



MECHANICAL ENGINEERING SCIENCE (UE23ME131A)

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MECHANICAL ENGINEERING SCIENCE

Unit1

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Chapter 1 – IC Engines and Turbines

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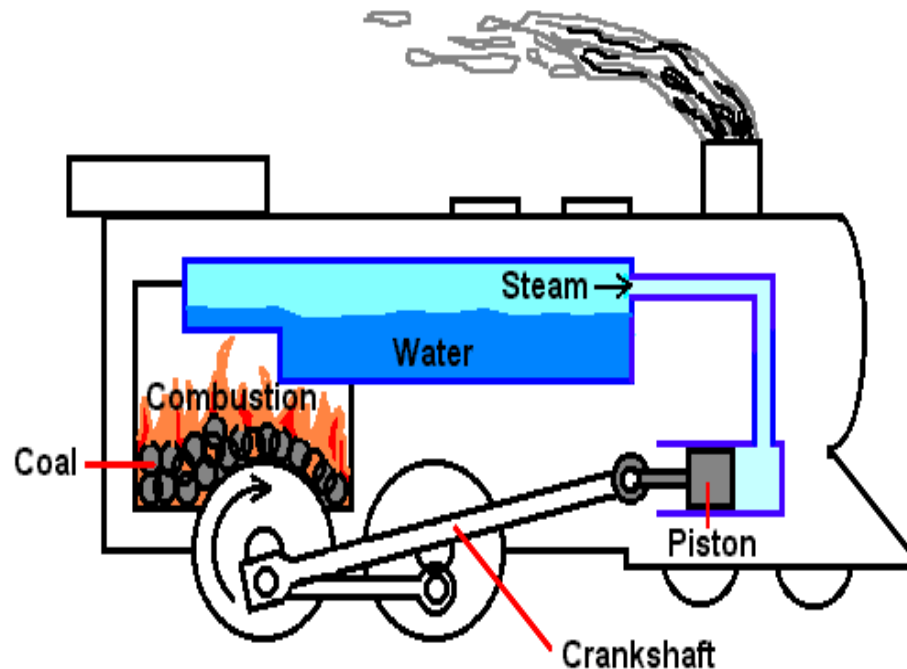
The distinctive feature of our civilization today, one that makes it different from all others, is the wide use of mechanical power. At one time, the primary source of power for the work of peace or war was chiefly man's muscles. Later, animals were trained to help and afterwards the wind and the running stream were harnessed. But, the great step was taken in this direction when man learned the art of energy conversion from one form to another. The machine which does this job of energy conversion is called an ENGINE.

- **ENGINE** – An engine is a device which transforms one form of energy into another form.
- **HEAT ENGINE** - Heat engine is a device which transforms the chemical energy of a fuel into thermal energy and utilizes this thermal energy to perform useful work. Thus, thermal energy is converted to mechanical energy in a heat engine.
- Heat engines can be broadly classified into two categories:
 - (i) Internal Combustion Engines (IC Engines)
 - (ii) External Combustion Engines (EC Engines)

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IC ENGINES

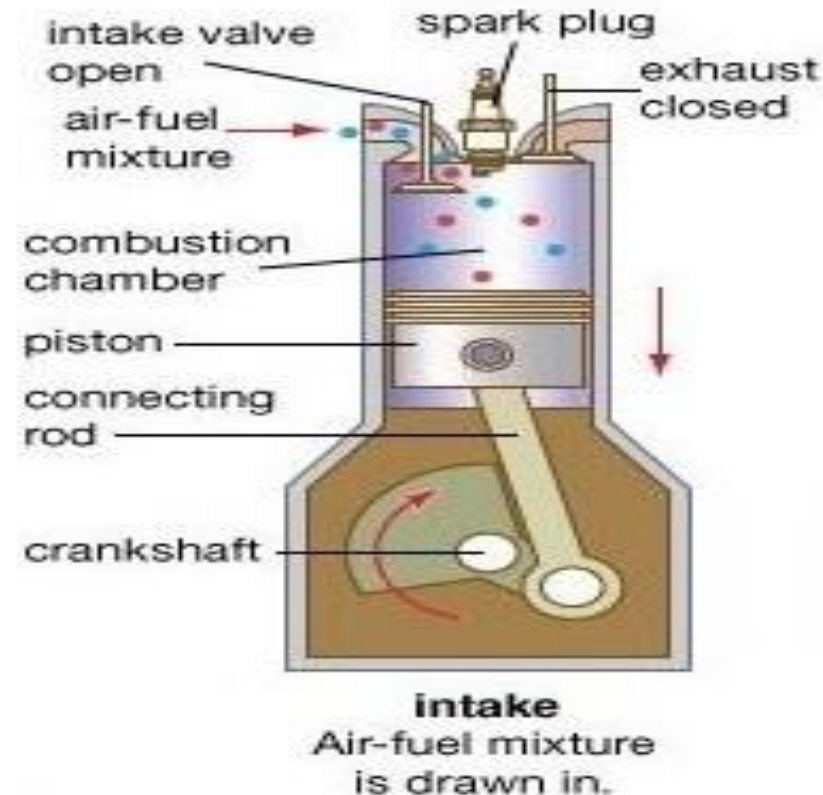
- External combustion engines are those in which combustion takes place outside the engine.
- For example, in a steam engine or a steam turbine, the heat generated due to the combustion of fuel is employed to generate high pressure steam which is used as the working fluid in a reciprocating engine or a turbine.



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IC ENGINES

- Internal combustion engines are those in which combustion takes place within the engine.
- For example, in case of petrol or diesel engines, the products of combustion generated by the combustion of fuel and air within the cylinder form the working fluid.



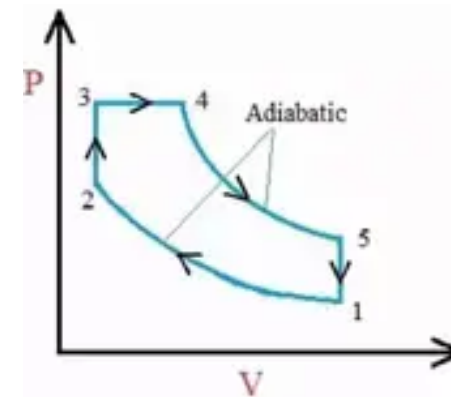
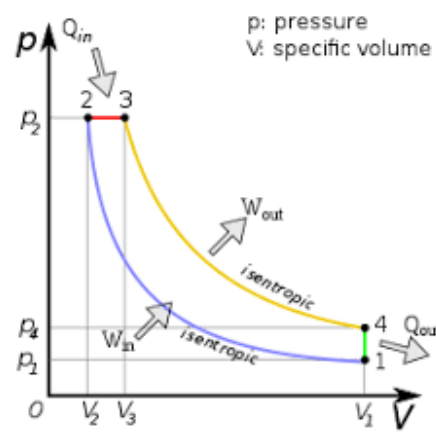
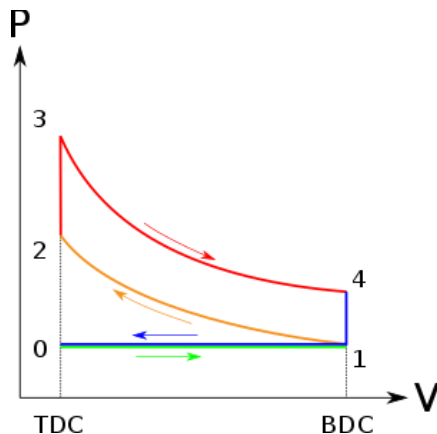
- **CLASSIFICATION OF IC ENGINES** - There are several criteria for classification of I.C. engines. Some of the important criteria can be explained as:
 - ▶ Number of strokes per cycle
 - ▶ Nature of thermodynamic cycle
 - ▶ Ignition systems
 - ▶ Fuel used
 - ▶ Arrangement of cylinders
 - ▶ Cooling systems
 - ▶ Fuel supply systems

Number of Strokes Per Cycle:

- I.C. engines can be classified as **four-stroke engines (4S)** and **two-stroke engines (2S)**.
- In four-stroke engines, the thermodynamic cycle is completed in four strokes of the piston or two revolutions of the crankshaft whereas, in two-stroke engines, the thermodynamic cycle is completed in two strokes of the piston or one revolution of the crankshaft.

Nature of Thermodynamic Cycle:

- I.C. engines can be classified as **Otto cycle, Diesel cycle, and Dual cycle engines**.



Ignition Systems:

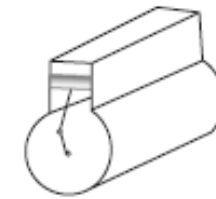
- There are two modes of ignition of fuel inside the cylinder — **spark ignition** and **compression ignition**.
- In spark ignition, sparking starts at the end of compression stroke from spark plug while in compression ignition the temperature of the fuel is increased to the self-ignition point by compressing the air alone and at the end of compression, fuel is injected into the cylinder.

Fuel Used:

- On the basis of fuel used, I.C. Engines can be classified as (a) **Gas engines** like CNG, LPG, etc. (b) **Petrol engine**, (c) **Diesel engine**, and (d) **Bi-fuel engine**. In a bi-fuel engine, two types of fuels are used like gaseous fuel and liquid fuel.

Arrangement of Cylinders:

- Another common method of classifying IC engines is by the cylinder arrangement. The cylinder arrangement is only applicable to multi cylinder engines.
- A number of cylinder arrangements are popular with designers. The details of various cylinder arrangements are shown.



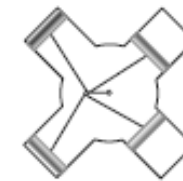
In-line



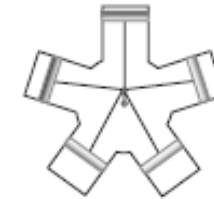
U-cylinder



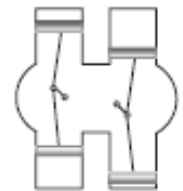
V-type



X-type



Radial



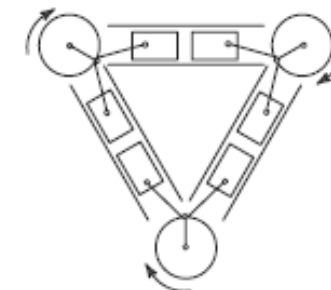
H-type



Opposed cylinder



Opposed piston



Delta type

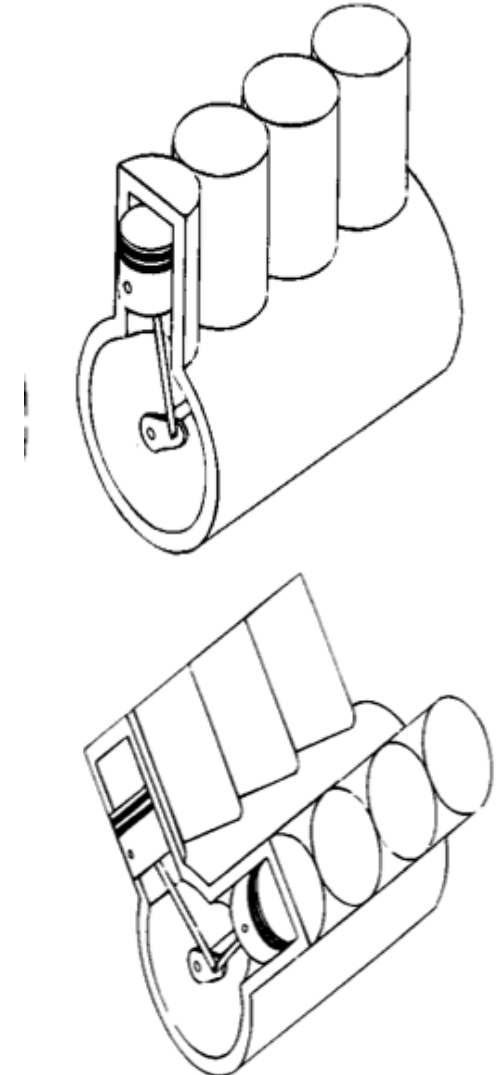
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IC ENGINES



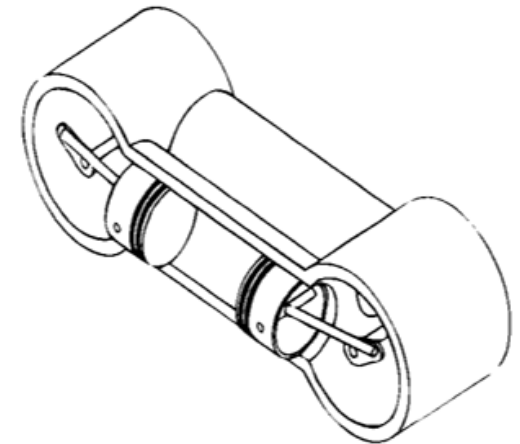
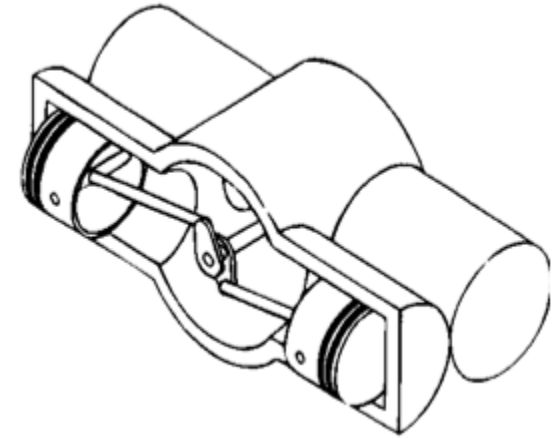
In-line Engine : The in-line engine is an engine with one cylinder bank, i.e. all cylinders are arranged linearly, and transmit power to a single crankshaft. This type is quite common with automobile engines. Four and six cylinder in-line engines are popular in automotive applications.

‘V’ Engine : In this engine there are two banks of cylinders (i.e., two in line engines) inclined at an angle to each other and with one crankshaft. Most of the high powered automobiles use the 8 cylinder ‘V’ engine, four in-line on each side of the ‘V’. Engines with more than six cylinders generally employ this configuration.



Opposed Cylinder Engine : This engine has two cylinder banks located in the same plane on opposite sides of the crankshaft. It can be visualized as two ‘in-line’ arrangements 180 degrees apart. It is inherently a well balanced engine and has the advantages of a single crankshaft. This design is used in small aircrafts.

Opposed Piston Engine : When a single cylinder houses two pistons, each of which driving a separate crankshaft, it is called an opposed piston engine. The movement of the pistons is synchronized by coupling the two crankshafts. Opposed piston arrangement, like opposed cylinder arrangement is inherently well balanced.



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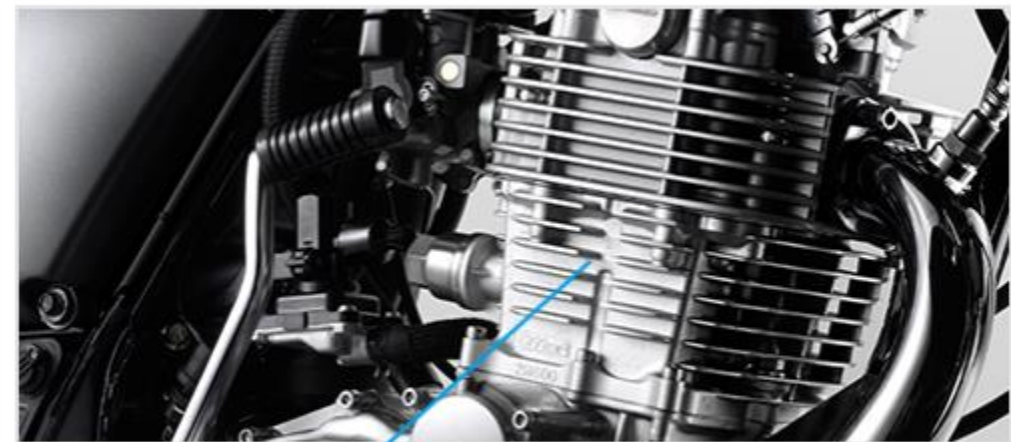
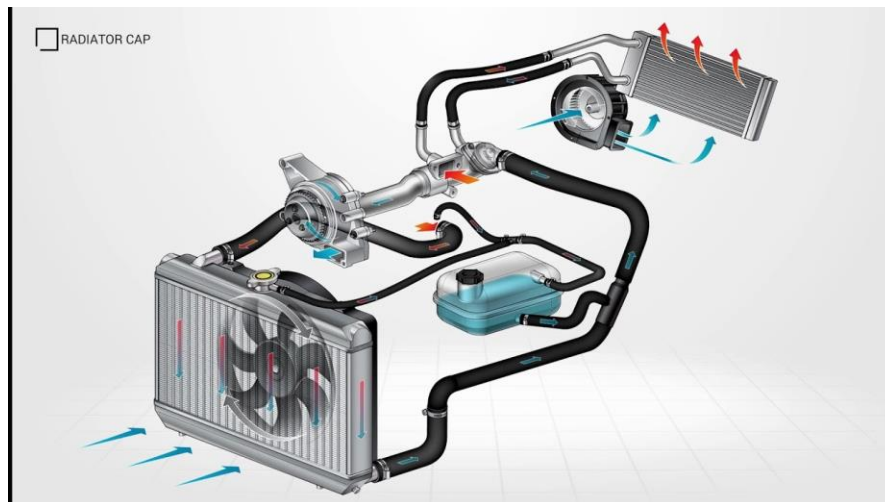
Radial Engine :

Radial engine is one where more than two cylinders in each row are equally spaced around the crankshaft. The radial arrangement of cylinders is most commonly used in conventional air-cooled aircraft engines. Pistons of all the cylinders are coupled to the same crankshaft.



Cooling Systems:

- There are two types of cooling systems in I.C. Engines—**water cooling** and **air cooling**.
- In water cooling, coolant and radiators are provided to cool the cylinder. In air cooling, fins are provided on the surface of the cylinder to radiate the heat into the atmosphere. Low power engines like motorbikes are equipped with air cooling systems, whereas large power producing engines like a car, bus, truck, etc. are equipped with water cooling systems.



Fins on an air-cooled engine

Fuel Supply Systems:

- On the basis of fuel supply systems, I.C. Engines can be classified as:
 - (a) **Carburetor engine,**
 - (b) **Air injection engine, and**
 - (c) **Airless or solid or Mechanical injection engines.**

- In a carburetor engine, air and fuel are properly mixed into the carburetor and then fed into the cylinder. In air injection engines, fuel is supplied to the cylinder with the help of compressed air. In mechanical injection engines, the fuel is injected into the cylinder with the help of mechanical pump and nozzle.