SNS COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

16GE101 Basic Mechanical Engineering

UNIT IV IC ENGINES

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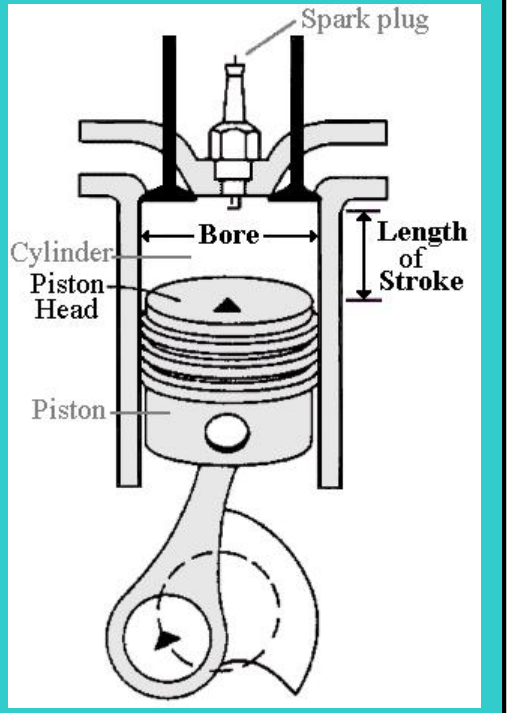
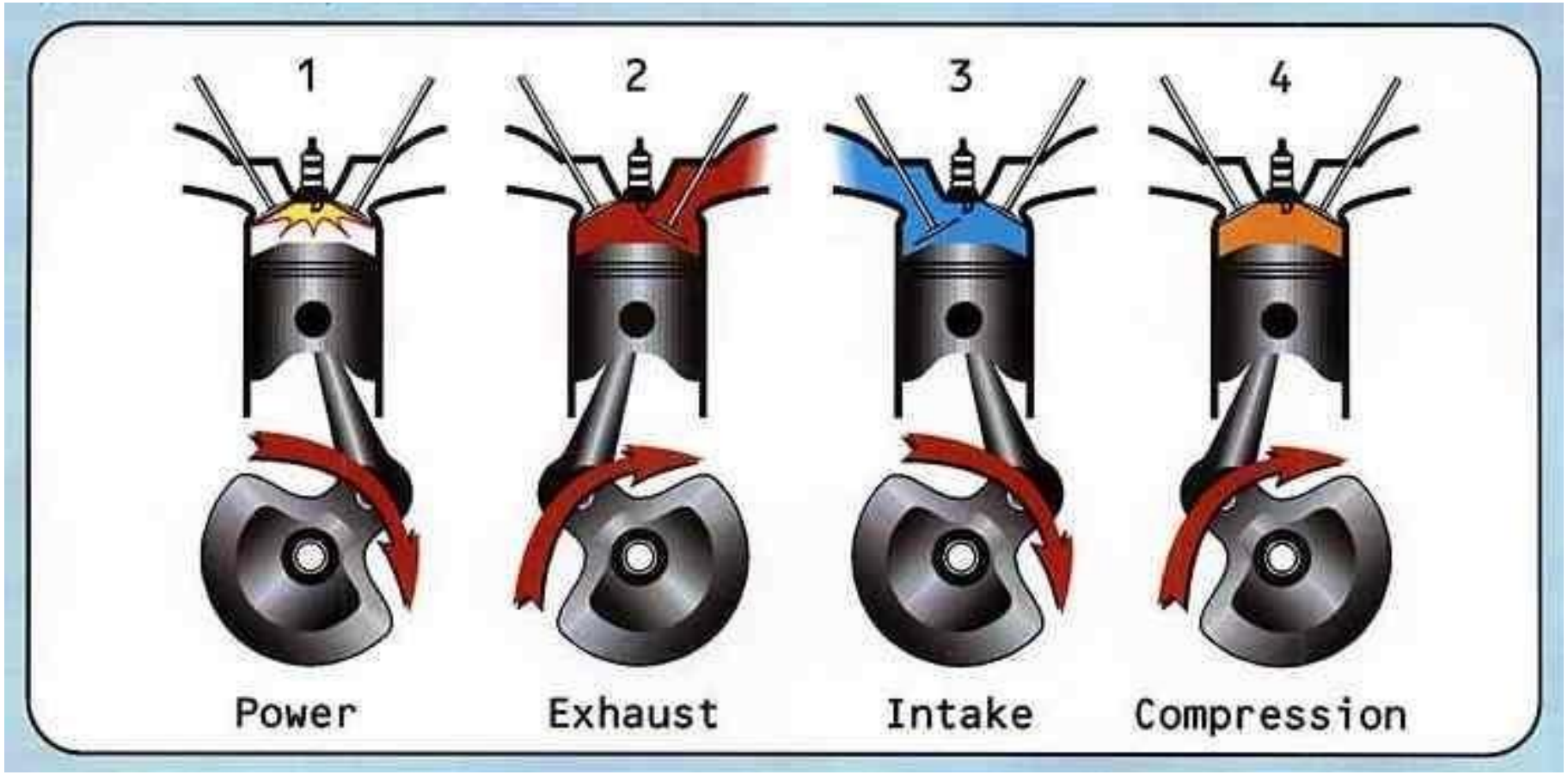
Four stroke cycle Petrol Engines

Construction :

- A piston reciprocates inside the cylinder
- The piston is connected to the crank shaft by means of a connecting rod and crank.
- The inlet and exhaust valves are Mounted on the cylinder head.
- A spark is provided on the cylinder Head.
- The fuel used is petrol



Four Stroke Petrol Engine- Working



Four Stroke Petrol Engine - Working

(a) Suction Stroke (First Stroke of the Engine)

- Piston moves down from TDC to BDC
- Inlet valve is opened and the exhaust valve is closed.
- Pressure inside the cylinder is reduced below the atmospheric pressure.
- The mixture of air fuel is sucked into the cylinder through the inlet valve

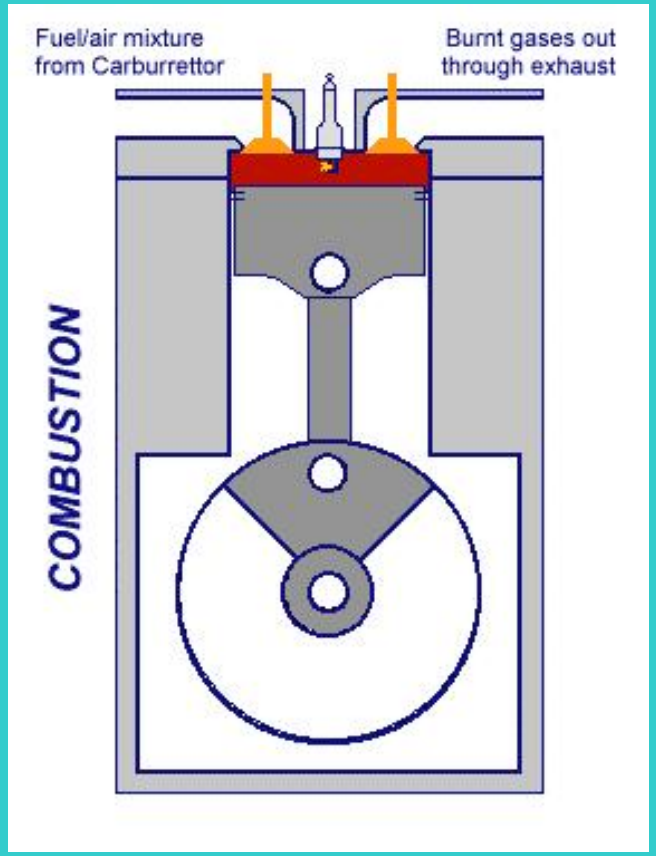
Four Stroke Petrol Engine - Working

(b) Compression Stroke : (Second Stroke of the piston)

Piston moves up from BDC to TDC

Both inlet and exhaust valves are closed.

The air fuel mixture in the cylinder is compressed.



Four Stroke Petrol Engine - Working

(c) Working or Power or Expansion Stroke: (Third Stroke of the Engine)

The burning gases expand rapidly. They exert

an impulse (thrust or force) on the piston.

The piston is pushed from TDC to BDC

This movement of the piston is converted into rotary motion of the crankshaft through connecting rod.

Both inlet and exhaust valves are

closed.

Four Stroke Petrol Engine - Working

(d) Exhaust Stroke (Fourth stroke of the piston)

Piston moves upward from BDC

Exhaust valve is opened and the inlet valve is closed.

The burnt gases are forced out to the atmosphere through the exhaust valve (Some of the burnt gases stay in the clearance volume of the cylinder)

The exhaust valve closes shortly after TDC

The inlet valve opens slightly before TDC and the cylinder is ready to receive fresh charge to start a new cycle.

Four Stroke Petrol Engine - Working

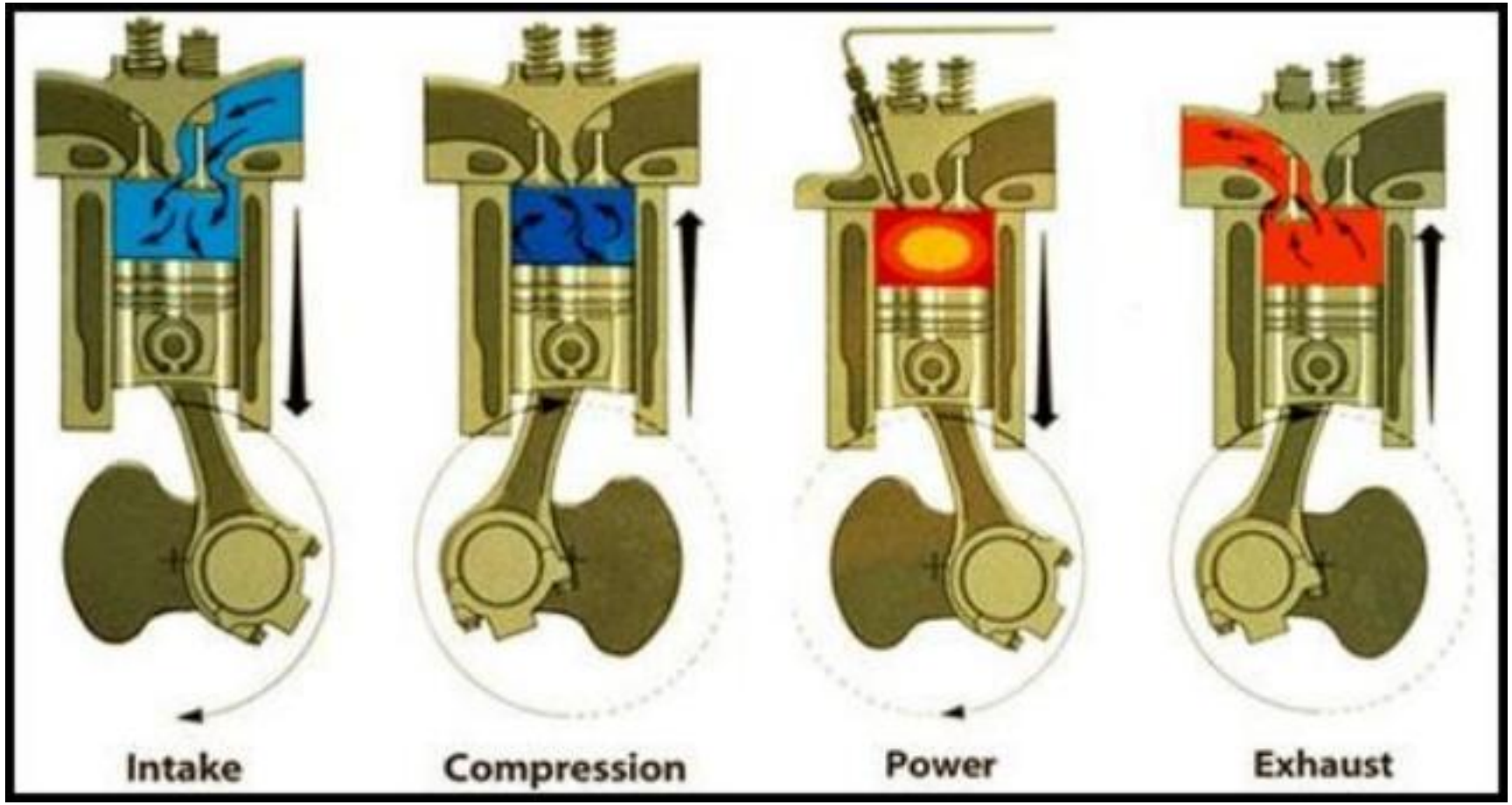
Summary :

Compression ratio varies from 5 to 8

The pressure at the end of compression is about 6 to 12 bar.

The temperature at the end of the compression reaches 250^{o} C to 350^{o} C

Four Stroke Diesel Engine



Four Stroke Diesel Engine

Construction:

- A piston reciprocates inside the cylinder
- The piston is connected to the crankshaft by means of a connecting rod and crank.
- The inlet and exhaust valves are mounted on the cylinder head.
- A fuel injector is provided on the cylinder head
- The fuel used is diesel.

Four Stroke Diesel Engine - Working

(a) Suction Stroke (First Stroke of the piston)

- Piston moves from TDC to BDC
- Inlet valve is opened and the exhaust valve is closed.
- The pressure inside the cylinder is reduced below the atmospheric pressure.
- Fresh air from the atmosphere is sucked into the engine cylinder through air cleaner and inlet valve.

Four Stroke Diesel Engine - Working

(b) Compression stroke (Second stroke of the piston)

Piston moves from BDC to TDC

Both inlet and exhaust valves are closed.

The air is drawn during suction stroke is compressed to a high pressure and temperature

Four Stroke Diesel Engine - Working

(c) Working or power or expansion stroke (Third stroke of the piston)

The burning gases (products of combustion) expand rapidly.

The burning gases push the piston move downward from TDC to BDC

This movement of piston is converted into rotary motion of the crank shaft through connecting rod.

Both inlet and exhaust valves are closed.

Four Stroke Diesel Engine - Working

(d) Exhaust Stroke (Fourth stroke of the piston)

Piston moves from BDC to TDC

Exhaust valve is opened the inlet valve is closed.

The burnt gases are forced out to the atmosphere through the exhaust valve. (some of the burnt gases stay in the clearance volume of the cylinder)

The exhaust valve closes shortly after TDC

The inlet valve opens slightly before TDC and the cylinder is ready to receive fresh air to start a new cycle.

Scavenging

Scavenging :

- It is the process of forcing out the burnt exhaust gases from the cylinder for admitting the fresh charge into the cylinder.
- This action takes place in the two stroke cylinder.

Scavenging Process

- The charge (air fuel mixture or air) enters the engine cylinder from the crank case at a pressure higher than the exhaust gases.
- This fresh charge forces the exhaust gases to the atmosphere through the exhaust port.
- During the period both the transfer and exhaust ports are kept open for a short period.
- Hence there is a possibility of the fresh charge escaping out with the burnt gases.
- This is over come by designing the piston to have a deflected shape.
- This shape of piston deflects the fresh charge upward in the engine cylinder.
- It also helps out in forcing out the exhaust gases to atmosphere.
- This process is known as **Scavenging.**

Comparison between SI and CI Engines (General Comparison)

S.No.	Spark Ignition Engines (SI)	Compression Ignition Engines (CI)
1	It draws air fuel mixture into the cylinder during suction stroke	It draws only air into the cylinder during suction stroke.
2	Petrol engines operate with low pressure and temperature	Diesel engines operate with high pressure and temperature
3.	Pressure ranges from 6 to 12 bar Temperature ranges from 250^{o} to 3 00^{o} C	Pressure ranges from 35 to 40 bar Temperature ranges from 600^{o} to 700^{o} C

Comparison between SI and CI Engines (General Comparison)

S.No.	Spark Ignition Engines (SI)	Compression Ignition Engines (CI)
4	It is fitted with carburettor and spark plugs	It is fitted with fuel injection pump and injectors
5	The burning of fuel takes place at constant volume	The burning of fuel takes place at constant pressure
6.	Ignition of air fuel mixture takes place by an electric spark produced by spark plug	Ignition of air fuel takes placed by a injection of fuel into the hot compressed air.

Comparison between SI and CI Engines (General Comparison)

S.No.	Spark Ignition Engines (SI)	Compression Ignition Engines (CI)
7	Petrol engines are quality governed engines. The speed of petrol engines are controlled by varying the quantity of air fuel mixture.	Diesel engines are quantity governed engines. The speed of diesel engines are controlled by varying quality of air fuel mixture. (rich or weak mixture)
8	Petrol engines are widely used in automobiles and aeroplanes etc.,	Diesel engines are widely used in heavy vehicles, such as buses, lorries, trucks etc.,

Comparison between SI and CI Engines (Merits and Demerits)

S.No.	Spark Ignition Engines (SI)	Compression Ignition Engines (CI)
1	**Merits:** Otto cycle is employed in petrol engine. Otto cycle is more efficient for a given compression ratio.	**Demerits:** Diesel engines works on diesel cycle. Diesel cycle is less efficient than Otto cycle for a given compression ratio.
2	Operating speed is more. Speed range is 3000 to 6000 rpm	Operating speed is less. Speed range is 400 to 3500 rpm.
3.	Starting is easy, since cranking effort required is less	Starting is difficult since more cranking effort is required.

Comparison between SI and CI Engines (Merits and Demerits)

S.No.	Spark Ignition Engines (SI)	Compression Ignition Engines (CI)
4	**Merits:** Initial cost and maintenance cost are less	**Demerits:** More initial and maintenance costs since the construction is heavy and sturdy.
5	Produces less noise.	Produces more noise.
6	Weight per unit power is less	Weight per unit power is more.

Comparison between SI and CI Engines (Merits and Demerits)

S.No.	Spark Ignition Engines (SI)	Compression Ignition Engines (CI)
4	**Demerits:** Thermal efficiency is less, since compression ratio is limited. 5 – 8	**Merits:** Thermal efficiency is high since compression ratio is high. 12 to 18.
5	Specific fuel consumption is more.	Specific fuel consumption is less
6	The fuel used is petrol. It is costlier than diesel. It is volatile and fire hazard is more	The fuel used is diesel. It is cheaper than petrol. It is less volatile and fire hazard is less.

Comparison between Four stroke cycle and two stroke cycle engine (Merits and Demerits)

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
1	**Merits:** One power stroke in one revolution of the crankshaft	**Demerits:** One power stroke in two revolutions of the crank shaft
2	Power developed for the same engine speed theoretically twice that of a four stroke engine	Power developed for the same engine speed is theoretically half that of two stroke engine.
3	Simple design and lighter in construction for the same power	For the same power complicated design and heavier in construction

Comparison between Four stroke cycle and two stroke cycle engine (Merits and Demerits)

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
4	**Merits:** Uniform torque is obtained. Hence a lighter fly wheel can be used	**Demerits:** Non uniform torque on the crankshaft. Hence a heavier flywheel is required for balancing.
5	Design of ports is simpler. Hence initial cost is less	Design valve mechanism is difficult. Hence initial cost is more.
6	Mechanical efficiency is high. No moving parts like cam, follower, rocker arm valves etc.,	Mechanical efficiency is less. Power is lost due to friction caused by valve mechanism

Comparison between Four stroke cycle and two stroke cycle engine (Merits and Demerits)

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
7	**Merits:** Starting is easy	**Demerits:** Starting is not so easy
8	These engines are generally air cooled	These engines are generally water cooled.

Comparison between Four stroke cycle and two stroke cycle engine (Merits and Demerits)

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
1	**DeMerits:** Consumption of lubricating oil is more, because less time is available to remove the heat	**Merits:** Consumption of lubricating oil is less, because more time is allowed for removing heat from the cylinder.
2	More wear and tear of moving parts.	Less wear and tear of parts is less
3	Some of the fresh air fuel mixture may escape with exhaust gases. Hence fuel consumption is more	Fuel cannot escape with exhaust gases. Hence fuel consumption is less.

Comparison between Four stroke cycle and two stroke cycle engine (Merits and Demerits)

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
4	**DeMerits:** Thermal efficiency is less.	**Merits:** Thermal efficiency is more.
5	It produces more noise due to sudden release of exhaust gases	Noise is less is less. Exhaust gases are released in separate stroke.
6	Scavenging is poor, since exhaust port is open only for a short time	Scavenging is better, since there is a separate exhaust stroke for the removal of exhaust gases

Comparison between Four stroke cycle and two stroke cycle engine (Merits and Demerits)

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
7	**Merits:** Poor scavenging leads to mixing of fresh charge with exhaust gases. This results in poor performance, slow running	**Demerits:** Better performance and efficiency is more
8	Used in light vehicles, like bikes, scooters, mopeds, etc.,	Used in heavy vehicles, like buses, lorries, trucks etc.,

I.C ENGINE TERMINOLGOGY

The standard terms used in I.C Engines are

1. **Bore**: Inside diameter of the cylinder is termed as Bore.

2.Top Dead Center (TDC): The extreme position reached by the piston at the top of the cylinder in the vertical engine is called Top Dead center.

3.Bottom Dead Center (BDC): The extreme position reached by the piston at the Bottom of the cylinder in the vertical engine is called Bottom Dead center.

I.C ENGINE TERMINOLGOGY

4. **Stroke:** The nominal distance travelled by the piston in the cylinder between the extreme upper and lower positions of the piston (TDC &BDC) is termed as stroke.
5. **Compression ratio (r):** It is the ratio of Maximum cylinder volume to the Clearance volume.
6. **Cylinder volume (v):** It is the sum of swept volume and the Clearance volume.

$$V = Vs + Vc$$

I.C ENGINE TERMINOLGOGY

7.Swept volume (Vs): It is the volume of space generated by the movement of piston from one dead center to another dead center.

8. **Clearance Volume(Vc):** It is the space in the cylinder, when the piston is at Top Dead Center

Major parts of an IC engine

1. Cylinder

It is a round cylindrical casting in which a piston slides in and out to make strokes.

Combustion take place inside the cylinder. The cylinder is closed by a cylinder head.

Material: Grey cast iron, Aluminium

Major parts of an IC engine

2. Cylinder head

It is fitted to the top of the cylinder. It has inlet and outlet values, spark plug, Fuel injector, Water jackets.

Material: C.I, Aluminium

3. Piston

It is a device which transmits the energy (or) force of the expanding gas to the connecting rod. It slides up and down inside the cylinder.

Material: C.I, Aluminium alloy, Cast steel

Major parts of an IC engine

4. **Piston rings:** Piston rings are inserted in the grooves of piston. Provides tight seal between the piston and cylinder wall.

There are two types of rings.

- ❖ Oil ring (One ring is used)
- ❖ Compression ring(Two ring is used)

4. **Connecting rod**: It converts the reciprocating motion of the piston into rotary motion of crankshaft. The small end of the connecting rod is connected to piston and the big end is connected to the crankshaft.

Material: Plain carbon steel, Aluminium alloys

Major parts of an IC engine

6. **Crank shaft**: It is the device used for getting power from the motion of the piston and connecting rod and this power is applied to the flywheel.

Material: Alloys steel.

7.Camshaft: It operates the opening and closing of the engine values. It has number of cams which are driven by crank shaft through timing gears. The function of the cam is to convert the rotary motion into the linear reciprocating motion

Material: Alloys steel

Major parts of an IC engine

8. **Crank case:** It is the bottom portion of the I.C engine and holds the cylinder and the crank case. It also serves as a pump for the lubricating oil.

Material: Aluminium alloy, Cast iron

9. **Flywheel**: It is a big wheel attached with crankshaft. It maintains the speed of the engine.

Major parts of an IC engine

10. Valves: The function of the value is to admit the fresh charge in the cylinder and to send the exhaust gases out. There are two values namely inlet value and outlet value.

Material: Inlet value: Nickel chrome.

Outlet value: Nickel chrome,
Stainless steel etc