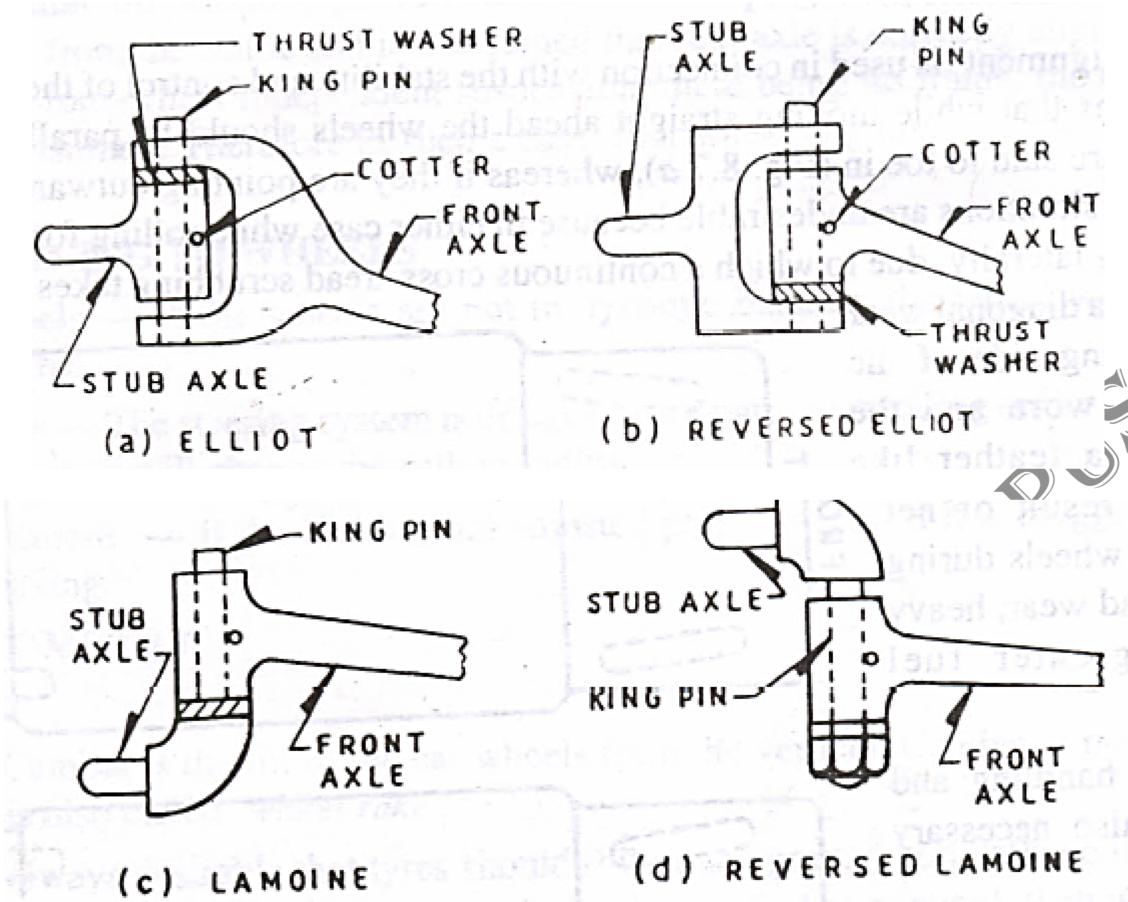
The sun gear shaft is rotated by the engine crank shaft. To obtain different speed ratios only one of the above units is made stationary by means of a brake band. For example ring gear is locked, the sun gear causes the planet gear to rotate. First, let the ring gear be locked. Due to rotation of the sun gear, the plannet 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 plannet carrier shaft. So : the driven shaft will remain stationary.

UNIT – III

VII (a). Draw the neat sketches of different types of stubaxles.

Ans :



VII (b). Explain the steering system of an automobile.

Ans: Steering system

Steering wheel:- This is the control wheel to steer a vehicle by the driver. This contains traffic indicating switch, light switch, etc.

Steering column:- It is hollow tube. The steering wheel is attached at its upper end and the steering sear is fitted at the lower end.

Steering gear:- The function of steering gear as follows.

- This gives the mechanical advantage and gets drivers effort reduced.
- The rotary movement bof the steering shaft at right angle is converted into a straight line motion by a drop arm.

Gear components are enclosed in a steering gear box. The steering gear box is classified as,

1. Worm and worm wheel.
2. Worm and sector arm wheel.
3. Screw and nut.
4. Cam and lever and
5. Rack and pinion.

By turning the steering wheel, motion is transmitted through steering shaft to the steering gear box. A drop arm which is splined to the steering gear box, rocking at one end, is connected to the drag link by a bail joint at the other end. This drag link transmits the motion to the steering arm and steering knuckle. The track road which is attached to the steering arm by ball joint turns the other wheel.

VIII. (a). Briefly describe about tubed tyre and tubeless tyre.

Tyres play a big role in the way a car handles itself. It not only affects the vehicles mileage but safety as well. Essentially, when it comes to tyres, there are of two types – Tube and Tubeless. Let's tell you in a bit more detail what to expect from these difference options.

As the name suggests, a tube tyre consists of a tube of air that is placed inside the tyre. The air acts as a cushion and makes driving over bumpy roads a bit smoother. It also maintains the shape of the tyre and most importantly supports the weight of the vehicle, keeping it stable.

On the other hand, a tubeless tyre weighs less and reduces un-sprung weight of the vehicle. This gives you superior
handling characteristics and inspires confidence in the driver. The overall result – a better driving experience!

However, the advantages of driving on a set of tubeless tyres far outweigh tubes. This is especially visible when a tyre gets punctured. With a sudden loss of air pressure, your car can get unstable and swerve, eventually leading to an accident. In similar condition, a tubeless tyre would lose its air slowly and uniformly, thus giving the driver ample time to slow the vehicle down.

Other advantages also lie in tubeless tyres like; its resistance when driving is much lower, the car feels lighter and has less friction, making it more economical. Apart from that, it has lesser components, generates low heat while on the move and causes minimal vibration. One of the most important difference is that they last longer than tubes.

VIII. (b) Explain the working of hydraulic brake system.

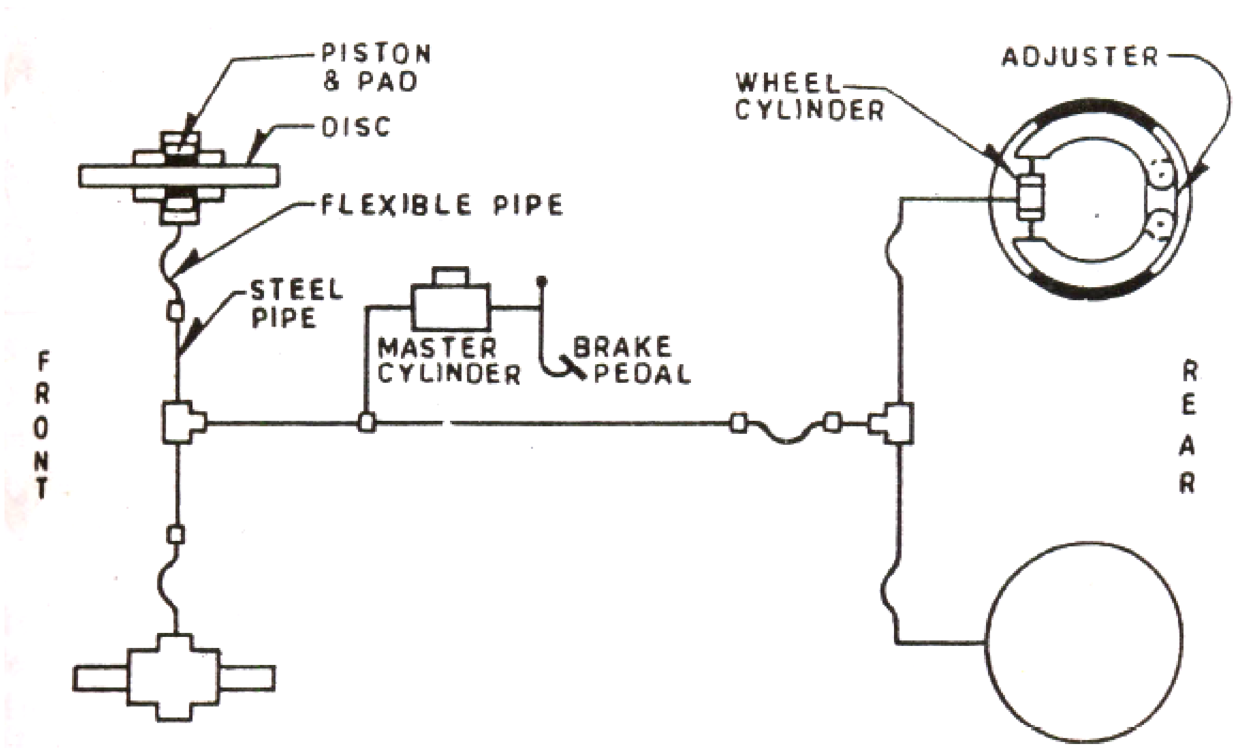
Ans: Brake system in which hydraulic pressure is applied is called; „Hydraulic system". The hydraulic pressure is applied instead of a cam as in the mechanical brake, to turn loose end of the brake shoes. The main components on the system are:

1. Master cylinder.
2. Wheel cylinder.

The principle of hydraulic brake system is shown in figure.

First, let us assume four cylinders of the same cross sections. Let a certain force be applied at the main cylinder as shown. If the same force is applied to all the other four cylinders, the weights are exactly supported by the liquid in all the cylinders. This fundamental explains that the pressure at the central cylinder is equall to that of all cylinders.
Hydraulic brake system consists of a master cylinder and four wheel cylinders. The brake fluid hose from the master cylinder and flows to all the cylinders through pipe lines.

Brake shoes held by springs are provided on all the four wheels. When the brake pedal is pressed, the piston on the master cylinder forces out the fluid from the cylinder, and passes through the cylinder and the pipe lines. When this fluid enters the wheel cylinders, it pushes the two pistons in the wheel cylinder and the shoes outwards which in turn pass against the brake drum.



UNIT – IV

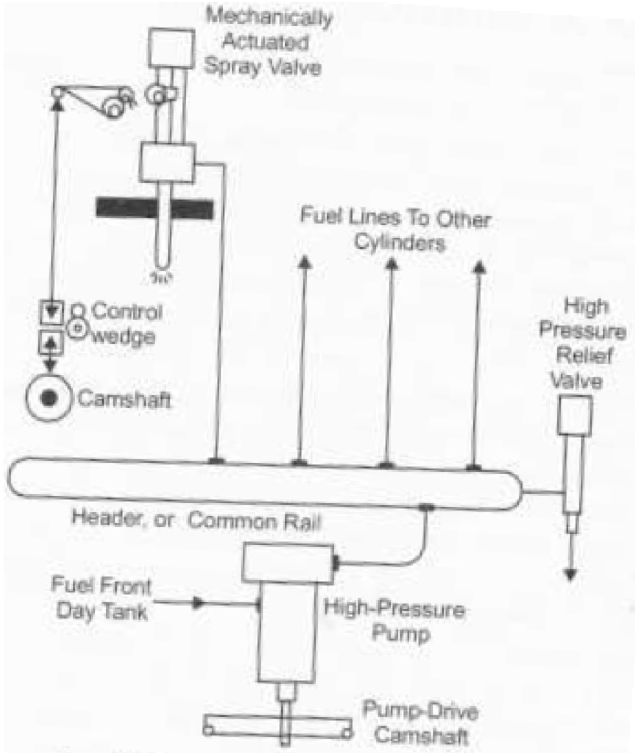
IX (a) Briefly describe about common rail direct injection system.

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 brakes 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 un burnt 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 occures 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.



Common Rail Injection System

IX (b) Explain the working of power window.

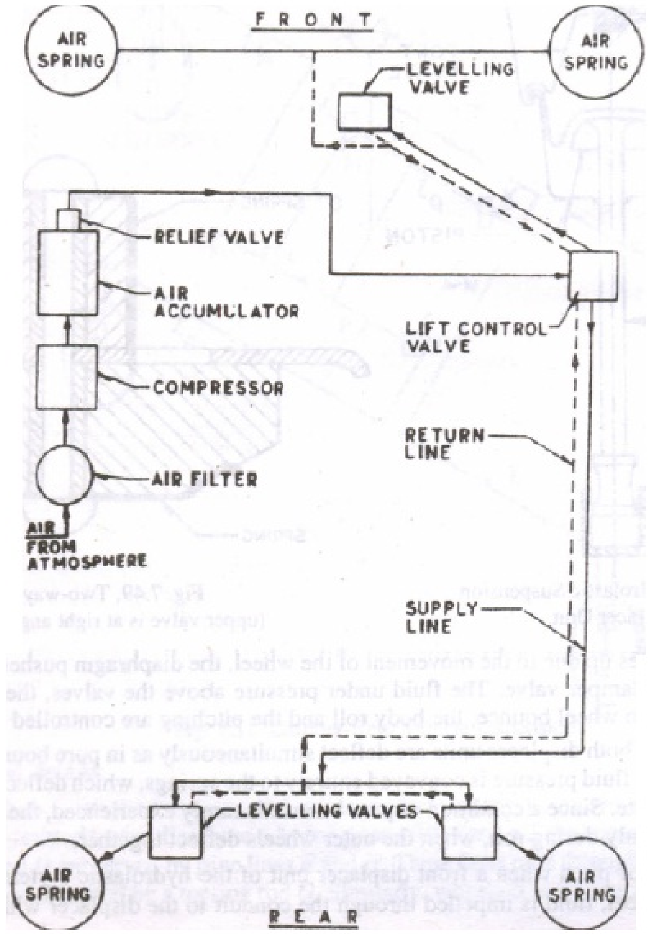
Ans : Power windows

With power windows, when one pushes the button up or down, and the windows move. It all begins with the car battery that sends the power to the power distribution box, from there the power is directed to the ignition; so that when the vehicle is turned ON, the windows will be in operation. From the ignition a wire runs to the fuse box before leading on to the window switch, this is essential in the case of a fault. The fuse will burn out therefore preventing any major costly repairs to larger components.

The majority of power windows work in the same way by having an automatic down feature on the driver side window. The power window motor is a small motor that has an attached worm gear. This worm gear is a length of metal with a spiral on one end, similar to that of a screw. The worm is attached to a gear; this circular gear has teeth around the outside. As the worm turns it moves the gear by linking the teeth inside the spiral; the gear is then linked to several spur gears. Spur gears are used to create gear reductions in machine with motors. The worm is fixed at a specific angle to the gear, which allows the worm to run the gear, but prevents the gear from turning the worm. The motion of the worm and gears create a gear reduction which gives enough force to turn or rotate things, this is called torque. There are supporting bars below each electric window and attached to each bar is an arm. This arm slides along the bars as the window rises and falls. The other end of the arm has a plate with teeth that slot into the teeth of the gears; as the gears turn so does the arm and in turn rises or lowers the window glass. On the opposite side of the bars is a counter arm that counter acts the weight of the window, so if the main arm is raised on the right side of the window the counter arm will be raised on the left, ensuring that the glass rises and falls evenly and level.

X (a) Briefly describe about air suspension system.

Ans: The layout of an air suspension system as shown in figure. The for air springs, which may be either the bellows type or the piston type as discussed above, are mounted on the same position are generraly the coil springs are mounted. An air compressor takes the atmospheric air through a filter and compresses it to a pressure of about 240Mpa, at which pressure the air in the accumulator tank is maintained, which is also provided with a safety relief valve. This high pressure air goes through the life control valve and the levelling valves, to the air springs as shown. The lift control valve is operated manually by means of a handle on the control panel, through a cable running from the valve to the handle



X (b) What are the different air pollutants from automobiles and its effect.

Ans: Types of air pollutants.

Emissions of many air pollutants have been shown to have variety of negative effects on public health and the natural environment. Emissions that are principal pollutants of concern include:

Hydrocarbons - A class of burned or partially burned fuel, hydrocarbons are toxins. Hydrocarbons are a major contributor to smog, which can be a major problem in urban areas. Prolonged exposure to hydrocarbons contributes toasthma, liver disease, lung disease, and cancer. Regulations governing hydrocarbons vary according to type of engine and jurisdiction; in some cases, "non-methane hydrocarbons" are regulated, while in other cases, "total hydrocarbons" are regulated. Technology for one application (to meet a non-methane hydrocarbon standard) may not be suitable for use in an application that has to meet a total hydrocarbon standard. Methane is not directly toxic, but is more difficult to break down in a catalytic converter, so in effect a "non-methane hydrocarbon" regulation can be considered easier to meet. Since methane is a greenhouse gas, interest is rising in how to eliminate emissions of it.

Carbon monoxide (CO) - A product of incomplete combustion, carbon monoxide reduces the blood's ability to carry oxygen; overexposure (carbon monoxide poisoning) may be fatal. Carbon Monoxide poisoning is a killer in high concentrations.

Nitrogen oxides (NOx) - Generated when nitrogen in the air reacts with oxygen at the high temperature and pressure inside the engine. NOx is a precursor to smog and acid rain. NOx is a mixture of NO, N2O, and NO2. NO2 is extremely reactive. It destroys resistance to respiratory infection. NOx production is increased when an engine runs at its most efficient (i.e. hottest) part of the cycle.

Particulate matter – Soot or smoke made up of particles in the micrometre size range: Particulate matter causes negative health effects, including but not limited to respiratory disease and cancer.

Sulphur oxide (SOx) - A general term for oxides of sulfur, which are emitted from motor vehicles burning fuel containing sulfur. Reducing the level of fuel sulfur reduces the level of Sulphur oxide emitted from the tailpipe.

Volatile organic compounds (VOCs) - Organic compounds which typically have a boiling point less than or equal to 250 °C; for example chlorofluorocarbons (CFCs) and formaldehyde. Volatile organic compounds are a subsection of Hydrocarbons that are mentioned separately because of their dangers to public health.