Hindbookcenter

GET IT ON Google Play

Hind Book Center & Photostat

KULKARNI ACADEMY

Mechanical Engineering

Toppers Handwritten Notes

I.C Engine

By- Praveen Kulkarni Sir

- Colour Print Out
- Blackinwhite Print Out
- Spiral Binding,& Hard Binding
- Test Paper For IES GATE PSUs IAS, CAT
- All Notes Available & All Book Availabie
- Best Quaity Handwritten Classroom Notes & Study Materials
- IES GATE PSUs IAS CAT Other Competitive/Entrence Exams

Visit us:-www.hindbookcenter.com

Courier Facility All Over India
(DTDC & INDIA POST)
Mob-9711475393

Hindbookcenter

GET IT ON Google Play

ALL NOTES BOOKS AVAILABLEALL STUDY MATERIAL AVAILABLE
COURIERS SERVICE AVAILABLE

MADE EASY , IES MASTER , ACE ACADEMY , KREATRYX

ESE , GATE, PSUs BEST QUALITY TOPPER HAND WRITTEN NOTES
MINIMUM PRICE AVAILABLE @ OUR WEBSITE

1. ELECTRONICS ENGINEERING
2. ELECTRICAL ENGINEERING
3. MECHANICAL ENGINEERING
4. CIVIL ENGINEERING
5. INSTRUMENTION ENGINEERING
6. COMPUTER SCIENCE

IES ,GATE , PSU TEST SERIES AVAILABLE @ OUR WEBSITE

- IES –PRELIMS & MAINS
- GATE

- NOTE;- ALL ENGINEERING BRANCHS
- ALL PSUs PREVIOUS YEAR QUESTION PAPER @ OUR WEBSITE

PUBLICATIONS BOOKS -

MADE EASY , IES MASTER ,ACE ACADEMY ,KREATRYX ,GATE ACADEMY, ARIHANT ,GK

RAKESH YADAV, KD CAMPUS , FOUNDATION , MC –GRAW HILL (TMH) ,PEARSON…OTHERS

HEAVY DISCOUNTS BOOKS AVAILABLE @ OUR WEBSITE

Shop No.7/8 Saidulajab Market Neb Sarai More, Saket, New Delhi-30	Shop No: 46 100 Futa M.G. Rd Near Made Easy Ghitorni, New Delhi-30	F518 Near Kali Maa Mandir Lado Sarai New Delhi-110030	

Website: www.hindbookcenter.com
Contact Us: 9711475393

Internal Combustion Engine
(I.C. Engine)
Classroom Notes

[Handwritten]

For GATE | ESE | PSU's

Mechanical Engineering

By: Mr. Praveen Kulkarni

www.kulkarniacademy.com +91-9000770927

Scanned with CamScanner

Index

Scanned with CamScanner

Ch-1 Basics of Engine

Engine:

it is a device which convert one form of energy into another useful form.

Based on combustion, engines are classified into

(1) Internal combustion Engine

(2) External combustion Engine

In internal combustion engine burning or combustion occurs in the cylinder and the power is developed in the same cylinder.

In external combustion engine heat is transferred from product of combustion to the working fluid.

Heat Engine:

heat engine is a device which converts chemical energy of fuel into heat (thermal) energy and subsequently heat energy is converted into mechanical power.

Advantages of IC Engine:

(1) Mechanical Simplicity

(2) Low initial cost due to the absense of boiler, turbine, condenser etc.

(3) High efficiency

(4) High power to weight ratio.

Scanned with CamScanner

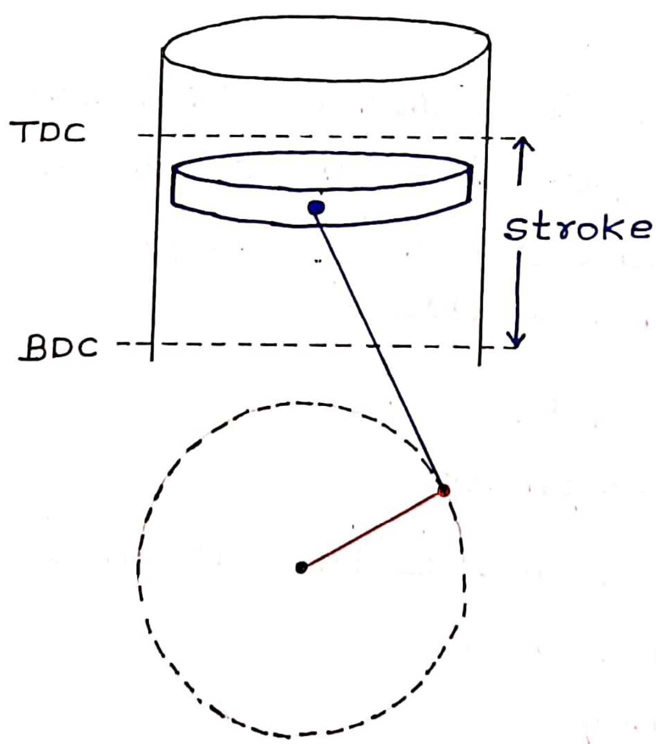
Engine Nomenclature:

(1) Top dead centre (TDC): it is the dead centre when the piston is farthest from the crank shaft.

- In case of horizontal engine TDC is known as inner dead centre (IDC).

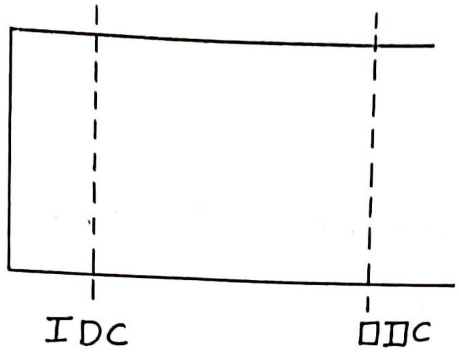
(2) Bottom dead centre (BDC): it is the dead centre when the piston is nearest to the crank shaft.

- In case of horizontal engine it is known as outer dead centre (ODC).



Vertical Engine

Scanned with CamScanner



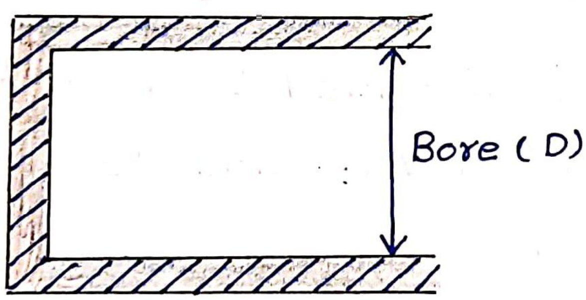
Horizontal engine

(3) Stroke or stroke length (L):

The distance between TDC and BDC is known as stroke or stroke length.

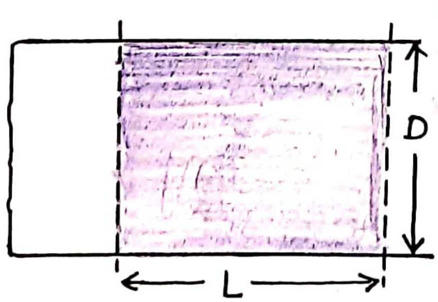
(4) Bore (D):

Inner diameter of cylinder is known as Bore.



(5) Stroke/swept/piston displacement volume (V_S):

it is the volume swept by the piston.



$$V_S = \frac{\pi}{4} D^2 L$$

Scanned with CamScanner

Where D = Inner diameter (Bore) of cylinder
L = stroke length

Note:

- If there are 'k' number of cylinders then the total swept volume.

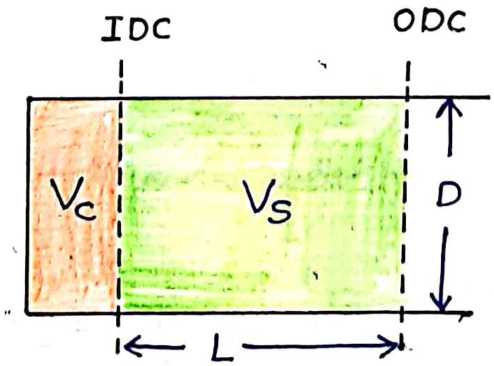
$$V_{Total\ swept} = K \times \frac{\pi}{4} D^2 L$$

- A 100 cc motorcycle means that the volume displaced by the piston inside the cylinder is 100 cubic centimeter.

(6) clearance Volume: (V_c):

it is the volume of the cylinder when the piston is at TDC or IDC.

- Clearance volume is provided to accommodate (or to provide space) valves and to prevent damaged to valves.



Total volume (V_T) = $V_c + V_s$

Scanned with CamScanner

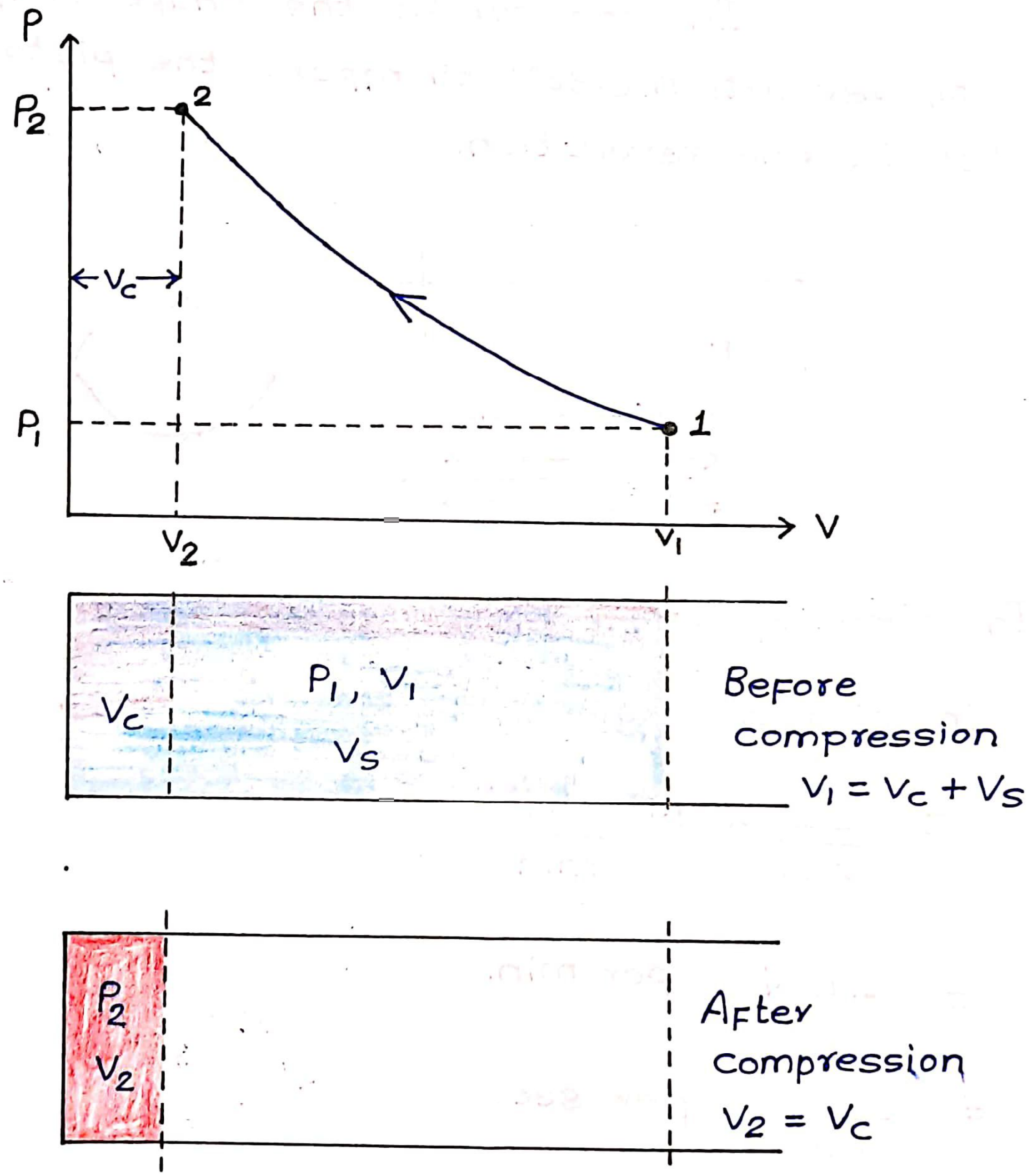
(7) clearance ratio (c):

it is the ratio of clearance volume to the swept volume.

$$c = \frac{V_c}{V_s}$$

(8) Compression ratio (r):

it is the ratio of volume before compression to the volume after compression.

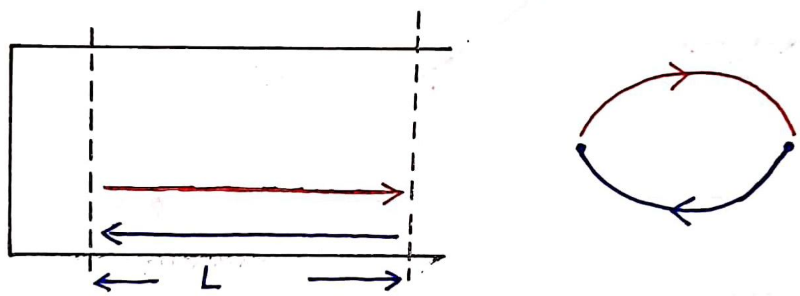


$$\gamma = \frac{\text{Volume before compression}}{\text{Volume after compression}}$$

$$\boxed{\gamma = \frac{V_1}{V_2} = \frac{V_c + V_s}{V_c} = 1 + \frac{V_s}{V_c}}$$

(9) Mean piston speed:

In one stroke the shaft complete half revolution (180°) therefore the piston covers '2L' in one revolution.



In 1 rev. of shaft piston covers → 2L

So, in N rev.

$$\Rightarrow \frac{2L}{\text{rev.}} \times N \frac{\text{rev.}}{\text{min}}$$

$$= 2LN \text{ per min.}$$

$$= \frac{2LN}{60} \text{ per sec.}$$

$$\text{Mean piston speed} = \frac{2LN}{60} \text{ (per sec.)}$$

Ch-2 Air-standard cycles

Assumptions:

(1) The working fluid is air and it is treated as an ideal gas.

(2) Specific heat C_p & C_v are assumed to be constant.

(3) The working fluid is of fixed mass. (closed system analysis).

(4) The working fluid doesnot undergo any chemical reaction i.e., it is constant chemical composition throughout the cycle.

(5) All processes are assumed to be reversible. (internally reversible).

(6) External heat addition

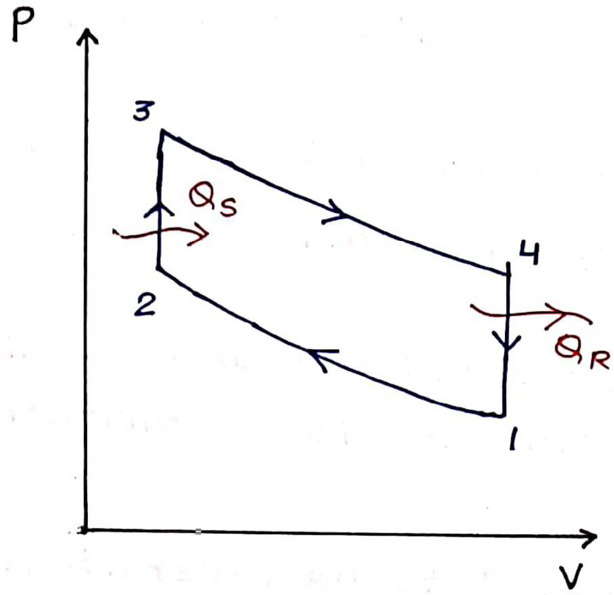
Internally reversible: A process is said to be internally reversible when the system properties are same throughout the volume at any given instant of time.

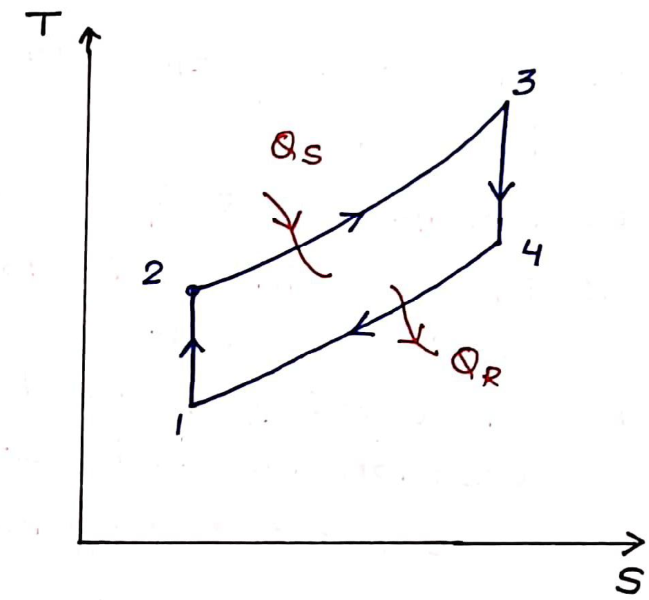
Note:

Generally C_p and C_v of air are taken at 25°C. This analysis is known as cold air cycle analysis.

Scanned with CamScanner

Otto cycle (constant Volume cycle):





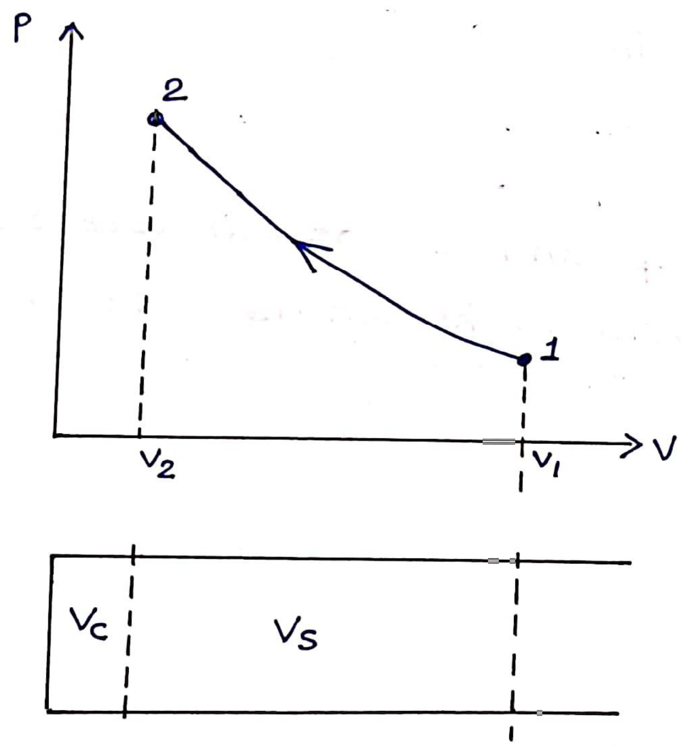
Process

1-2 : Reversible adiabatic compression

2-3 : Constant volume Heat addition

3-4 : Reversible adiabatic expansion

4-1 : constant volume heat rejection.



compression ratio (r) = $\frac{V_1}{V_2}$

Process 2-3 : heat addition at constant volume

$$\delta Q = du$$

$$Q_S = mc_v(T_3 - T_2)$$

Process 4-1 : heat rejection at constant volume

$$Q_R = mc_v(T_4 - T_1)$$

Efficiency:

$$\eta = \frac{\text{Net work}}{\text{Heat supplied}}$$

$$= \frac{Q_S - Q_R}{Q_S} = 1 - \frac{Q_R}{Q_S}$$

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

$$= 1 - \frac{(T_4 - T_1)}{(T_3 - T_2)} = 1 - \frac{T_1\left(T_4/T_1 - 1\right)}{T_2\left(T_3/T_2 - 1\right)} \quad \text{——— (1)}$$

Process 1-2 : rev. adiabatic compression

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = (r)^{\gamma-1} \quad \text{——— (2)}$$

Scanned with CamScanner

Process 3-4 : rev. adiabatic expansion

$$T_3 V_3^{\gamma-1} = T_4 V_4^{\gamma-1}$$

$$\frac{T_3}{T_4} = \left(\frac{V_4}{V_3}\right)^{\gamma-1} \qquad \begin{cases} V_4 = V_1 \\ V_3 = V_2 \end{cases}$$

$$\frac{T_3}{T_4} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = (r)^{\gamma-1} \quad \text{——— (3)}$$

from equation (2) and (3)

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

$$\boxed{T_1 T_3 = T_2 T_4} \ *$$

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

$$\text{or} \quad \frac{T_4}{T_1} - 1 = \frac{T_3}{T_2} - 1 \quad \text{——— (4)}$$

from equation (1) and (4)

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

$$\boxed{\eta = 1 - \frac{1}{(r)^{\gamma-1}}}$$