সকলকে
জানাই
আন্তরিক
শুভেচ্ছা

Engr. Rahamat Ullah

Chief Instrutor (Power)
Automobile Technology
Bangladesh Sweden Polytechnic Institute
Kaptai.

Presentation for

Second semester
Automobile Technology

Subject-

Automobile Engine system-1

প্রেষনা

Video

Topics

Automotive Engine
And
2 & 4-Stroke Internalnal Combussion Engine

শিখন ফল

- এই পাঠ শেষে ছাত্ররা বলতে পারবে-

  - IC Engine সম্পর্কে।
  - বিভিন্ন অংশের কার্যাবলী সম্পর্কে।
  - বিভিন্ন Stroke সম্পর্কে।
  - ইঞ্জিন সিলিন্ডারের বিভিন্ন অংশ সম্পর্কে।
  - ইঞ্জিনের প্রকারভেদ সম্পর্কে ।
  - গ্যাস টারবাইন সম্পর্কে।
  - টার্বোচার্জার সম্পর্কে।
  - ইঞ্জিন ইফিসিয়েন্সি সম্পর্কে।
  - অটোমোটিভ অপারেশন সম্পর্কে।

Lerning Presentation

Difination-

The **internal combustion engine** (ICE) is an engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit.

Engine Clasification of Stroke

4-Stroke Engine

- (Petrol & Diesel Engine)

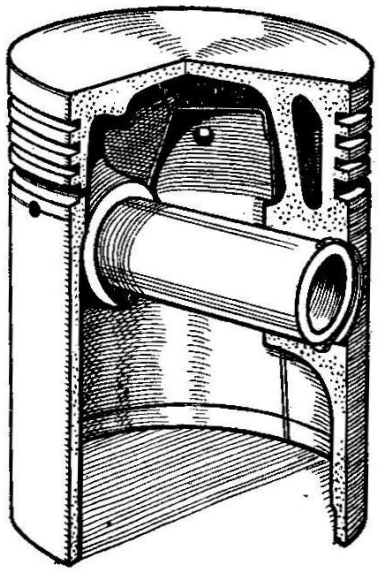
2-Stroke Engine

- (Petrol & Diesel Engine)

ইঞ্জিনের বিভিন্ন অংশের নাম

Cylinder Head

Cylinder Block



Piston

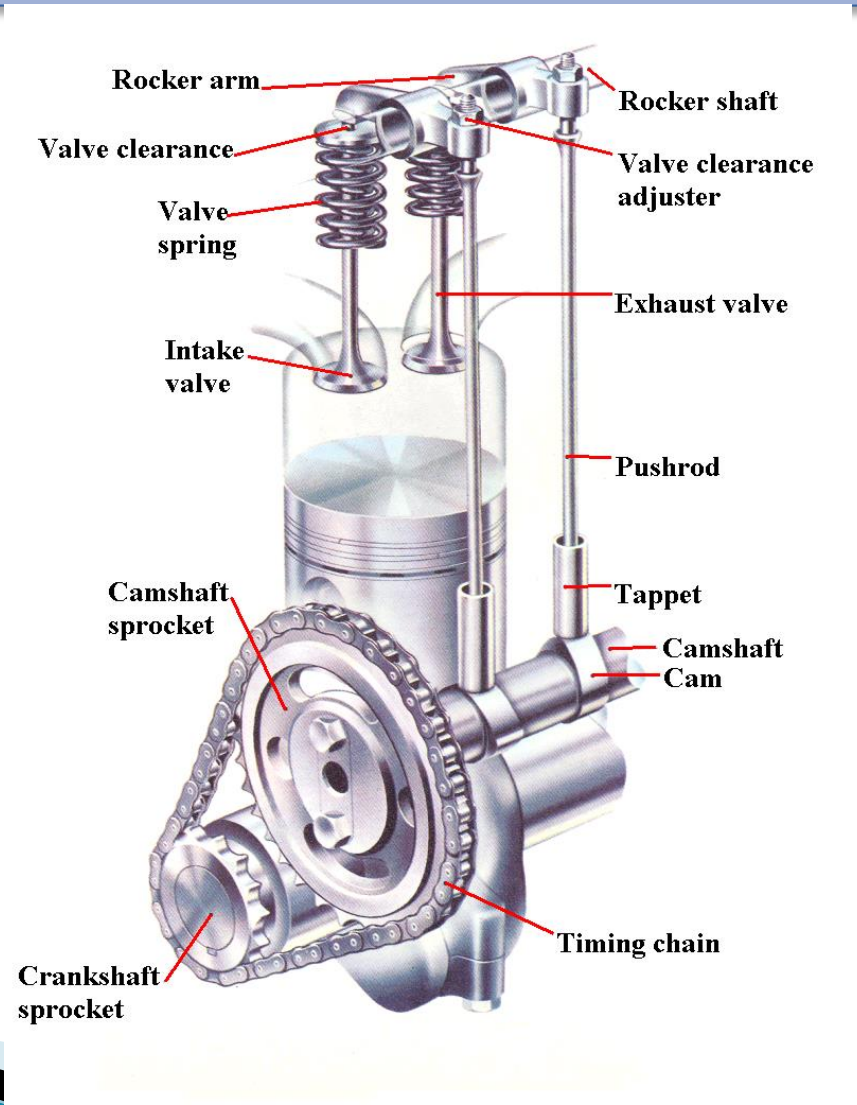
Spark Plug

Connecting Rod

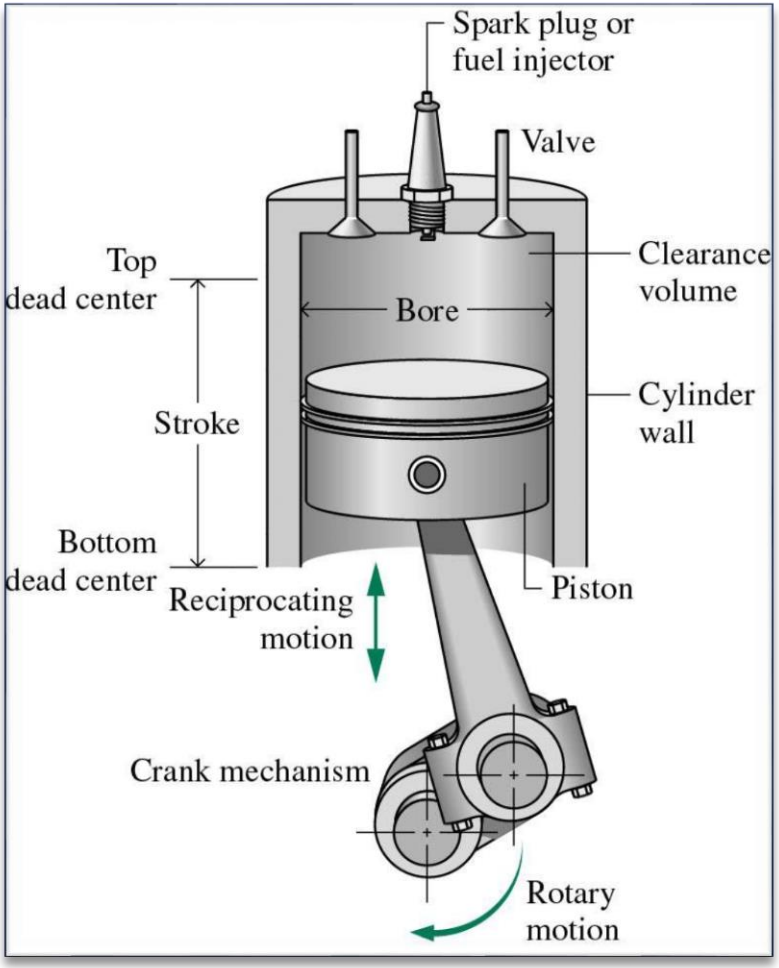
Cam Shaft

Piston Ring

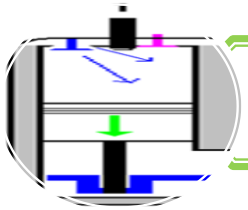
ইঞ্জিনের গঠন প্রণালী



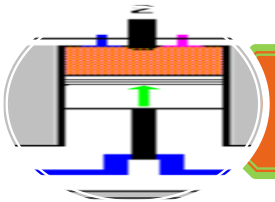
ইঞ্জিনের অভ্যন্তরীন বিভিন্ন অংশের নাম



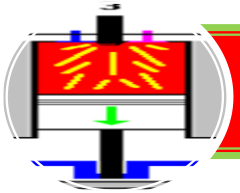
Stroke of Engine



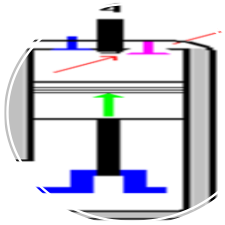
Suction Stroke



Compression Stroke

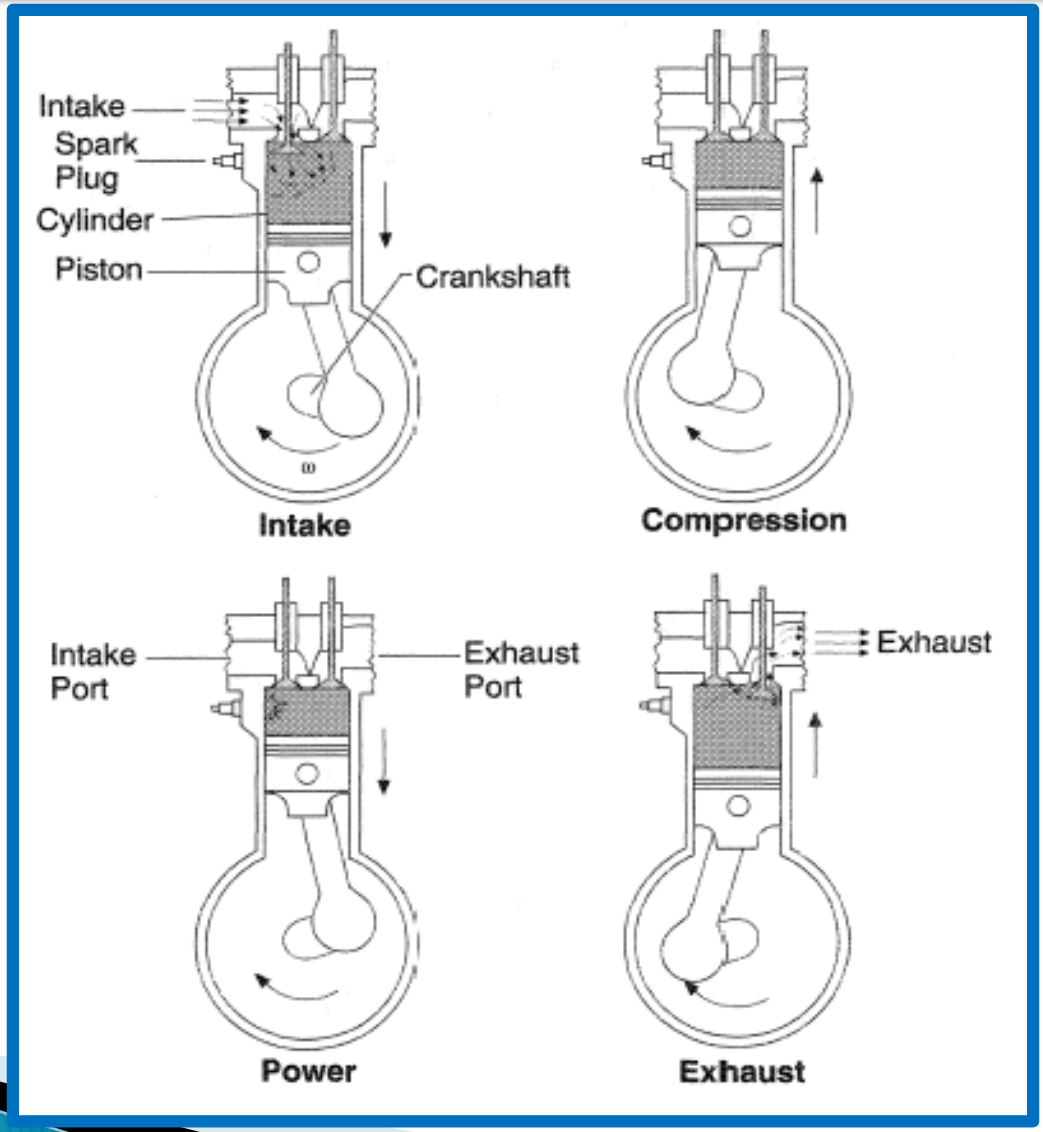


Power Stroke



Exhaust Stroke

Total Stroke of a Engine



Working Process of Stroke

Suction Stroke-

- Air Intake on the cylinder
- Intake valve open and Exhaust valve close
- Piston motion TDC to BDC

Compression Stroke-

- Intake and exhaust valve both are close.
- Air compress on the cylinder.
- Piston motion BDC to TDC.

Power Stroke–

- Intake and Exhaust both are close
- Spray fuel on the combussion cember
- Produce power on the cylinder
- Piston motion TDC to BDC

Exhaust Stroke

- Intake valve close and exhaust valve open
- Burning Fuel outcome from the cylinder
- Piston motion BDC to TDC

Animation of Complete Stroke

My movie.wmv

Engine

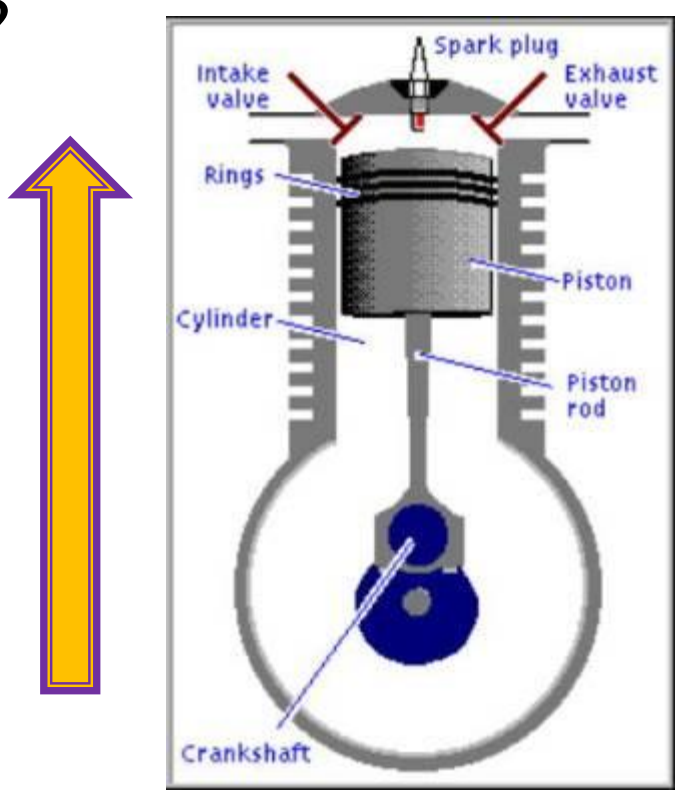
How 4 Stroke Engines Work.wmv

ICT Education

Principal of IC Engine

অনুশীলন

এই Stroke এর নাম কী ?



Compretion Stroke

পাঠ মূল্যায়ন

নিম্নলিখিত প্রশ্নের উত্তর দাও-

১. বোর কাকে বলে ?

২. Sweept volume বলতে কী বোঝায় ?

৩. ইঞ্জিনের C.C বলতে কী বোঝায় ?

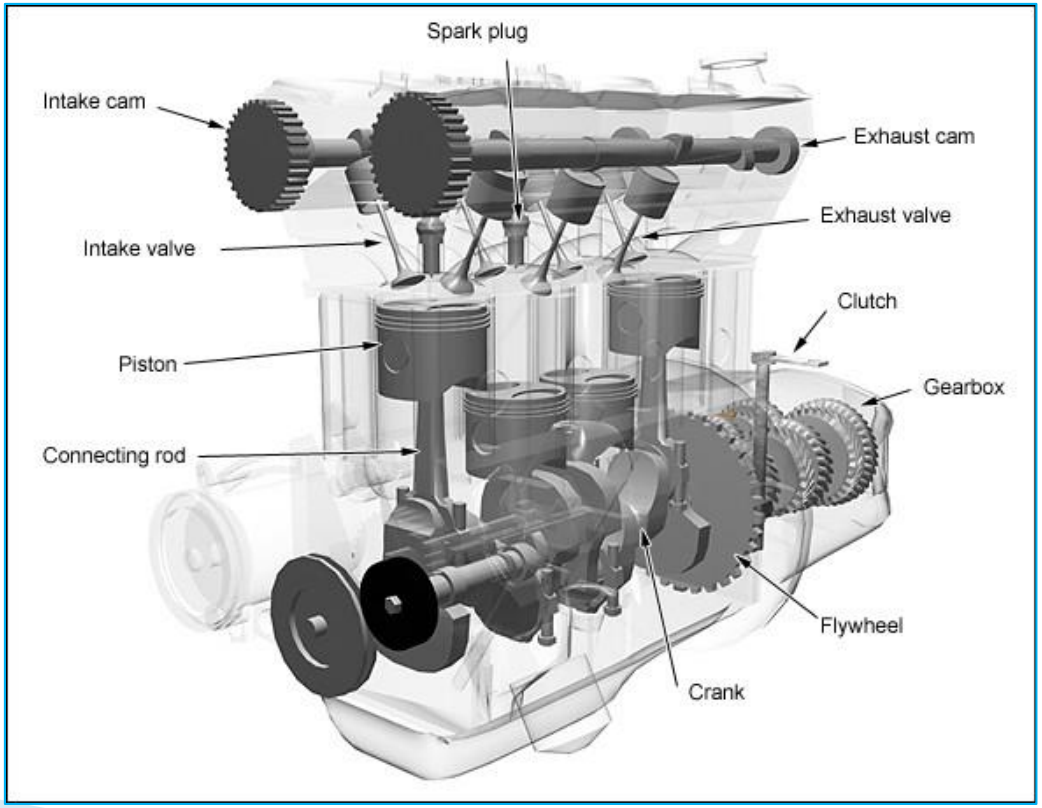
৪. কম্প্রেসন রেশিও বলতে কী বোঝায় ?

বাড়ির কাজ

একটি ফোর-ষ্টোক পেট্রোল ইঞ্জিনের গঠন প্রণালী বর্ণনা কর ।

Preparation for next class

Description of Multi Cylinder Four Stroke Diesel Engine.



ENGINE DIMENTION

- Definition of BORE, Crank throw, Clearance Volume, Swept volume and Compression ratio.
- Define Square, Over Square and Under Square Engine.
- Valve arrangement of V-head, I-head, L-head, F-head and T-head Engine.
- Solve problems on Piston displacement, Compression ratio and Clearance volume.

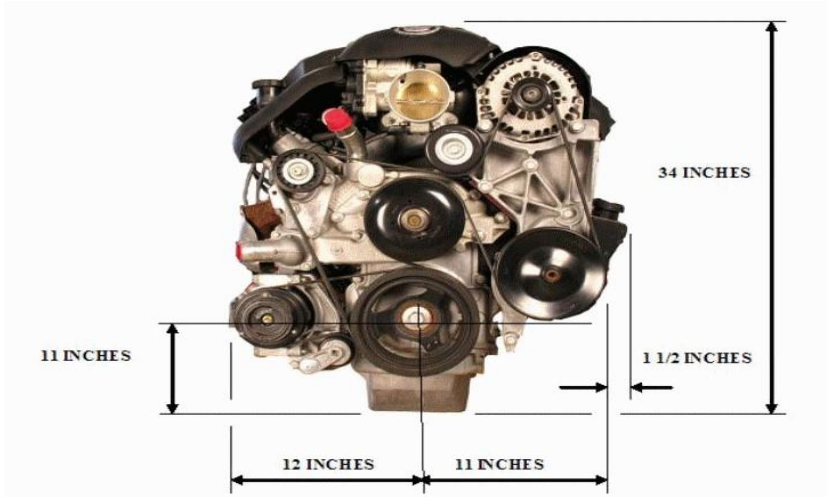
ENGINE DIMENTION

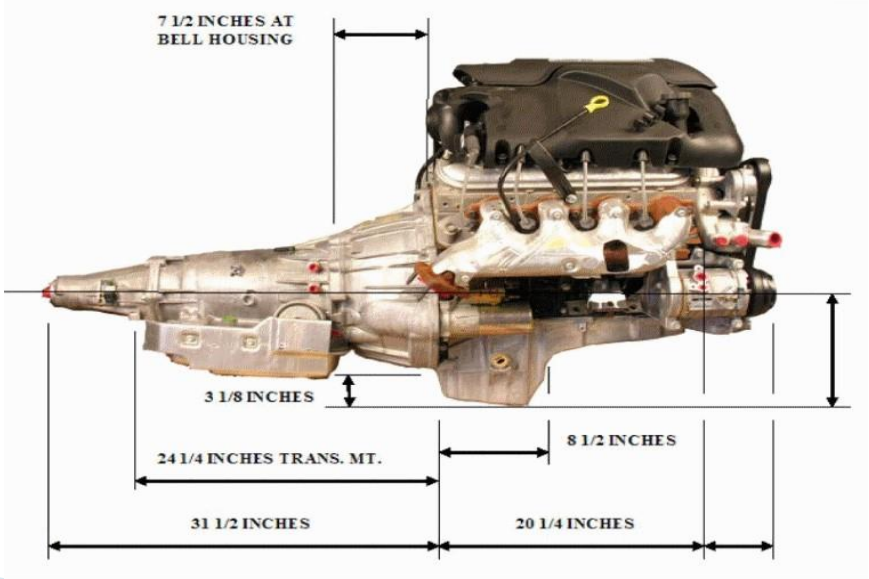
No. of Cylinders	1
Compression Ratio	15.8:1
Cylinder Bore	8.8 cm
Total Displacement	0.537 L
Injectors (Bosch)	7 holes, 0.13 mm dia
Stroke	8.83 cm
Connecting rod length	14.9 cm
Number of valves	4
Intake Temperature	60°C
IVO	362 CAD*[a]
IVC	595 CAD*[a]
EVO	143 CAD*[a]
EVC	385 CAD*[a]
Oil temperature	90°C
Water Temperature	90°C

* Firing TDC is 0 CAD or 720 CAD

a for lift ≈ 0.03mm

ENGINE DIMENTION





ENGINE DIMENTION

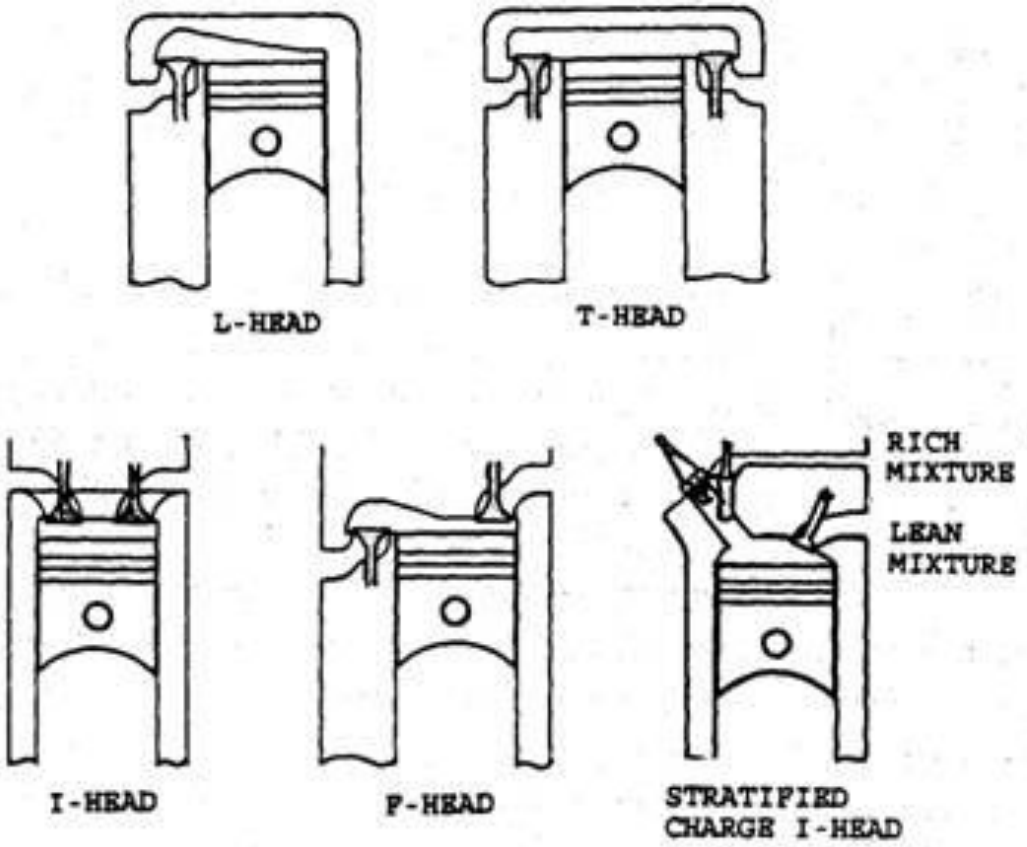
- **Bore:** In a piston engine, the **bore** (or **cylinder bore**) is the diameter of Engine Cylinder.
- Engine displacement is calculated based on bore, stroke length and the number of cylinders
- $$\text{Piston displacement} = \pi \left(1/2 \times \text{bore} \right)^2 \times \text{stroke} \times n_{\text{cylinders}}$$
- The stroke ratio, determined by dividing the bore by the stroke, traditionally indicated whether an engine was designed for power at high engine speeds (rpm) or torque at lower engine speeds. The term "bore" can also be applied to the bore of a locomotive cylinder or steam engine pistons.

ENGINE DIMENTION

- The valves in the head are actuated from the camshaft through tappets, push rods, and rocker arms (I-head arrangement), while the valves in the block are actuated directly from the camshaft by tappets (L-head arrangement). Basic engine construction varies little, regardless of the size and design of the engine.

ENGINE DIMENTION

Valve Arrangement



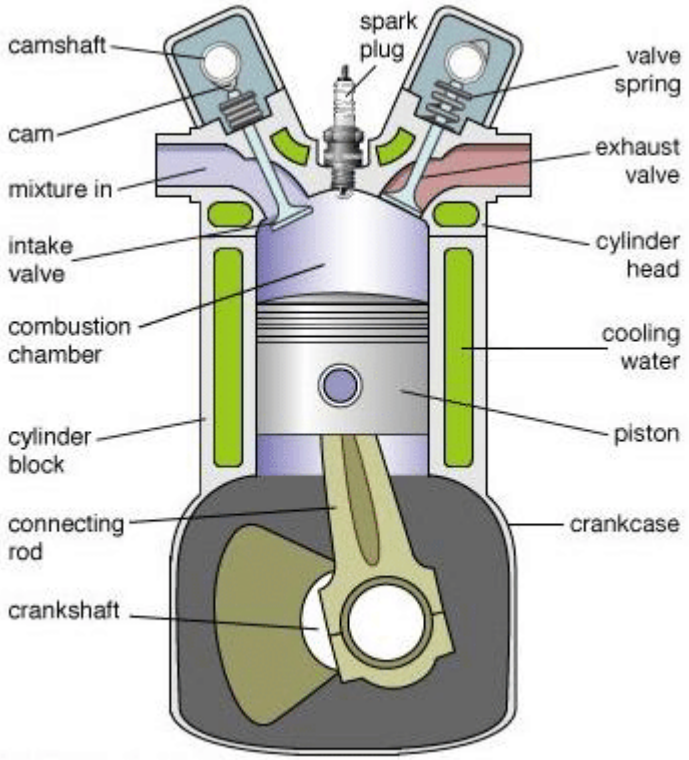
Spark Ignition (SI) Engine

- 4-Stroke SI Engine Definition:-

A four-stroke engine is an internal combustion engine that utilizes four distinct piston strokes (intake, compression, power, and exhaust) to complete one operating cycle. A complete operation in a four-stroke engine requires two revolutions (720^0) of the crankshaft

Spark Ignition Engine

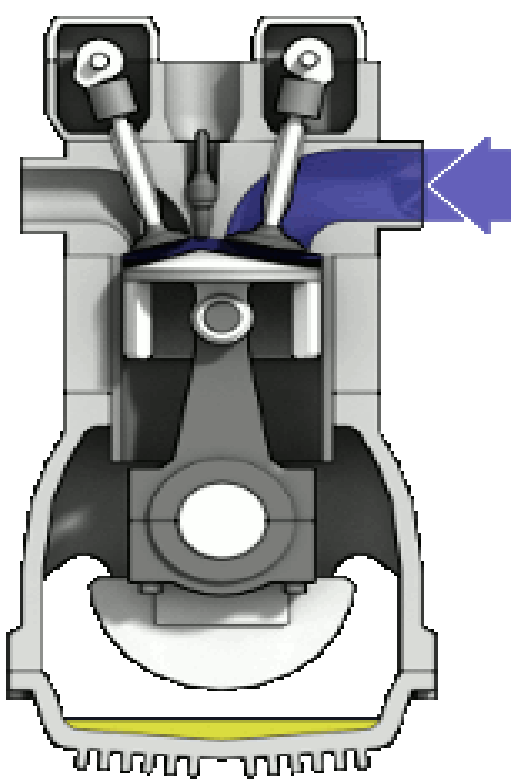
- Figure of SI Engine:-



Spark Ignition Engine

- Working Process of SI Engine:-

1



Spark Ignition Engine

- Description SI Engine:-

A **four-stroke** (also **four-cycle**) **engine** is an internal combustion (IC) engine in which the piston completes four separate strokes while turning the crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

Intake: Also known as induction or suction. This stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing a partial vacuum (negative pressure) in the cylinder through its downward motion.

Spark Ignition Engine

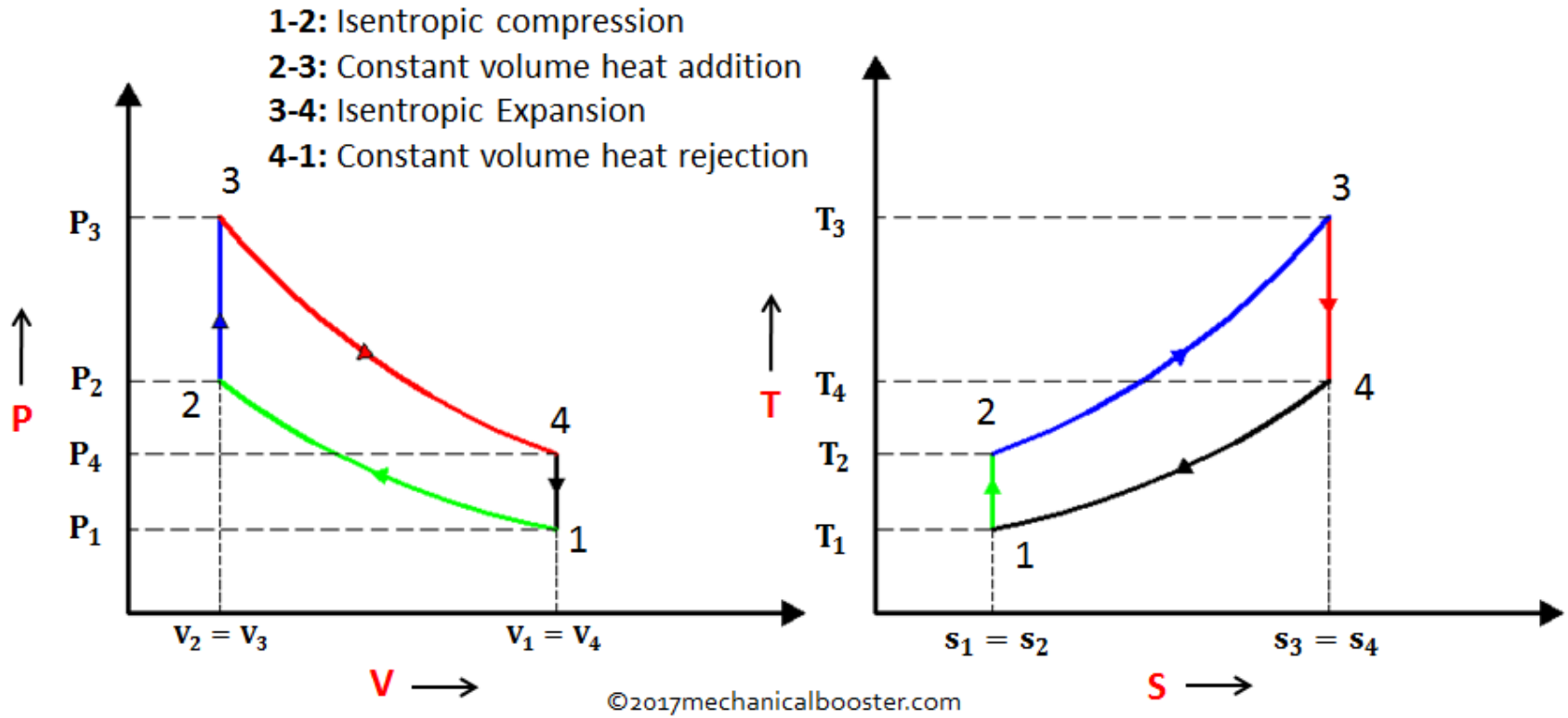
- Description SI Engine:-
  - **Compression**: This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.

  - **Combustion**: Also known as power or ignition. This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat generated by high compression (diesel engines), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.

Spark Ignition Engine

- Description SI Engine:-
  - **Exhaust**: Also known as outlet. During the *exhaust* stroke, the piston, once again, returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust port.
- Four-stroke engines are the most common internal combustion engine design for motorized land transport, being used in automobiles, trucks, diesel trains, light aircraft and motorcycles. The major alternative design is the two-stroke cycle.

Spark Ignition Engine



P-V and T-S Diagram of Otto Cycle

Spark Ignition Engine

- Process:-
  - 0-1 = suction
  - 1-2 = isentropic compression
  - 2-3 = heat addition at constant volume
  - 3-4 = isentropic expansion
  - 4-1 = constant volume heat rejection
  - 1-0 = exhaust.

Spark Ignition Engine

- Otto Cycle:-
  - This cycle consists of two reversible adiabatic processes and two constant volume processes as shown in figure on P-V and T-S diagrams.
  - The process 1-2 is reversible adiabatic compression
  - The process 2-3 is heat addition at constant volume
  - The process 3-4 is reversible adiabatic expansion
  - The process 4-1 is heat rejection at constant volume.

Spark Ignition Engine

Heat supplied : $Q_1 = mc_v\,(T_3 - T_2)$

Heat rejected : $Q_2 = mc_v\,(T_4 - T_1)$

Efficiency : $\eta = 1\,\frac{Q_2}{Q_1} = 1 - \frac{mc_v\,(T_4 - T_1)}{mc_v\,(T_3 - T_2)}$

$$\eta = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

Process 1 – 2 : $T_1 V_1 \gamma - 1 = T_2 V_2 \gamma - 1$

$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma - 1}$$

or $$\left(\frac{V_1}{V_2}\right) = \frac{T_2}{T_1}$$

Process 3 – 4 : $T_3 V_3 \gamma - 1 = T_4 V_4 \gamma - 1$

$$\left(\frac{V_4}{V_3}\right)^{\gamma - 1} = \frac{T_2}{T_1} \qquad \text{also} \quad \frac{V_4}{V_3} = \frac{V_1}{V_2}$$

$$\Rightarrow \quad \frac{T_3}{T_4} = \frac{T_2}{T_1} \quad \Rightarrow \quad \frac{T_3}{T_2} = \frac{T_4}{T_1}$$

$$\Rightarrow \quad \frac{T_3}{T_2} - 1 = \frac{T_4}{T_1} - 1$$

(subtracting 1 from both sides)

$$\Rightarrow \quad \frac{T_3 - T_2}{T_2} = \frac{T_4 - T_1}{T_1}$$

$$\Rightarrow \quad \frac{T_1}{T_2} = \frac{T_4 - T_1}{T_3 - T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma - 1} = \left(\frac{1}{r_k}\right)^{\gamma - 1}$$

Substituting in eq. (*i*) hotto $= 1 - \frac{1}{r_k^{\gamma - 1}}$

where r_k = compression ratio.

Compression Ignition (CI) Engine

- Definition of Diesel Engine:-
  - A diesel engine is **a type of internal combustion heat engine, powered by diesel.** These engines run small electric generators called diesel generators, bus, truck and other Specials vehicles etc.
  - An internal combustion engine in which air is compressed to a temperature sufficiently high to ignite fuel injected into the cylinder where the combustion and expansion actuate a piston.

Compression Ignition (CI) Engine

- **How does a diesel engine work:-**
  - A diesel engine works by using pistons to compress a mixture of air (containing oxygen) with diesel fuel. When this air is compressed at a ratio of about 15:1 the mixture explodes forcing the piston back up and creating the reciprocating motion. This motion is then converted to rotary motion by the engines crank shaft

Compression Ignition (CI) Engine

- **The engines fuel System**
  - The fuel system includes the fuel injection pump, the lift pump, the injectors and all the fuel pipes. There will also be some fuel filters and maybe a water separator preventing poor quality fuel from damaging your diesel engine.
- **The engines lubrication system /oil system**
  - The lubrication system keeps your engine running smoothly, preventing the moving parts from wearing by using the oil under pressure to lubricate and reduce friction. The oil system will have an oil pump and oil filters to keep the oil clean from contaminants.

Compression Ignition (CI) Engine

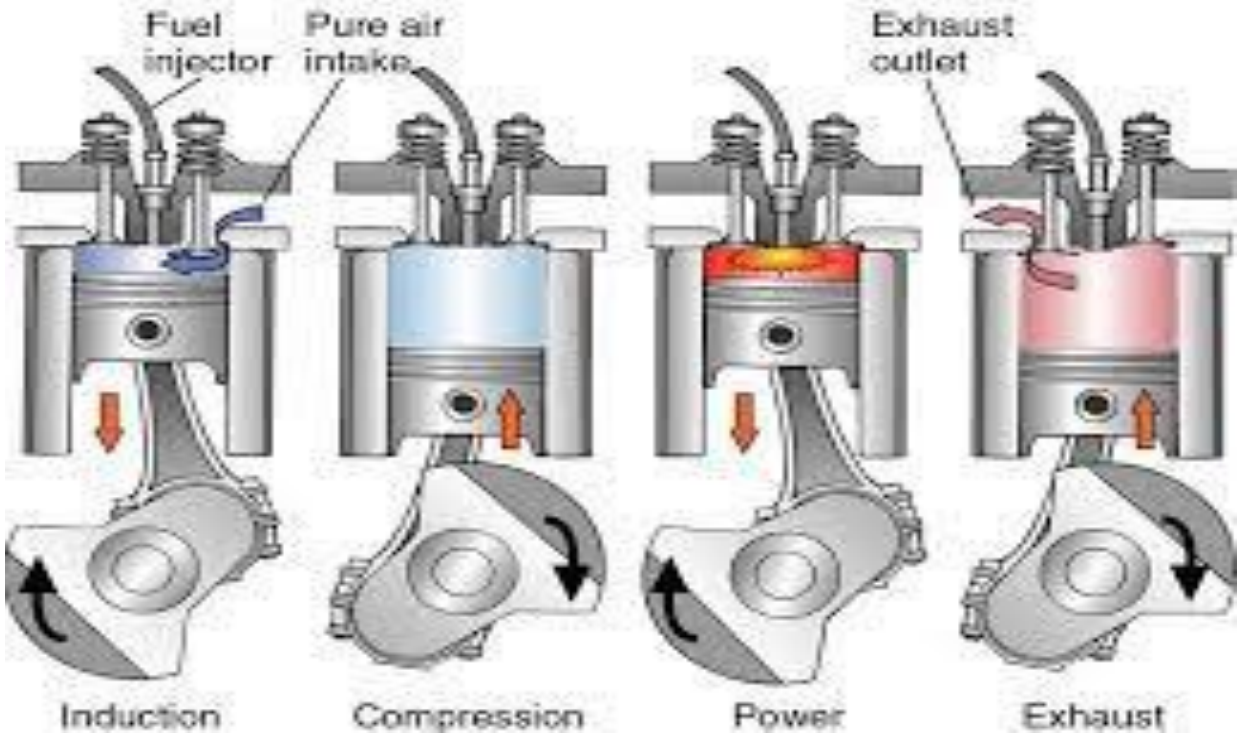
- **The engines cooling system**
  - The cooling system handles the engine coolant – normally a mixture of distilled water and glycol with some additional additives to help prevent corrosion. There may also be a coolant filter on some engines and a "water pump" which is actually a coolant pump. The coolant pump is used to push the coolant round the engine and whichever device is used to cool the liquid – usually a radiator, but sometimes a heat exchanger.
- **The engines exhaust system**
  - Getting rid of the waste combustion gas is very important – moving the waste gas from the engines cylinders out through the exhaust manifold to the main muffler system that reduces the noise. The muffler isn't usually part of the engine, but an addition to reduce the noise to the customers requirements. The exhaust gas will pass through the turbo-charger to make it spin where one is fitted.

Compression Ignition (CI) Engine

- Major parts of a diesel engine:-
  - The engine block
  - The pistons
  - The crank shaft
  - The Injection Pump and engine governing system
  - The injectors
  - The starter motor
  - The head
  - The valves
  - Often a Turbocharger
  - The Fuel Filters
  - The Oil Filters
  - The Air Filters
  - The Flywheel

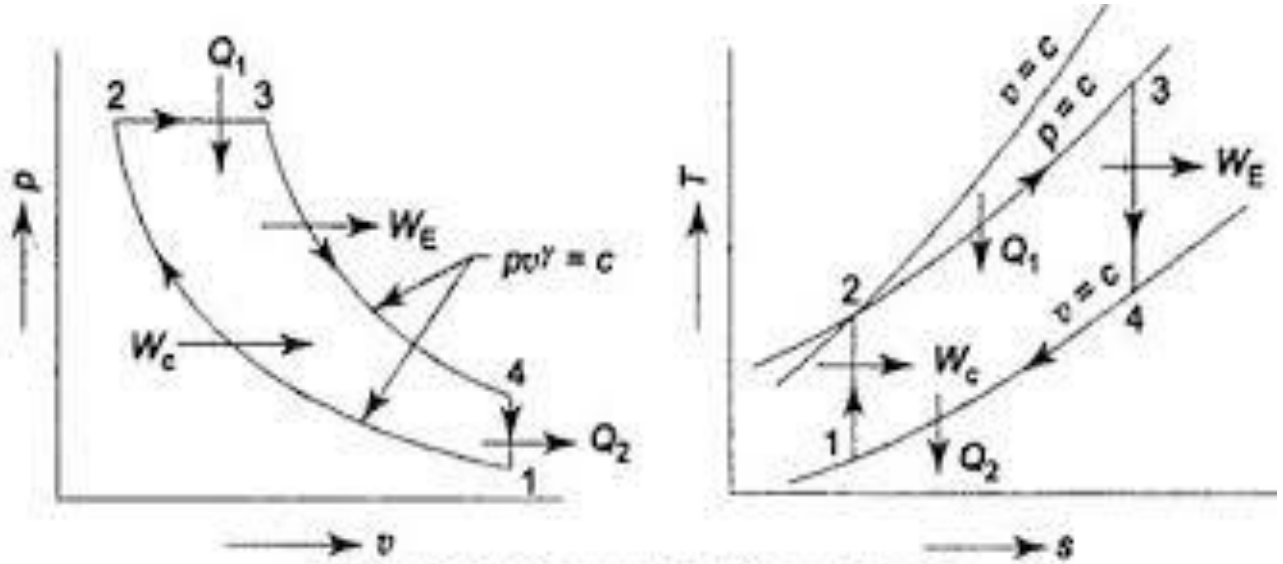
Compression Ignition (CI) Engine

- Diesel Engine Working Process:-



Compression Ignition (CI) Engine

- Diesel Cycle (Constant Pressure Cycle):-
  - Diesel cycle is also known as the constant pressure cycle because all addition of heat takes place at constant pressure. The cycle of operation is shown in figure on P-V and T-S diagrams.



PV and TS diagram for Diesel Cycle

Compression Ignition (CI) Engine

- The 4 processes are as follows:-
  - Isentropic (reversible adiabatic) Compression
  - Constant pressure heat addition
  - Isentropic Expansion
  - Constant volume heat rejection.

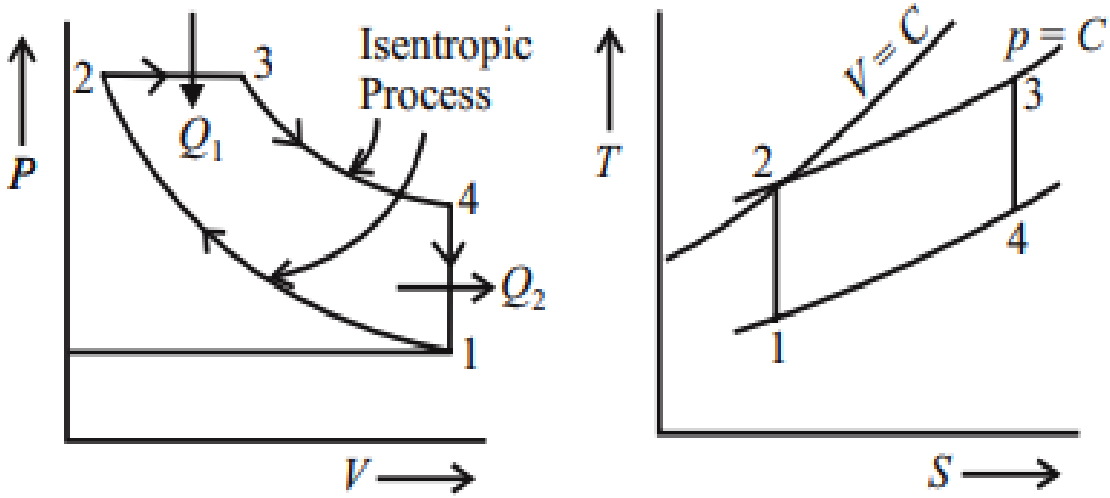


Fig. 4.4

Compression Ignition (CI) Engine

- Two stroke diesel engine:-
  - A two-stroke diesel engine is a diesel engine that uses compression ignition in a two stroke combustion cycle
- Two stroke Cycle:-
  - In the two-stroke cycle, the four stages of internal combustion engine operation (intake, compression, ignition, exhaust) occur in one 360° revolution of the crank shaft, whereas in a four-stroke engine they take two complete revolutions.

Compression Ignition (CI) Engine

- The air standard efficiency of the Diesel cycle can be calculated as follows :-

Heat supplied: $Q_1 = Q_{2-3} = mc_p(T_3 - T_2)$

Heat rejected: $Q2 = Q_{4-1} = mc_v(T_4 - T_1)$

$$\eta = 1 - \frac{Q_2}{Q_1} = 1\frac{mc_v(T_4 - T_1)}{mc_p(T_3 - T_2)}$$

$$\eta = 1 - \frac{(T_4 - T_1)}{(T_3 - T_2)}$$

Compression ratio : $r_k = V_1/V_2$ ...(i)

Expansion ratio : $r_e = V_4/V_3$ ...(ii)

Cut of ratio : $r_c = V_3/V_2$ ...(iii)

It is seen that $r_k = r_e r_c$

Process 1-2 : $T_1V_1\gamma - 1 = T_2V_2\gamma - 1$

$$\left(\frac{V_1}{V_2}\right)^{\gamma-1} = \frac{T^2}{T_1} \Rightarrow T_2 = T_1(r_k)\gamma - 1$$

Process 2-3 : $\frac{P_2V_2}{T_2} = \frac{P_3V_3}{T_3} \Rightarrow \frac{V_3}{V_2} = \frac{T_3}{T_2} = r_c$

(As $P_2 = P_3$)

Process 3-4 : $T_3V_3\gamma - 1 = T_4V_4\gamma - 1$

$$\Rightarrow \left(\frac{V_4}{V_3}\right)^{\gamma-1} = \frac{T_3}{T_4} \Rightarrow T_3 = T_4(r_c)\gamma - 1$$

Substituting $\eta = 1 - \frac{(T_4 - T_1)}{\gamma T_4 (r_c)^{\gamma-1} - T_1 (r_k)^{\gamma-1}}$

$$\frac{T_3}{T_1} = rc\ (\eta)^{\gamma-1} \quad \left[\because \frac{T_3}{T_2} = r_c \text{ and } \frac{T_2}{T_1} = (r_k)^{\gamma-1}\right]$$

$$\frac{T_3}{T_4} = r_c^{\gamma-1}$$

$$\frac{T_4}{T_1} = \frac{r_c \cdot r_k^{\gamma-1}}{\left(\frac{r_k}{r_c}\right)^{\gamma-1}} = r_c^{\gamma}$$

$$\eta = 1 - \frac{T_1\left[r_c^{\gamma} - 1\right]}{\gamma T_2\left[r_c - 1\right]}$$

$$\gamma = 1 - \frac{1}{\gamma(r_k)^{\gamma-1}} \frac{\left[r_c^{\gamma} - 1\right]}{\left[r_c - 1\right]}$$

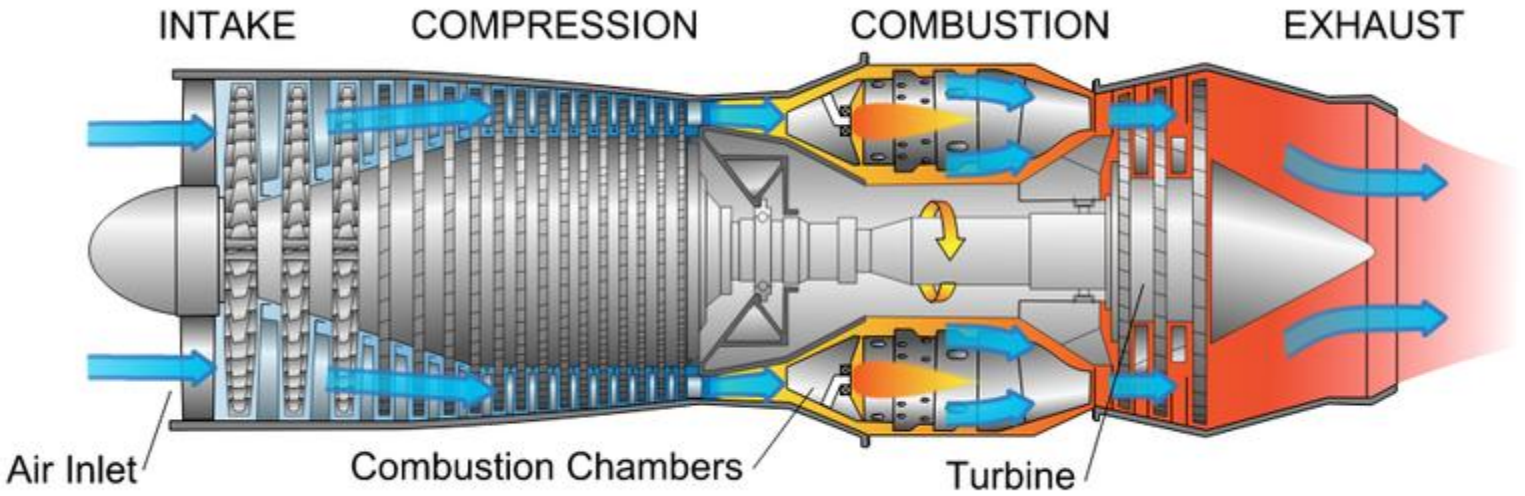
As $r_c > 1$, so $\frac{1}{\gamma}\left[\frac{r_c^{\gamma} - 1}{r_c - 1}\right]$

Gas Turbine

- Definition:-
  - A gas turbine is a type of turbine that uses pressurized gas to spin it in order to generate electricity or provide kinetic energy to an airplane or jet.

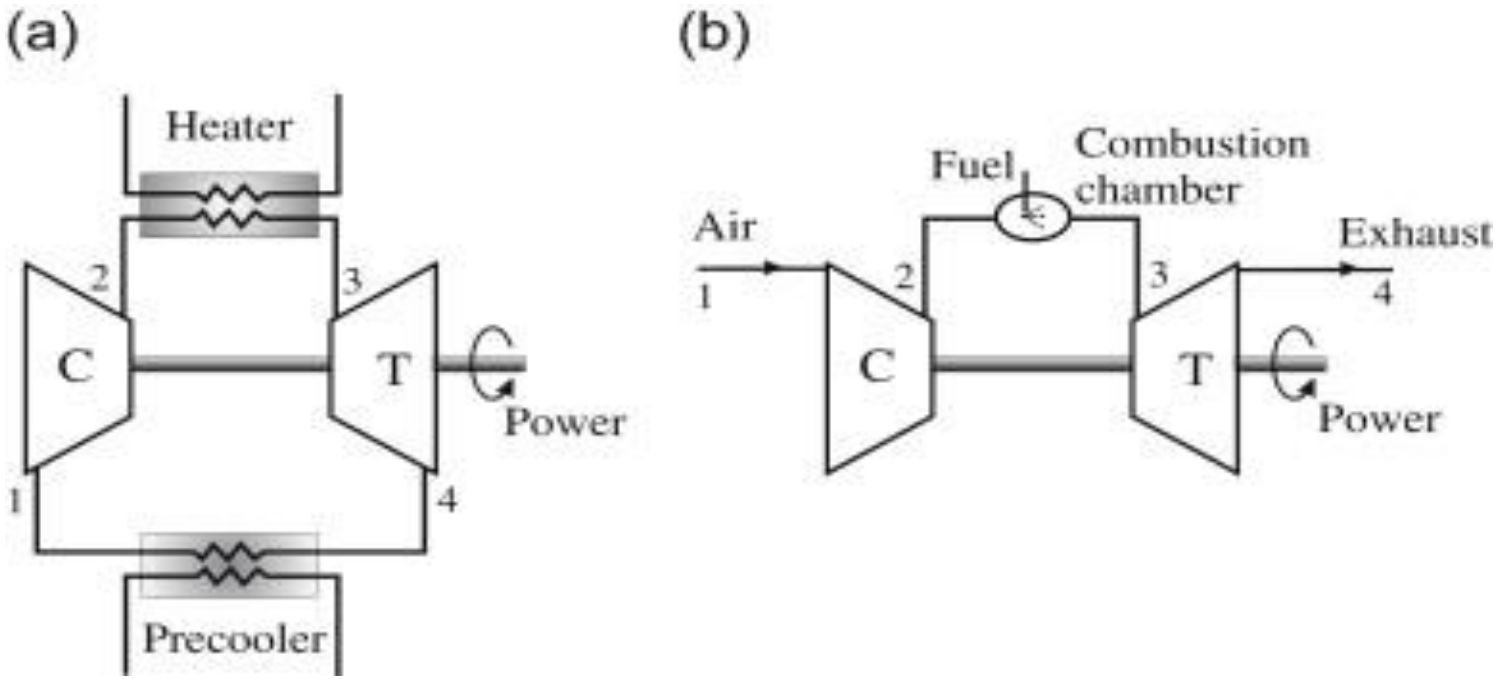
Gas Turbine

- Construction of Gas turbine:-



Gas Turbine

- Flow Diagram of Gas Turbine:-



Gas Turbine

- Open cycle gas turbine:-

Figure 1: Open-cycle gas turbine configuration

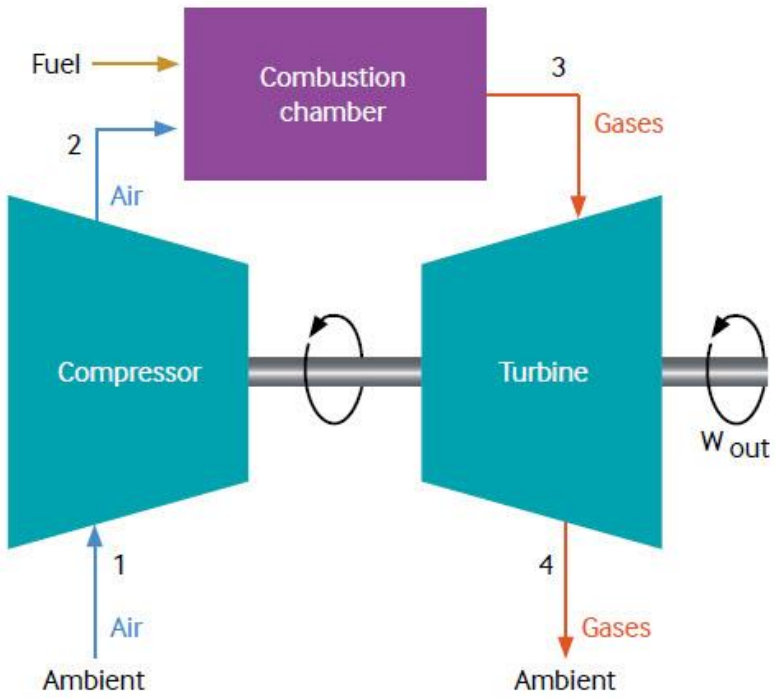
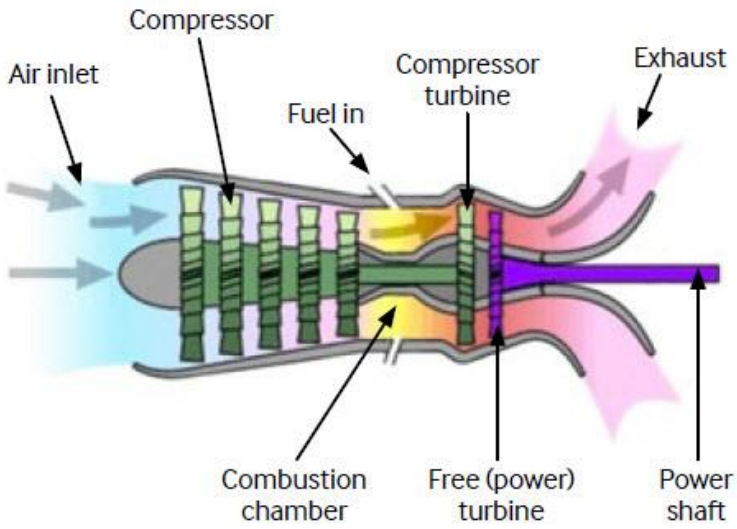
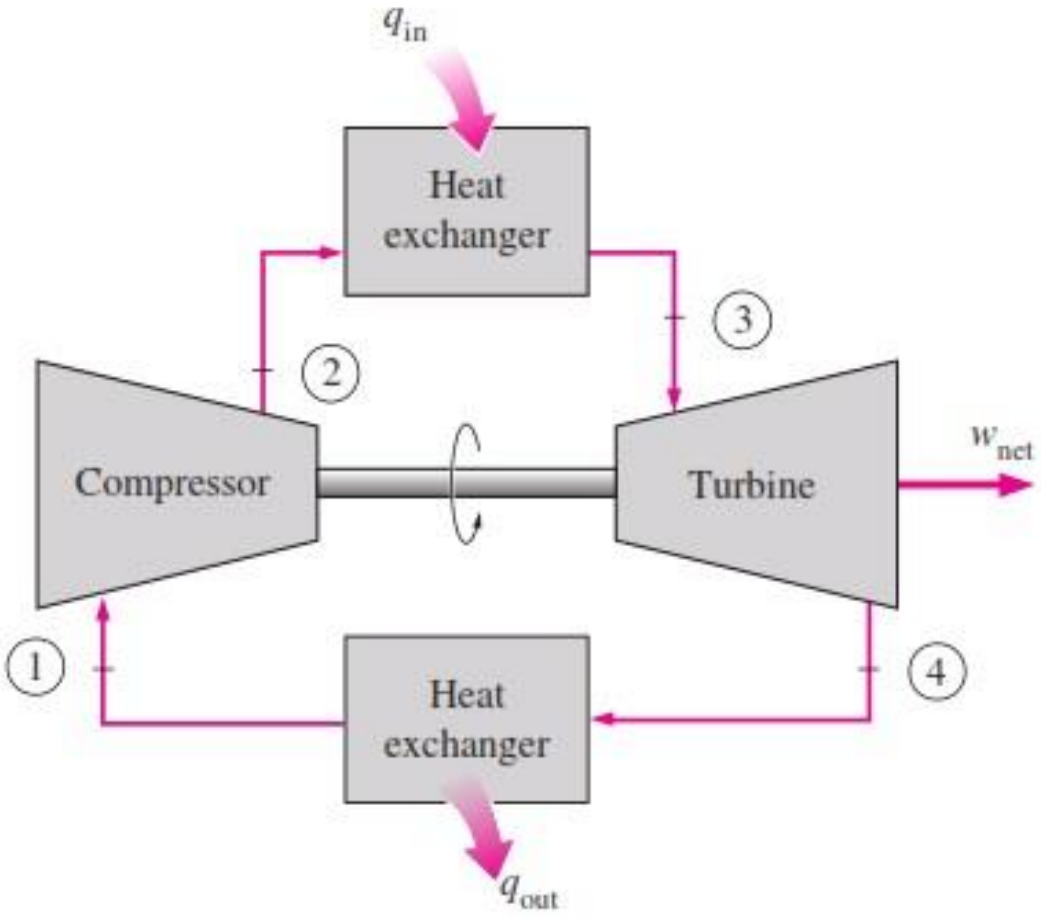


Figure 2: Open-cycle gas turbine cross-section

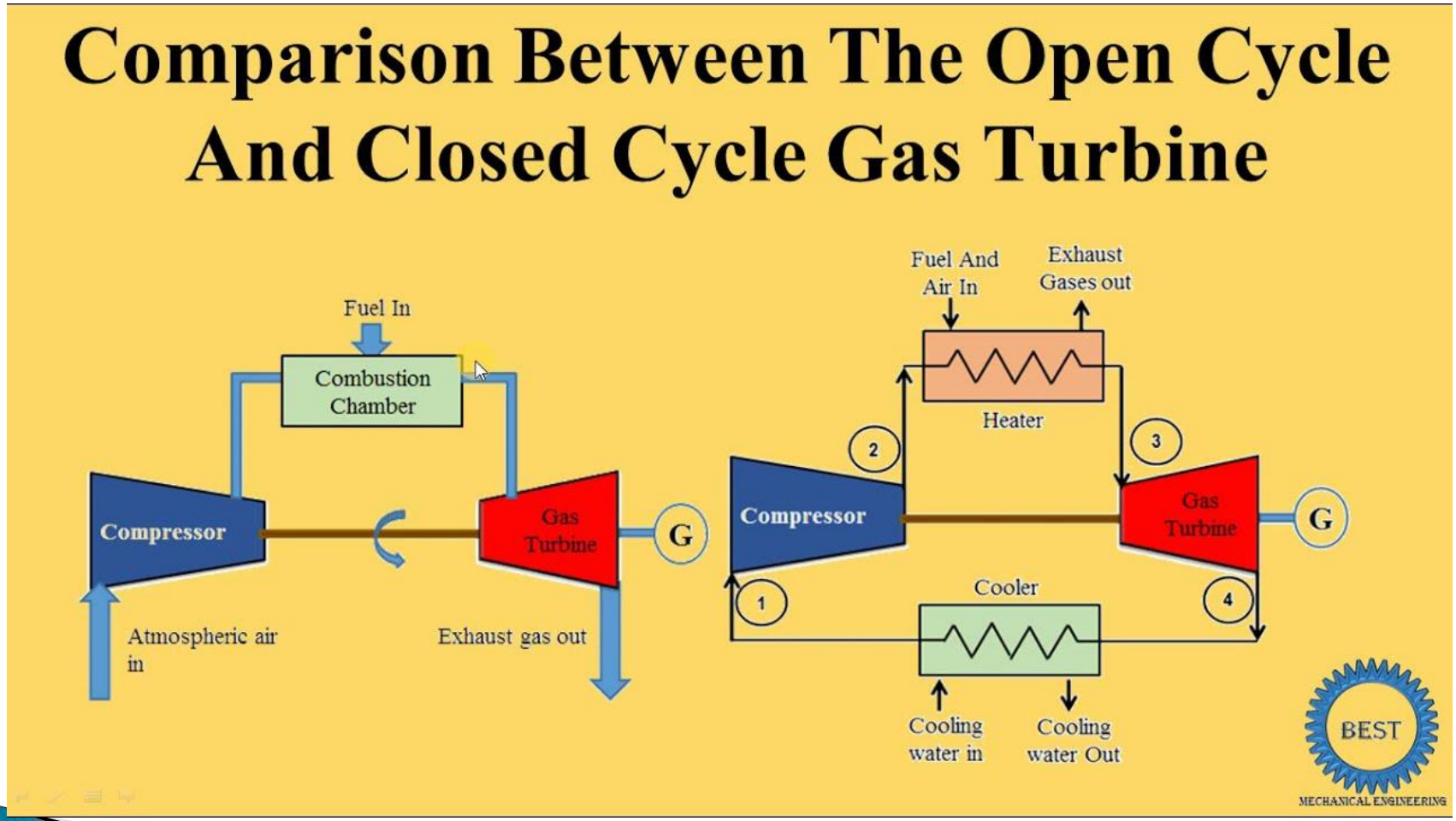


Gas Turbine

- Closed Cycle Gas Turbine:-



Gas Turbine

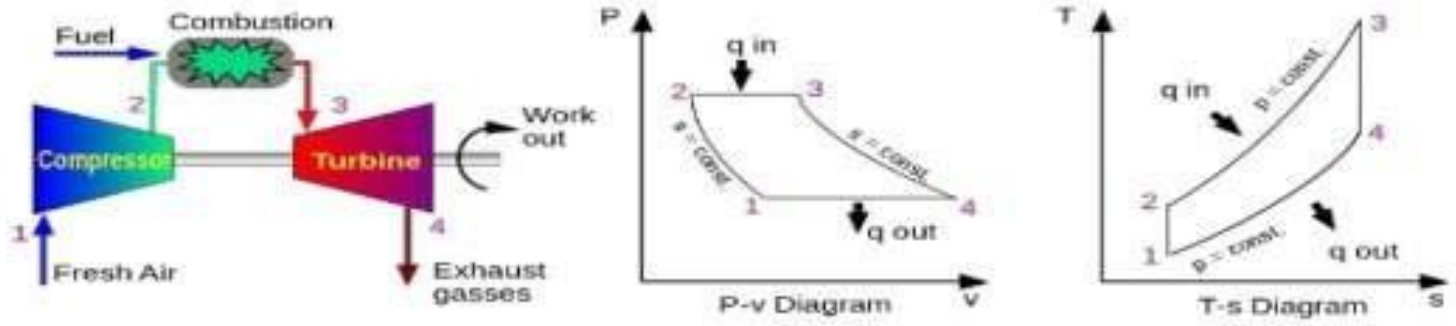

Comparison Between The Open Cycle And Closed Cycle Gas Turbine
Fuel In
Combustion Chamber
Compressor
Gas Turbine
G
Atmospheric air in
Exhaust gas out
Fuel And Air In
Exhaust Gases out
Heater
2
3
Compressor
Gas Turbine
G
Cooler
1
4
Cooling water in
Cooling water Out
BEST
MECHANICAL ENGINEERING

Gas Turbine

- Gas turbine cycle:-

GAS TURBINE BASED ON CYCLE

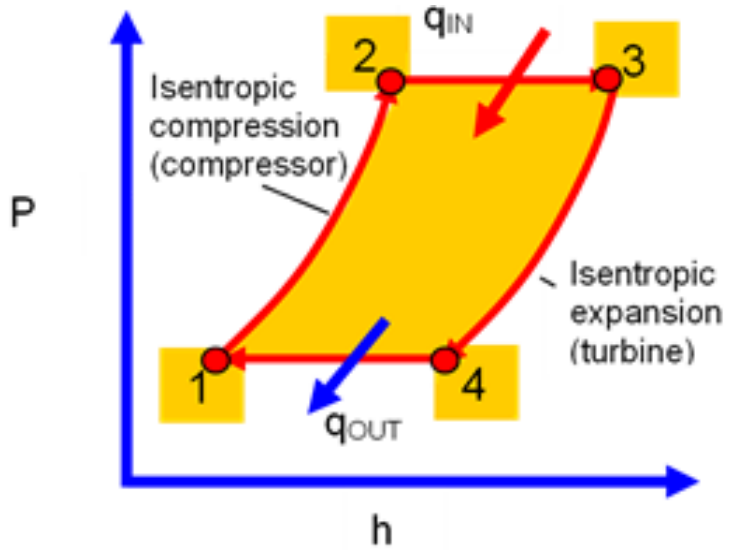
➢ Idealized Brayton Cycle

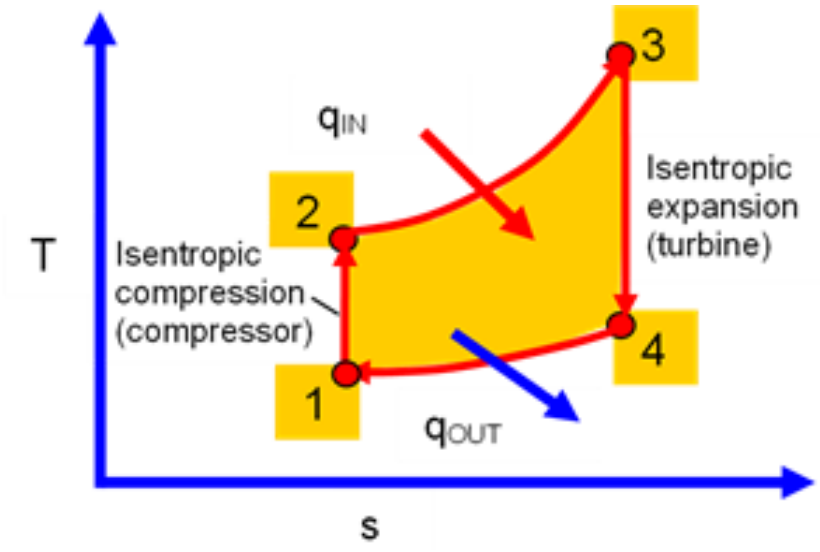


engihub.com

Gas Turbine

- P-H and T-S Diagram of Gas turbine:-





Turbo Charger

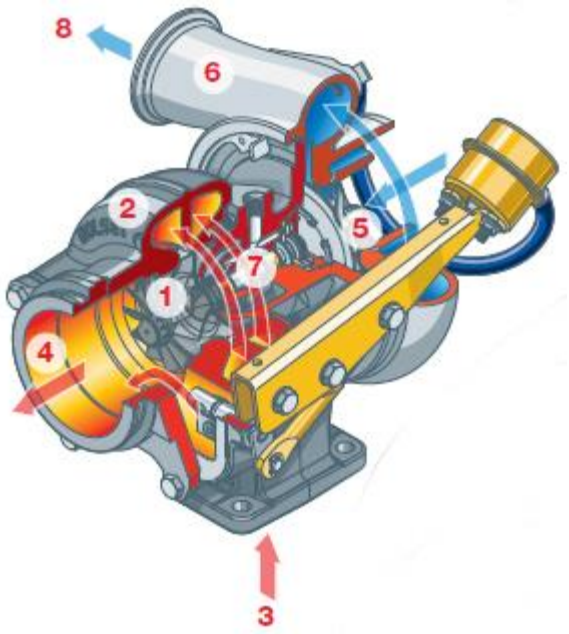
- **The engines Turbo charger**
  - Most engines will have a turbo fitted. This device compresses the combustion air to make the engine more powerful.
  - A significant difference between a turbocharged diesel engine and a traditional naturally aspirated gasoline engine is **the air entering a diesel engine is compressed before the fuel is injected**. This is where the turbocharger is critical to the power output and efficiency of the diesel engine.

Turbo Charger

- Turbocharger Work:-
  - A turbocharger is made up of two main sections: the turbine and the compressor. The turbine consists of the **turbine wheel (1)** and the **turbine housing (2)**. It is the job of the turbine housing to guide the **exhaust gas (3)** into the turbine wheel. The energy from the exhaust gas turns the turbine wheel, and the gas then exits the turbine housing through an **exhaust outlet area (4)**. The compressor also consists of two parts: the **compressor wheel (5)** and the **compressor housing (6)**. The compressor's mode of action is opposite that of the turbine. The compressor wheel is attached to the turbine by a **forged steel shaft (7)**, and as the turbine turns the compressor wheel, the high-velocity spinning draws in air and compresses it. The compressor housing then converts the high-velocity, low-pressure air stream into a high-pressure, low-velocity air stream through a process called diffusion. The **compressed air (8)** is pushed into the engine, allowing the engine to burn more fuel to produce more power. See on figure…

Turbo Charger

1.The turbine wheel
2.The turbine housing
3.Exhaust gas
4.Exhaust outlet area
5.The compressor wheel
6.The compressor housing
7.Forged steel shaft
8.Compressed air



সবাইকে

ধন্যবাদ