



# MECHANICAL ENGINEERING SCIENCE (UE25ME141A/B)

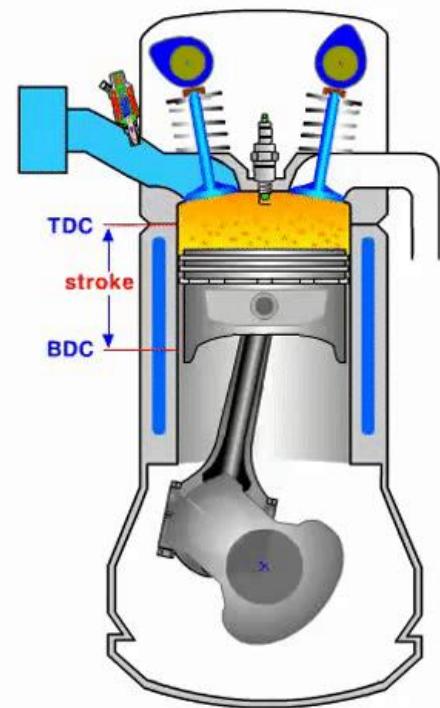
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Department of Mechanical Engineering

### WORKING PRINCIPLE OF 4S PETROL ENGINE (SPARK IGNITION ENGINE)

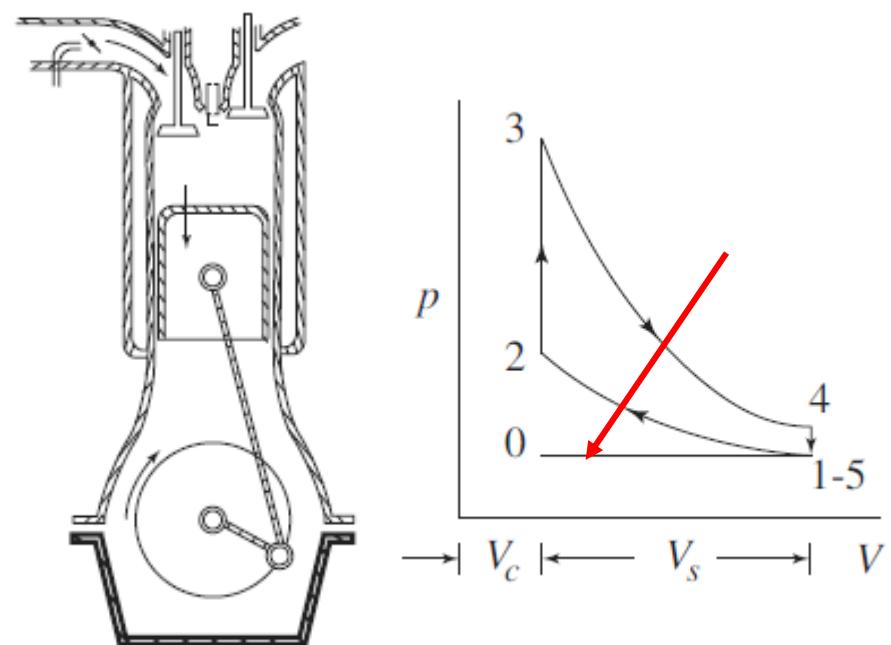
- In a four-stroke engine, the cycle of operations is completed in **four strokes** of the piston or **two revolutions** of the crankshaft.
- During the four strokes, there are five events to be completed, viz., suction, compression, combustion, expansion and exhaust. Each stroke consists of  $180^\circ$  of crankshaft rotation and hence a four-stroke cycle is completed through  $720^\circ$  of crank rotation.
- The cycle of operation for an ideal four-stroke SI engine consists of the following four strokes :
  - (i) **suction or intake stroke;**
  - (ii) **compression stroke;**
  - (iii) **expansion or power stroke and**
  - (iv) **exhaust stroke.**



## WORKING PRINCIPLE OF 4S PETROL ENGINE

### Suction Stroke:

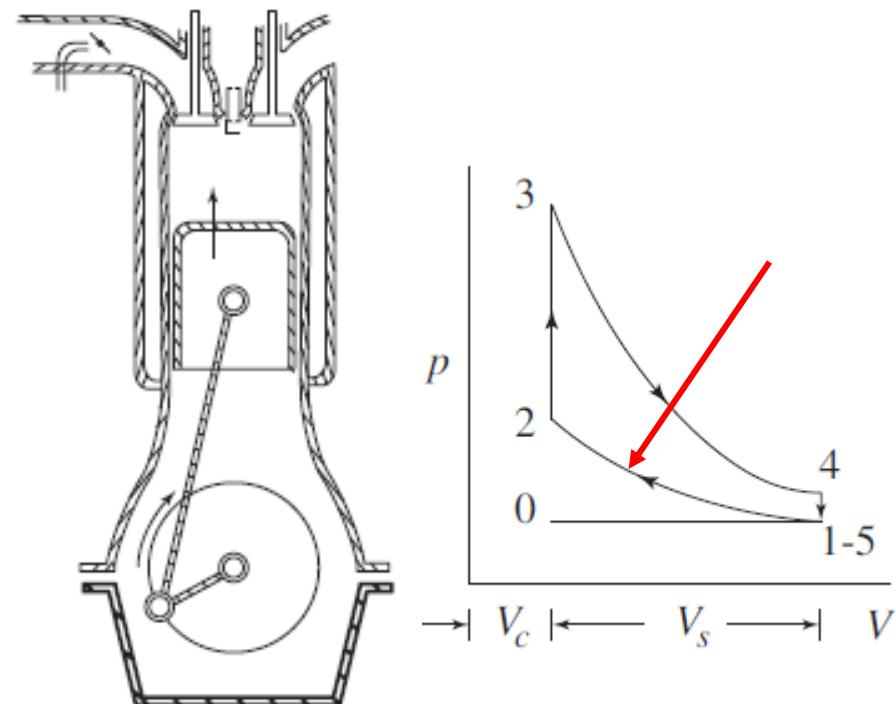
- Suction stroke 0→1 starts when the piston is at the top dead centre and about to move downwards.
- The inlet valve is assumed to open instantaneously and at this time the exhaust valve is in the closed position.
- Due to the suction created by the motion of the piston towards the bottom dead centre, the charge consisting of fuel-air mixture is drawn into the cylinder.
- When the piston reaches the bottom dead centre the suction stroke ends and the inlet valve closes instantaneously.



## WORKING PRINCIPLE OF 4S PETROL ENGINE

### Compression Stroke:

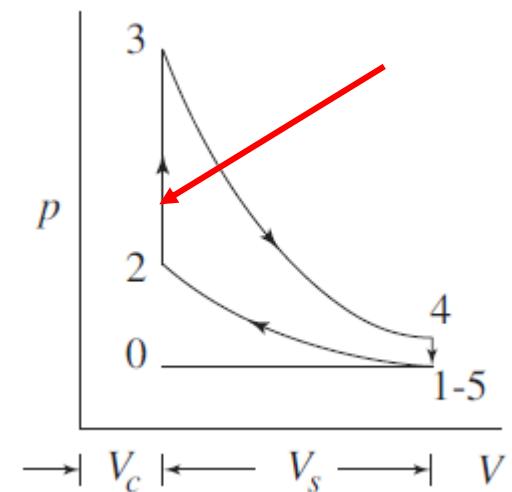
- The charge taken into the cylinder during the suction stroke is compressed by the return stroke of the piston 1→2.
- During this stroke both inlet and exhaust valves are in closed position.
- The mixture which fills the entire cylinder volume is now compressed into the clearance volume.



### WORKING PRINCIPLE OF 4S PETROL ENGINE

#### Compression Stroke:

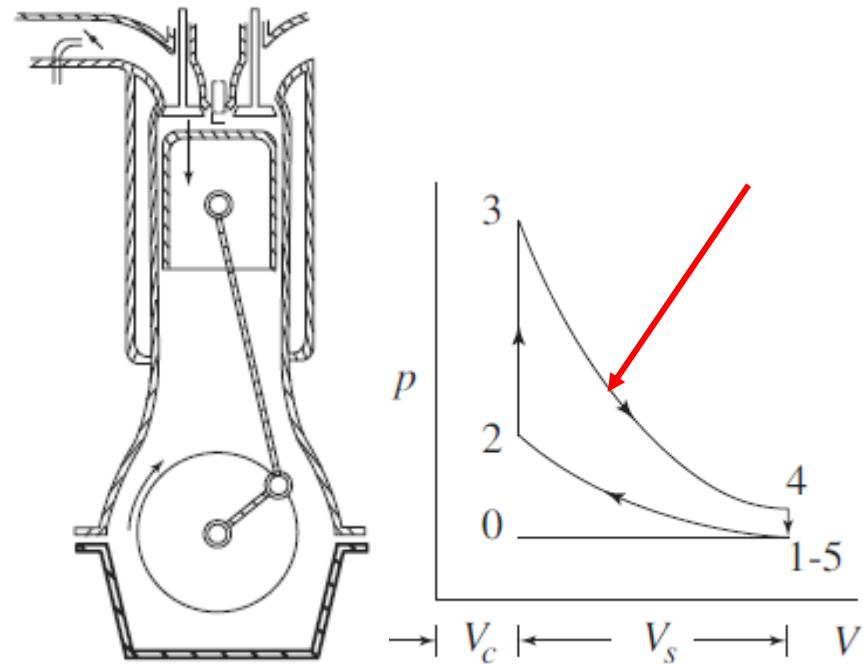
- At the end of the compression stroke the mixture is ignited with the help of a spark plug located on the cylinder head.
- In ideal engines it is assumed that burning takes place instantaneously when the piston is at the top dead centre and hence the burning process can be approximated as **heat addition at constant volume**.
- During the burning process the chemical energy of the fuel is converted into heat energy producing a temperature rise of about  $2000^{\circ}\text{C}$  (process 2→3).
- The pressure at the end of the combustion process is considerably increased due to the heat release from the fuel.



## WORKING PRINCIPLE OF 4S PETROL ENGINE

### Expansion or Power Stroke :

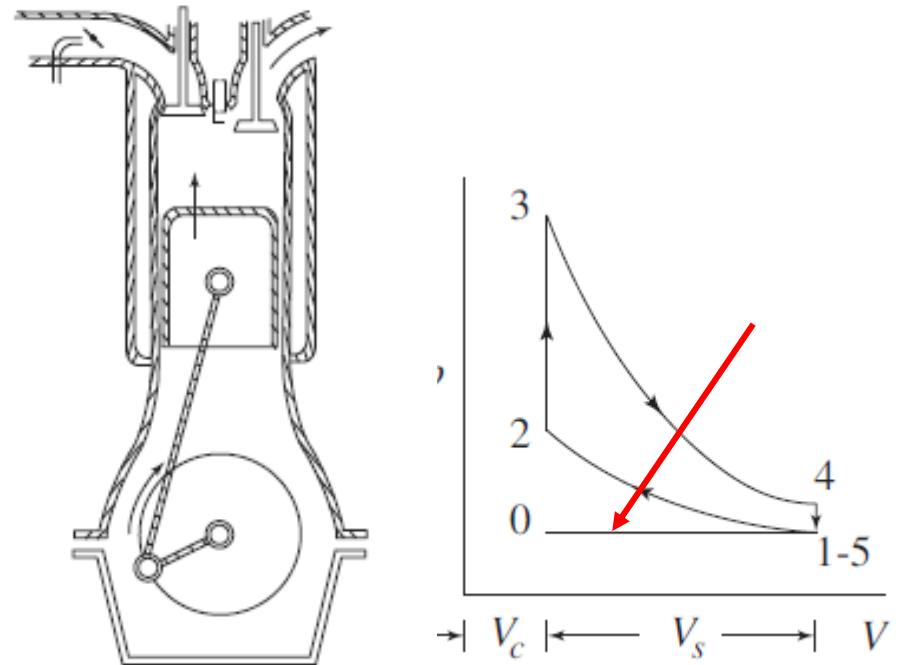
- The high pressure of the burnt gases forces the piston towards the BDC, (stroke 3→4).
- Both the valves are in closed position.
- Of the four-strokes only during this stroke power is produced. Both pressure and temperature decrease during expansion.



## WORKING PRINCIPLE OF 4S PETROL ENGINE

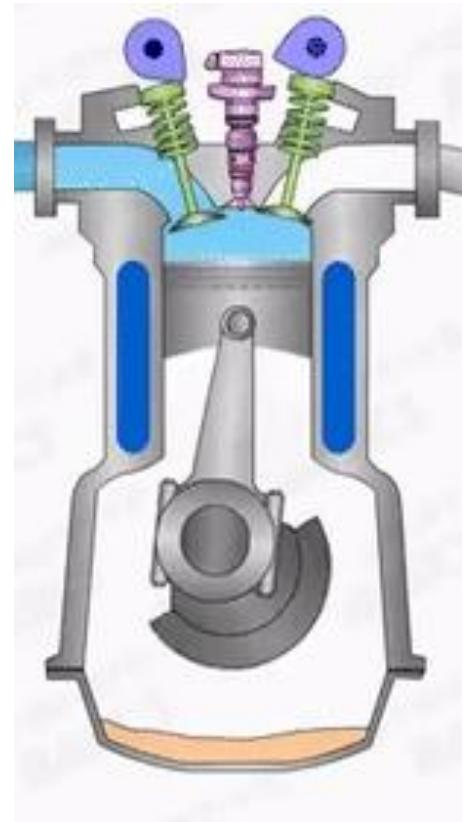
### Exhaust Stroke:

- At the end of the expansion stroke the exhaust valve opens instantaneously and the inlet valve remains closed.
- The pressure falls to atmospheric level a part of the burnt gases escape.
- The piston starts moving from the bottom dead centre to top dead centre (stroke  $5 \rightarrow 0$ ) and sweeps the burnt gases out from the cylinder almost at atmospheric pressure.
- The exhaust valve closes when the piston reaches TDC.



### WORKING PRINCIPLE OF 4S DIESEL ENGINE (COMPRESSION IGNITION ENGINE)

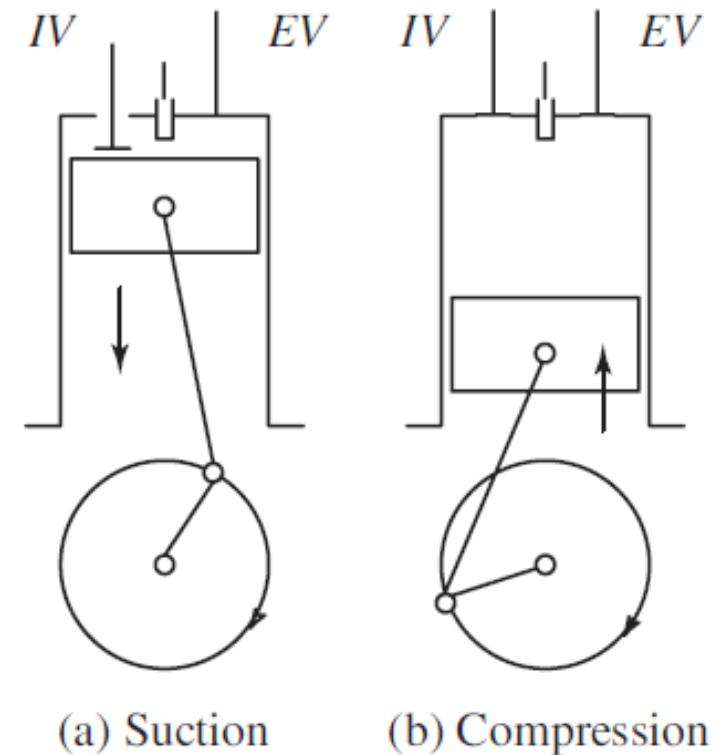
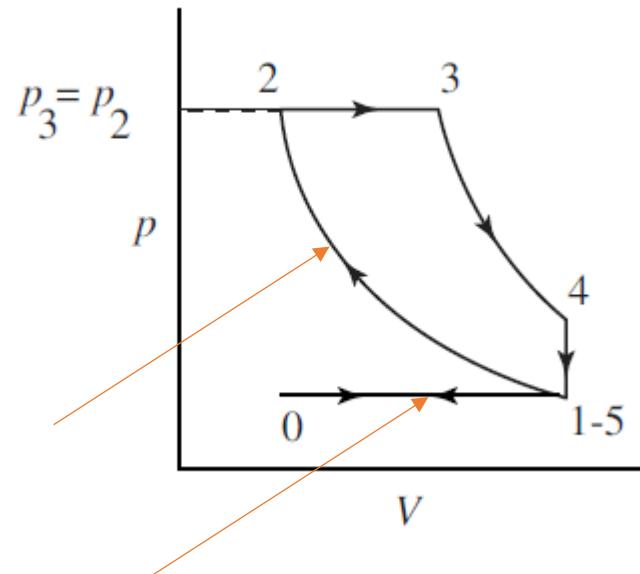
- The four-stroke CI engine is similar to the four-stroke SI engine but it operates at a much higher compression ratio. The compression ratio of an SI engine is between 6 and 10 while for a CI engine it is from 16 to 20.
- In the CI engine during suction stroke, air, instead of a fuel-air mixture, is inducted.
- Due to higher compression ratios employed, the temperature at the end of the compression stroke is sufficiently high to self ignite the fuel which is injected into the combustion chamber.
- In CI engines, a high pressure fuel pump and an injector are provided to inject the fuel into the combustion chamber. The carburettor and ignition system necessary in the SI engine are not required in the CI engine.



## WORKING PRINCIPLE OF 4S DIESEL ENGINE

**Suction Stroke:** Air alone is inducted during the suction stroke. During this stroke inlet valve is open and exhaust valve is closed.

**Compression Stroke:** Air inducted during the suction stroke is compressed into the clearance volume. Both valves remain closed during this stroke.

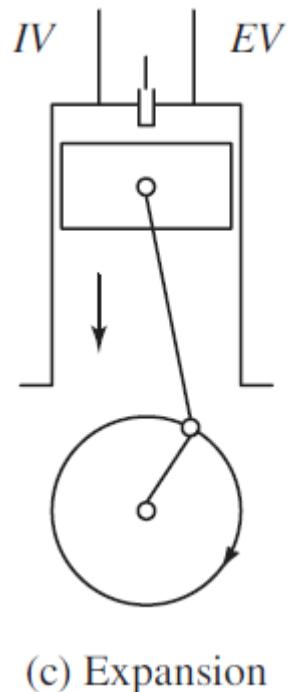
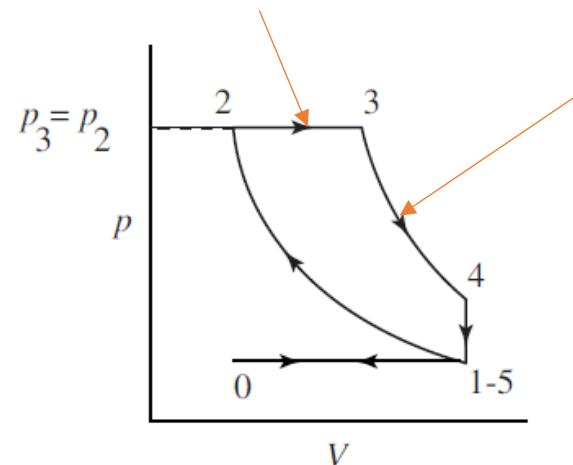


### WORKING PRINCIPLE OF 4S DIESEL ENGINE

**Expansion Stroke** : Fuel injection starts nearly at the end of the compression stroke.

The rate of injection is such that combustion maintains the pressure constant in spite of the piston movement on its expansion stroke increasing the volume. Heat is assumed to have been added at **constant pressure**.

After the injection of fuel is completed (i.e. after cut-off) the products of combustion expand. Both the valves remain closed during the expansion stroke.



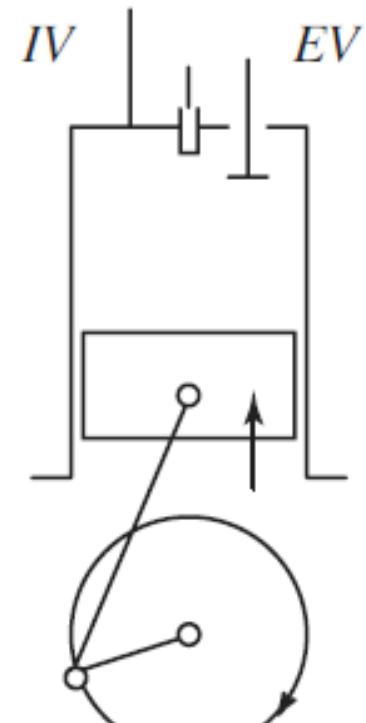
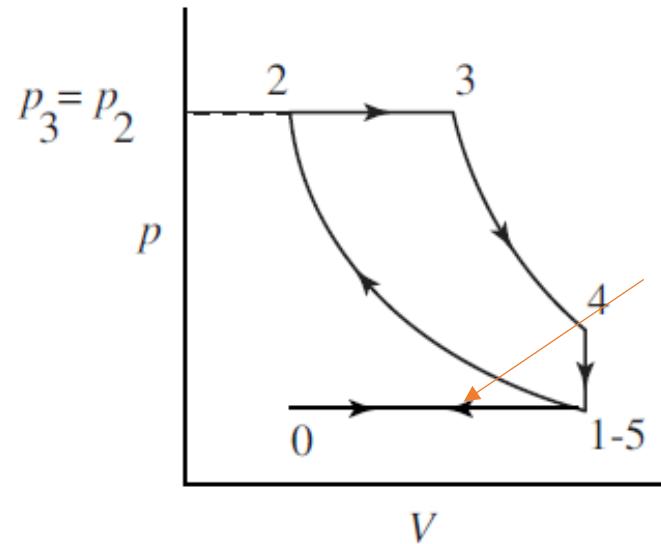
(c) Expansion

## WORKING PRINCIPLE OF 4S DIESEL ENGINE

### Exhaust Stroke :

The piston travelling from BDC to TDC pushes out the products of combustion.

The exhaust valve is open and the intake valve is closed during this stroke.



(d) Exhaust

# THANK YOU

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