ROLL NO. | | - | | |

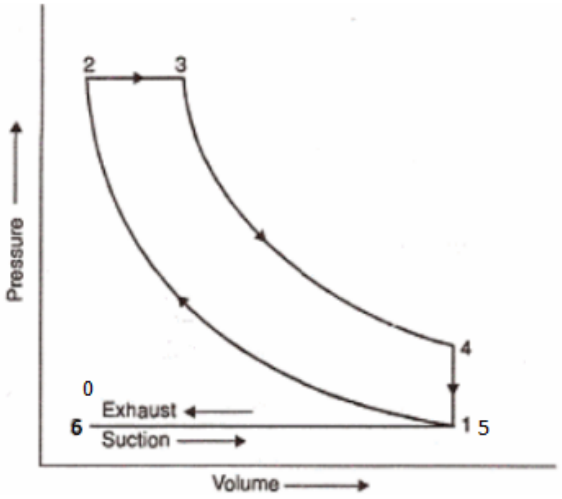
Internal Assessment Test I

Sub:	Elements of Mechanical Engineering					Sub Code:	21ME15	Branch:	Chemistry Cycle	
Date:	26/01/2022	Duration:	90 min's	Max Marks:	50	Sem / Sec:	1st / I - O		OBE	
	Answer any Five Questions							MARKS	CO	RBT
1	With P-V diagram and neat sketches, explain the working of a four stroke diesel engine.							10	CO1	L2
2	Discuss the following lathe operations with neat sketches: i. Taper turning by swiveling of compound rest, ii. Thread cutting.							10	CO2	L2
3	Write briefly about construction and working of horizontal milling machine.							10	CO2	L2
4	Explain with neat sketch, the following drilling operations: i. Boring, ii. Reaming, iii. Counter sinking.							10	CO2	L2
5	With neat diagram explain different components of an IC engine.							10	CO1	L2
6	Explain with neat sketch following milling operations: i. Up Milling, ii. Down Milling and Gang Milling.							10	CO2	L2
7	Explain construction and working of two stroke petrol engine with neat diagrams.							10	CO1	L2

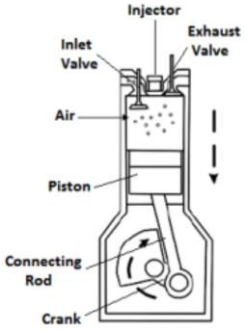
IAT – I Solution

1. **With P – V diagram and neat sketches, explain the working of a four stroke diesel engine.**

In a 4 stroke diesel engine, one cycle of operation is completed in 4 strokes of a piston or two revolutions of a crankshaft. It consists of 4 strokes namely suction, compression, expansion and exhaust.



- 0-1 Suction stroke
- 1-2 Compression stroke
- 2-3 Constant pressure heat addition
- 3-4 Power stoke
- 4-5 Constant volume heat rejection
- 5-6 Exhaust stroke

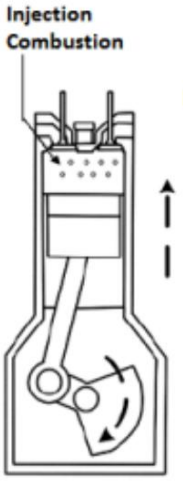


Suction Stroke:

In this stroke the piston starts moving from TDC to BDC. The inlet valve opens and the exhaust valve remains closed. During the piston movement, a suction force is created because of which air enters into the cylinder. It is represented by the curve 0-1 on the P – V diagram. When the piston reaches BDC, the inlet valve closes.

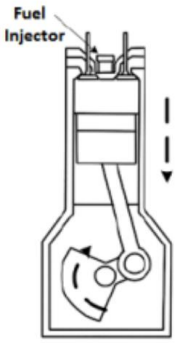
Compression Stroke:

In this stroke both the valves are closed. The piston moves from BDC to TDC thereby compressing the air to a very high pressure and temperature represented by the curve 1-2 on P-V diagram. At the end of the compression stroke the air would have reached the auto – ignition temperature of diesel.



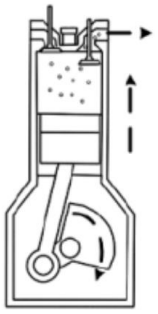
At the end of the compression stroke, fuel (diesel) is injected into the cylinder by the fuel injector. Since the temperature of air inside the cylinder is auto – ignition temperature of diesel, as soon as diesel enters the cylinder, combustion occurs. This would exert a pressure on the piston pushing it down. Due to this movement the volume increases. The rate of injection of fuel is that the combustion maintains the pressure constant inspite of the piston movement which is represented by the curve 2-3 on the P-V diagram. Hence, heat is added to the system at constant pressure. Because of this, a diesel engine cycle is also called as a constant pressure heat addition cycle.

Expansion Stroke:



In this stroke both the valves are closed. The burnt gases exert pressure on the piston thereby causing it to move from TDC to BDC. Due to expansion, the pressure drops and the volume increases which is represented by the curve 3-4 on the P – V diagram. At the end of expansion stroke the exhaust valve opens. Since the pressure of burnt charge is more than the atmospheric pressure, it escapes out of the cylinder with the piston still at BDC. As the burnt charge carry away some amount of heat with it, this processes is called as heat rejection at constant volume and is represented by the curve 4-5 on the P- V diagram.

Exhaust Stroke:

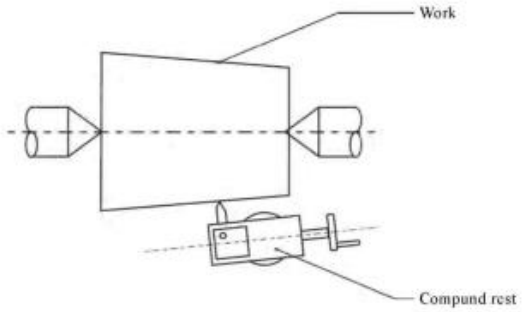


In this stroke, the inlet valve is closed and the exhaust valve is open. The piston moves from BDC to TDC thereby pushing the remaining burnt charge out of the cylinder and preparing it for the next cycle of operation. This stroke is represented by the curve 5-6 on the P – V diagram.

2. Discuss the following lathe operations with neat sketches : (i) Taper turning by swiveling of the compound rest, and (ii) Thread cutting

(i) Taper turning by swiveling of the compound rest

Taper turning is a machining operation, which means that the diameter of cylindrical workpieces gradually decreases from one part to another. It generates a conical shape from a cylindrical workpiece. This method uses the principle of turning taper by rotating the workpiece on the lathe axis and feeding the tool at an angle to the axis of rotation of the workpiece. The tool is mounted on the compound rest which is attached to a circular base, graduated in degrees. The compound rest can easily be swiveled or rotated and clamped at any desired angle as shown in figure. Once the compound rest is set at the desired half taper angle, rotation of the compound slide screw will cause the tool to be fed at that angle and generate a corresponding taper. This method is limited to turn a short but steep taper because of the limited movement of the cross-slide. The angle of taper is calculated using the formula given.



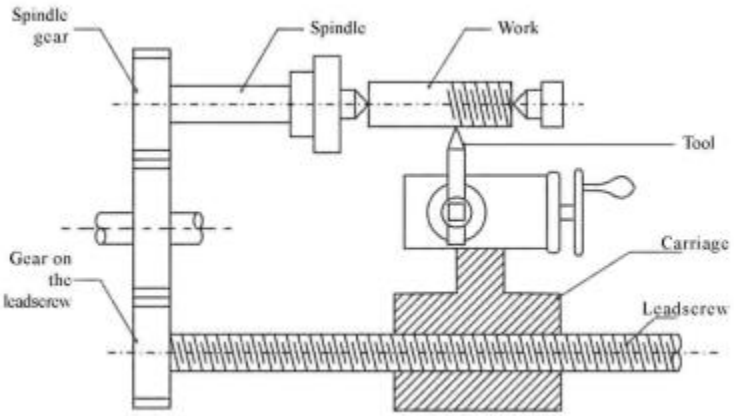
$$\tan \varnothing = \frac{D - d}{2l}$$

Where D – Larger diameter
d – Smaller diameter
l – Length of the taper
Ø - Half taper angle

(ii) Thread cutting

Thread cutting is one of the most important operations performed in a lathe. The process of thread cutting is to produce a helical groove on a cylindrical surface by feeding the tool longitudinally.

The job is revolved between centres or by a chuck. The longitudinal feed should be equal to the pitch of the thread to be cut per revolution of the work piece. The cutting tool must travel a distance equal to the pitch (in mm) as the work piece completes a revolution. The definite relative rotary and linear motion between job and cutting tool is achieved by locking or engaging a carriage motion with lead screw and nut mechanism and fixing a gear ratio between head stock spindle and lead screw. To make or cut threads, the cutting tool is brought to the start of job and a small depth of cut is given to cutting tool using cross slide.



3. Write briefly about construction and working of horizontal milling machine.

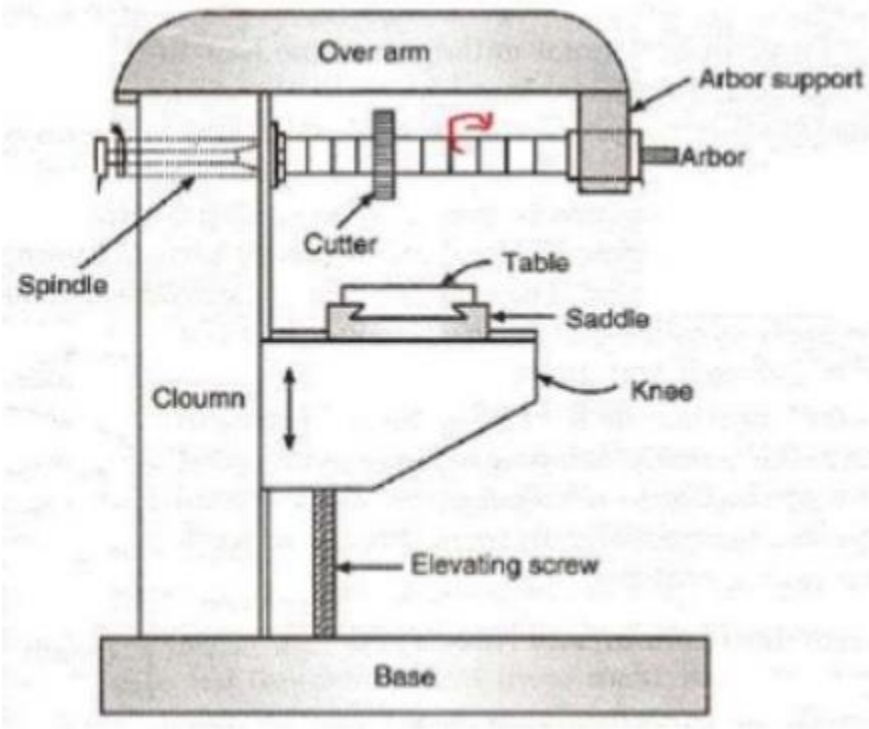
The Horizontal Milling Machine is a very robust and sturdy machine. A variety of cutters are available to removed/shape material that is normally held in a strong machine vice. This horizontal miller is used when a vertical miller is less suitable. For instance, if a lot of material has to be removed by the cutters or there is less of a need for accuracy - a horizontal milling machine is chosen. Figure below shows the different parts of horizontal machine.

Construction:

Horizontal milling machine consist of the following parts.

Base

It is accurately machined on its top and bottom surface and serves as a foundation member for all other parts. It carries the column at its one end. In some machines, the base is hollow and serves as a reservoir for cutting fluid.



Column

It is the main supporting frame mounted vertically on the base. The column is box shaped, heavily ribbed inside and houses all the driving mechanisms for the spindle and table feed. The front vertical face of the column is accurately machined and is provided with dovetail guide ways to supporting the knee. The top of the column is finished to hold an over arm that extends outward at the front of the machine.

Knee

It slides up and down on the vertical guide ways of the column face. The adjustment of height is affected by an elevating screw mounted on the base that also supports the knee. The knee houses the feed mechanism of the table, and different controls to operate it. The top face of the knee forms a slideway for the saddle to provide cross travel of the table.

Table

The table rests on ways on the saddle and travels longitudinally. The top of the table is accurately finished and T-slots are provided for clamping the work and other fixtures on it. A lead screw under the table engages a nut on the saddle to move the table horizontally by hand or power. The longitudinal travel of the table may be limited by fixing trip dogs on the side of the table. In universal machines, the table may also be swiveled horizontally.

Overhanging arm

The overhanging arm that is mounted on the top of the column extends beyond the column face and serves as a bearing support for the other end of the arbor. The arm is adjustable so that the bearing support may be provided nearest to the cutter.

Front brace

The front brace is and extra support that is fitted between the knee and the over arm to ensure further rigidity to the arbor and the knee. The front brace is slotted to allow for the adjustment of the height of the knee relative to the over arm.

Spindle: The spindle of the machine is located in the upper part of the column and receives power from the motor through belts, gears, clutches and transmits it to the arbor. The front end of the spindle just projects from the column face and is provided with a tapered hole into which various cutting tools and arbors may be inserted. The accuracy in metal machining by the cutter depends primarily on the accuracy, strength, and rigidity of the spindle.

Arbor

It may be considered as an extension of the machine spindle on which milling cutters are securely mounted and rotated. The arbors are made with taper shanks for proper alignment with the machine spindles having taper holes at their nose.

Working:

The workpiece mounted on the table is raised against the revolving cutter by an elevating screw to give the required depth of cut. The table is moved in a horizontal plane to give feed to the workpiece. Horizontal milling machines are suitable for obtaining grooves, slots, gear teeth etc.

4. Explain with neat sketch, the following drilling operations: i. Boring, ii. Reaming, and iii. Counter sinking.

(i) Boring

To enlarge a pre-existing hole by means of an adjustable cutting tool with only one cutting edge. This is necessary where suitable sized drill is not available or where hole diameter is so large that it cannot be ordinarily drilled. The cutter is held in a boring bar which has a taper shank to fit into the spindle socket. For perfect finishing a hole, the job is drilled slightly undersized.

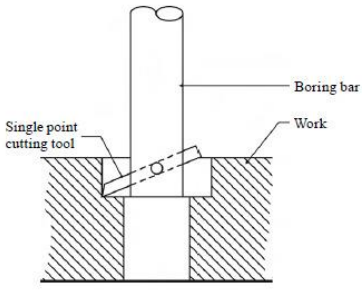
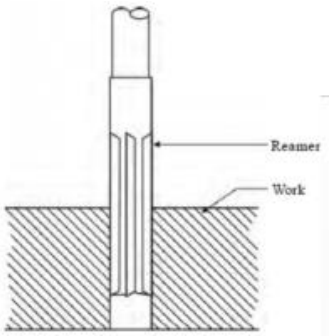


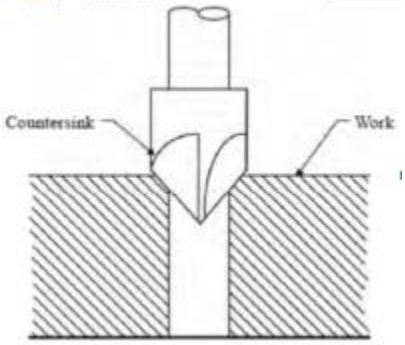
Fig 2.19 Boring

(ii) Reaming



It is an accurate way of sizing and finishing a hole which has been previously drilled. The speed of the spindle is made half that of drilling and automatic feed may be employed. The tool used for reaming is known as the reamer which has multiple cutting edges. Reamer cannot originate a hole. It simply follows the path which has been previously drilled and removes a very small amount of metal.

(iii) Counter Sinking



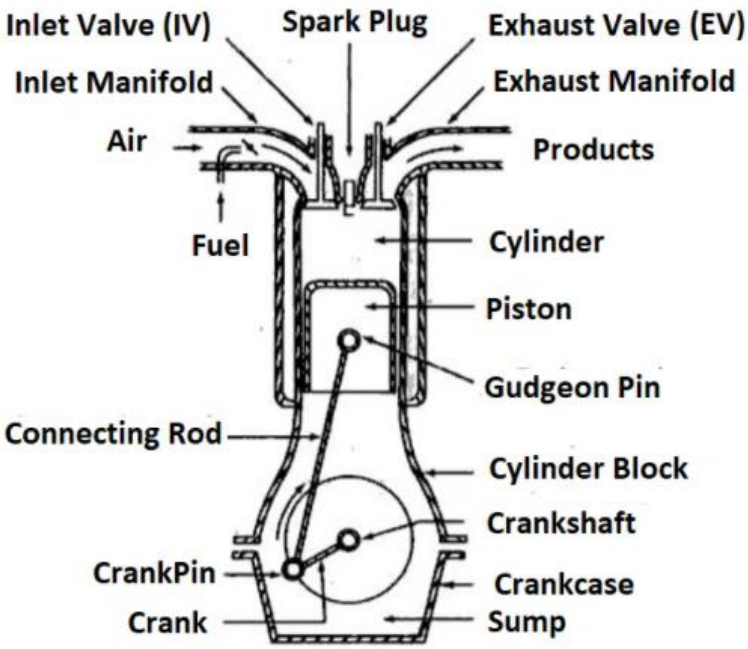
It is the operation of making a cone-shaped enlargement of the end of hole to provide a recess for a flat head screw or countersunk rivet fitted into the hole. The tool used for countersinking is called a countersink. Standard countersunks have 60°, 82° or 90° included angle and the cutting edges of the tool are formed at the conical surface. The cutting speed in countersinking is 25% less than that of drill.

5. With a neat diagram explain different components of an IC engine

The following are the parts of an IC engine:

Cylinder

It is considered as the heart of the IC engine. It is a cylindrical shaped vessel in which combustion takes place.



Cylinder head

The top end of the cylinder is closed by a removable cylinder head. It contains the valves and seals the working end of the cylinder.

Piston

Piston is a close fitting hollow cylindrical plunger made to reciprocate inside the cylinder in order to receive gas pressure and transmit thrust.

Piston rings

To provide a good sealing fit between the piston and cylinder, pistons are equipped with piston rings. It comprises of compression ring (provides fit) and oil rings (carry away heat).

Connecting rod

It forms a link between the piston and the crankshaft. It converts the reciprocating motion of piston to the rotary motion of the crankshaft.

Crank

The crank is a lever with one end connected to the connecting rod and the other end to the crankshaft. As the piston reciprocates, it rotates about the crankshaft and causes the connecting rod to oscillate.

Crankshaft

It is the output shaft which is partly enclosed in the crankcase. It supports the crank and flywheel and also drives the output camshaft.

Crankcase

The main body of the engine to which the cylinders are attached is called as the crankcase. It houses the connecting rod, crank and a part of crankshaft. Acts as a sump for the lubricating oil.

Inlet Manifold

The pipes which connects the inlet valves/ports of various cylinders to a common inlet pipe for the engine is called the inlet manifold.

Exhaust Manifold

The pipes which connect the outlet valves or ports of various cylinders to a common exhaust system, is called as exhaust manifold.

Inlet Valves

It controls the entry of fresh charge into the cylinder.

Exhaust valve

It discharges the burnt charge out of the cylinder.

Cams

It is an element designed to control the movement of the valves.

Camshaft

It is the output shaft which supports the cam. It is driven through gear or chain drives.

Governor

It is a device for automatically regulating the output of a machine by regulating the supply of working fluid. It controls the fluctuations of engine speed due to load changes.

Flywheel

It is a heavy disc mounted on the crankshaft and acts as an energy reservoir.

Fuel pump

Fuel pump in petrol engine is used to supply fuel to the carburetor where as in diesel engine it supplies fuel to fuel injector or fuel atomizer.

Parts common to petrol engines:

Spark plug

It is present on the cylinder head. Its main function is to generate a spark from the ignition system to the combustion chamber.

Carburetor

The function of carburetor is to atomize and metre the liquid fuel and mix it with air as it enters the induction system of the engine.

Part common to diesel engine:

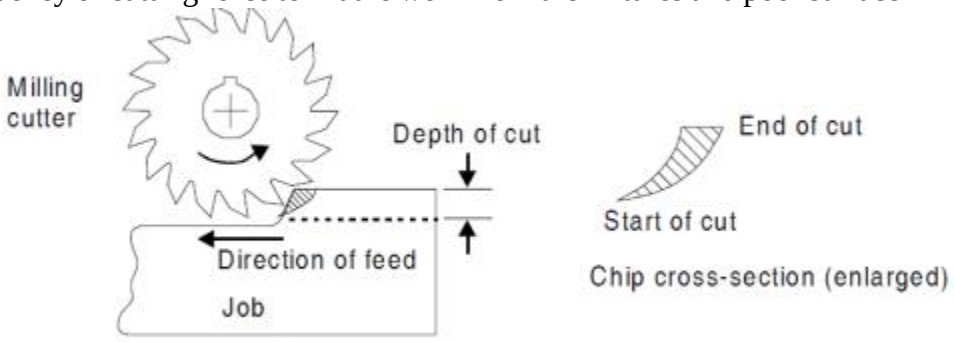
Fuel atomizer/Injector

It is a component fitted on the cylinder head of diesel engines to spray metered quantity of diesel into the combustion chamber.

6. Explain with neat sketch following milling operations: i. Up Milling, ii. Down milling, and iii. Gang milling.

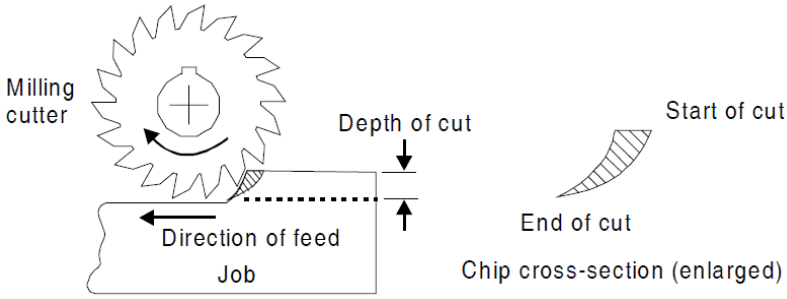
(i) Up Milling

In the up-milling or conventional milling, as shown in the figure. In this method metal is removed by a cutter rotating against the direction of travel of the workpiece. In this type of milling, the chip thickness is minimum at the start of the cut and maximum at the end of cut. As a result the cutting force also varies from zero to the maximum value per tooth movement of the milling cutter. The major disadvantages of up-milling process are the tendency of cutting force to lift the work from the fixtures and poor surface finish obtained.



(ii) Down Milling

Down milling or climb milling is shown in figure. In this method, the metal is removed by a cutter rotating in the same direction of feed of the workpiece. The effect of this is that the teeth cut downward instead of upwards. Chip thickness is maximum at the start of the cut and minimum in the end. In this method, it is claimed that there is less friction involved and consequently less heat is generated on the contact surface of the cutter and workpiece.



(iii) Gang Milling

It is the operation of machining several surfaces of work simultaneously by feeding the table against a number of cutters (either of same type or of different type) mounted on the arbor of the machine. This method saves much of machining time and mostly used in production work.

7. Explain construction and working of two stroke petrol engine with neat diagrams.

A two-stroke engine is a type of internal combustion engine that completes a power cycle with two strokes of the piston during only one crankshaft revolution.

Construction

Piston: Piston transfers the expanding force of gases to the mechanical rotation of the crankshaft through a connecting rod.

Crankshaft: It converts reciprocating motion to rotational motion

Connecting rod: It transfers motion from the piston to crankshaft.

Flywheel: It is a mechanical device used to store energy.

Spark Plug: It delivers a spark to the combustion chamber and it in turn ignites the air-fuel mixture leading to expansion or power generation.

Inlet Port: Allows fresh charge (air – fuel mixture) to enter into the crankcase.

Exhaust Port: Discharges burnt charge out of the cylinder.

Working

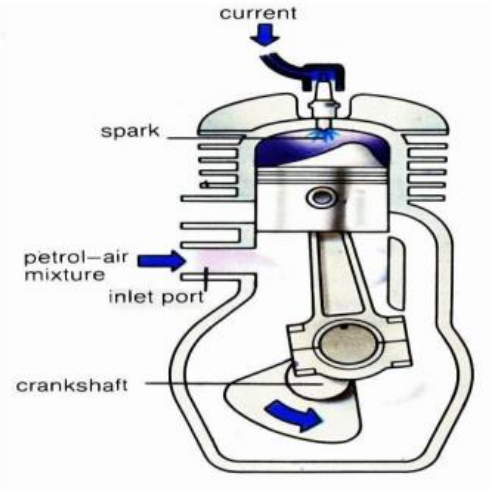
Downward stroke / First stroke

Assuming at start of this stroke fuel mixture is ready for ignition and combustion process has already started. In this stage, the piston, while going down towards BDC, uncovers both the transfer port and the exhaust port. In this stage, the inlet port opens and fresh fuel-air mixture enters into the crank case when piston is at TDC. As the piston moves downwards the transfer port uncovers and through it the fresh charge enters into the cylinder chamber. As the fresh charge enters the cylinder chamber it pushes out the exhaust gases from the cylinder which is known as scavenging process. While doing so crankshaft completes half a revolution. Further movement of the piston uncovers the transfer port, thus permitting the slightly compressed charge in the crank case to enter the engine cylinder. The top of the piston has usually a projection to deflect the fresh charge towards the top of the cylinder before flowing through the exhaust ports.

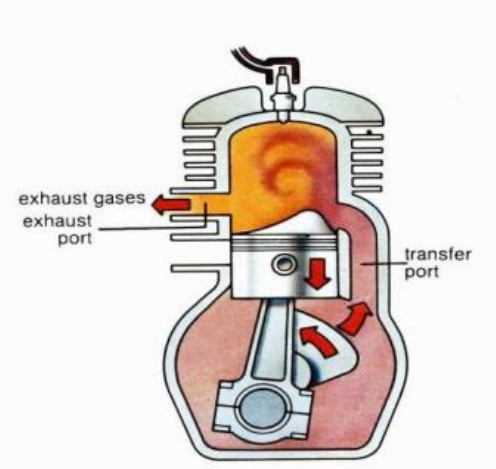
This has the dual purpose:

a) Scavenging the upper part of the cylinder of the combustion products and

b) Preventing the fresh charge from flowing directly towards the exhaust ports.



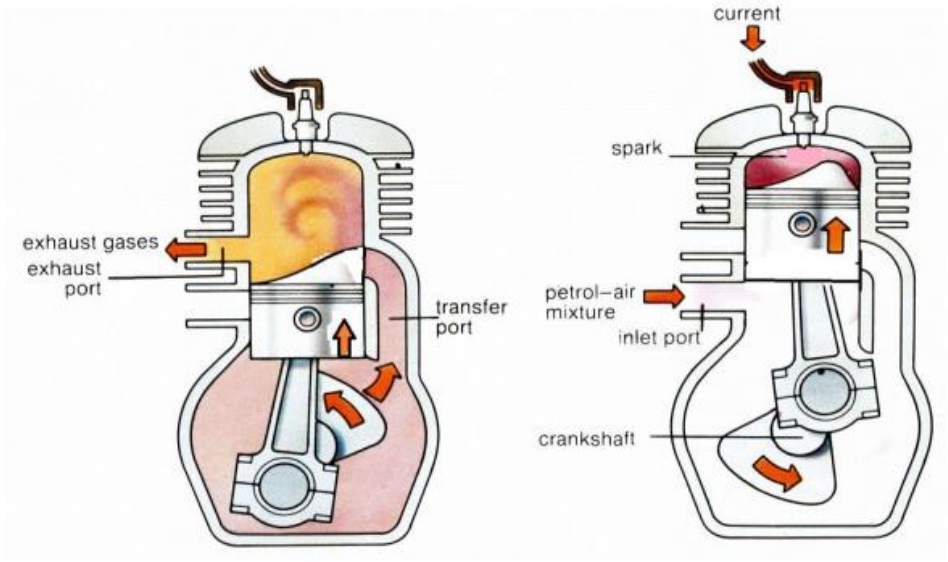
Beginning of the first stroke



Piston uncovers transfer port During first stroke

Upward stroke / Second stroke

As the piston moves upwards it opens the inlet port and closes the transfer port. But still the exhaust port is kept open which allows the exhaust gases to escape from the cylinder chamber. As the inlet port opens the fresh charge enters into the crank case of the engine. As the piston moves upwards it compresses the fresh charge to high temperature and pressure there by preparing the mixture for ignition. Shortly before this piston reaches the TDC (during compression stroke), the charge is ignited with the help of a spark plug. It suddenly increases the pressure and temperature of the products of combustion. But the volume, practically, remains constant. Due to rise in the pressure, the piston is pushed downwards with a great force. The hot burnt gases expand due to high speed of the piston. During this expansion, some of the heat energy produced is transformed into mechanical work. This completes the cycle and the engine cylinder is ready to take in the charge again.



Transfer port covered *Compression commenced*