ME 165
Mechanical Engineering Fundamentals

Lecture 4

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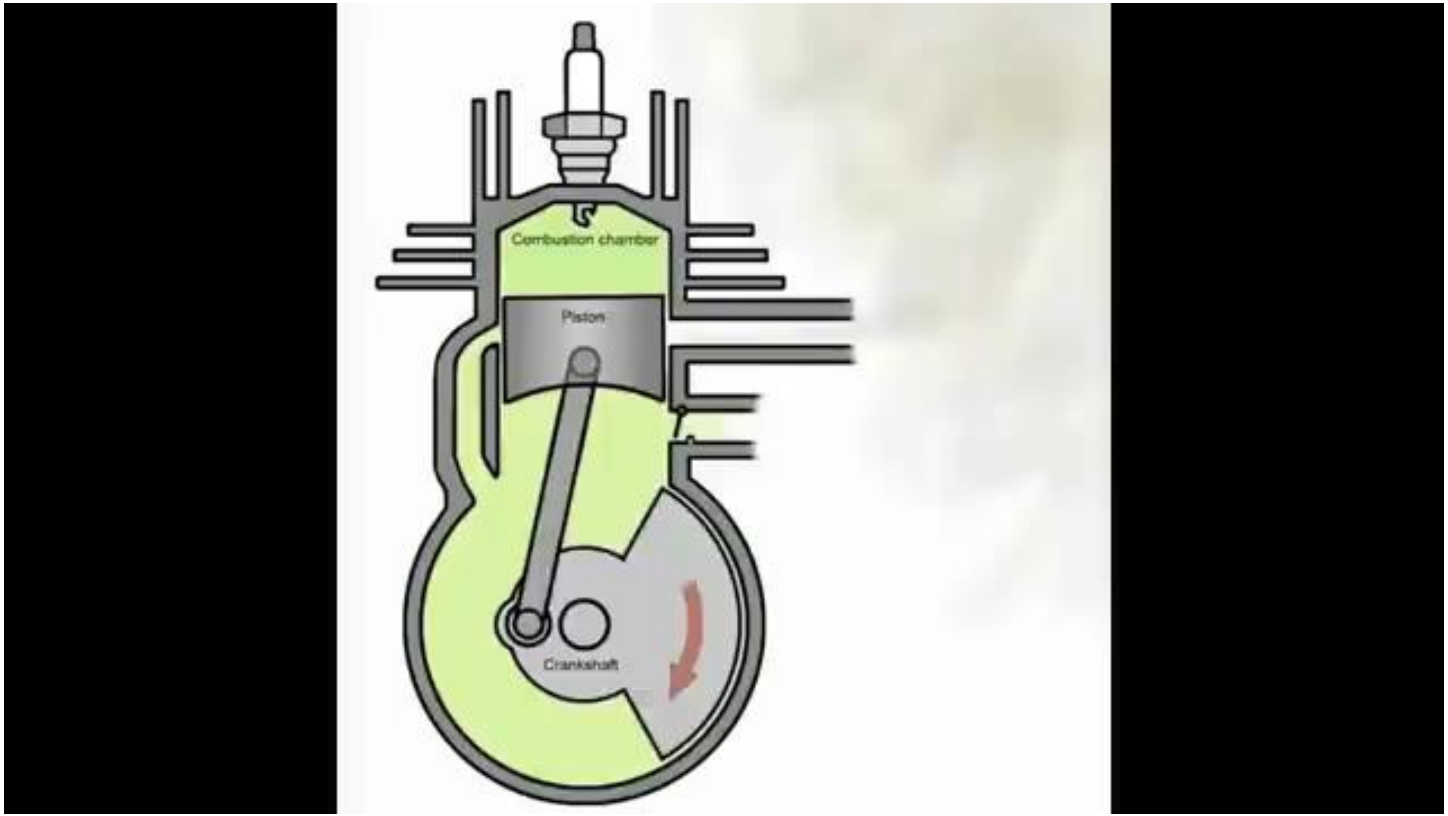
2-stroke SI (Petrol) engine operation



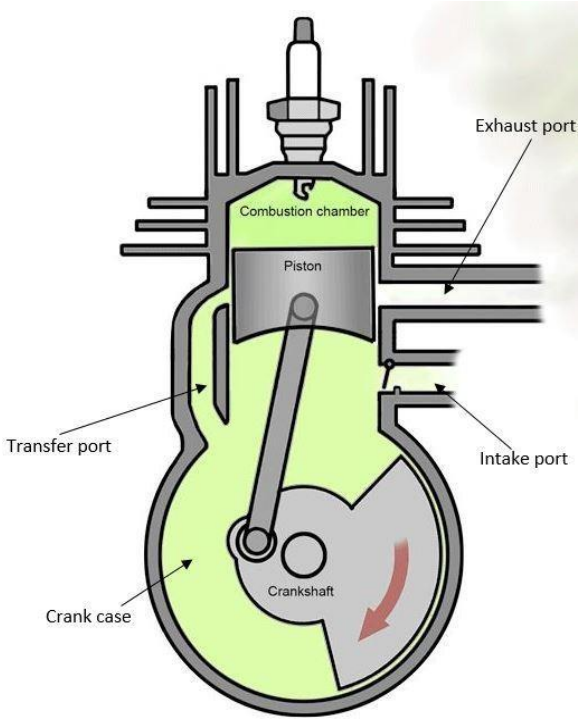
https://www.youtube.com/watch?v=xNLE8G3pC0k

2-stroke SI (Petrol) engine operation

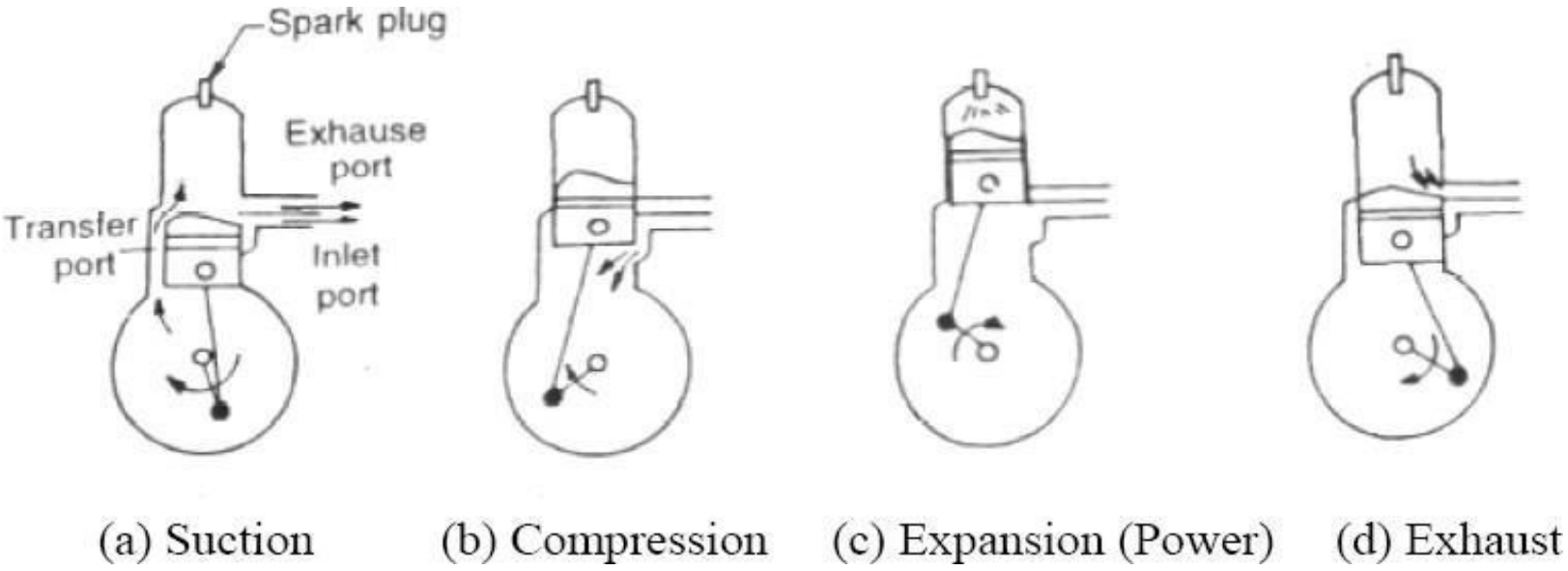
In Brief:

(a) and (b): Up-stroke of the piston : Suction and Compression.

(c) and (d) : Down stroke of the piston : Expansion and Exhaust.



2-stroke SI (Petrol) engine operation



(a) Suction (b) Compression (c) Expansion (Power) (d) Exhaust

Comparison of 2-stroke and 4-stroke Engines

4-stroke Engine	2-stroke Engine
1. The intake, compression, combustion and exhaust occur in two upward and two downward strokes of the piston.	1. All four events are accomplished in one downward stroke, and one upward stroke.
2. Needs complicated valve train arrangement for intake and exhaust strokes.	2. Intake and exhaust are both integrated into the compression and combustion movement of the piston, eliminating the need for valves.
3. Outputs power once in every two revolutions of the crankshaft.	3. The engine delivers power on every revolution.
4. The engine is heavier for the same power rating, i.e., low power to weight ratio.	4. Higher power-to-weight ratio because it is much lighter.
5. More expensive than the 2-stroke engines.	5. Less expensive because of its simpler design.
6. It has limited orientation if oil is to be retained in the sump.	6. It can be operated in any orientation because it lacks the oil sump
7. More fuel efficient, less noisy, less polluting and longer lifespan.	7. Less fuel-efficient because of the simpler design, resulting in poorer mileage than a four stroke engine.
8. Less noisy.	8. Twice as much noisy.
9. Less polluting.	9. Very much polluting.
10. Usually lasts longer.	10. Does not last very long.

Problem 1

A six-cylinder two-stroke engine with a compression ratio r = 9 produces a torque of 1100 Nm at a speed of 2100 rpm. It has a bore b of 123 mm and a stroke s of 127 mm.

a) What is the displacement volume and the clearance volume of a cylinder?

b) mean piston speed

Solution:

$V_d = (\pi/4) * b^2 * L$

We know that $r = (V_d + V_c)/ V_c$

$U_p = 2NL/60$

Problem 1

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a) What is the displacement volume and the clearance volume of a cylinder?

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Solution:

$V_d = (\pi/4) * b^2 * L$

$= 1.51 \times 10^{-3} m^3$

We know that $r = (V_d + V_c)/ V_c$

The clearance volume, $V_c = V_d /(r - 1)$

$= 1.89 \times 10^{-4} m^3$

$U_p = 2NL/60 = 2 * (2100/60) * 0.127 = 8.89$ m/s

Problem 2

A three-liter SI V6 engine that operates on a four-stroke cycle at 3600 RPM. The compression ratio is 9.5, length of the connecting rods is 16.6 cm, the engine is square (B=L) Calculate:

a) Cylinder bore
b) Stroke length
c) Average piston speed
d) Clearance volume of one cylinder

Solution:a. Given, Swept volume,
$V_s = 3 \times 10^{-3} m^3$ RPM of engine, N = 3600
The engine bore, B=? Stroke length, L =?

We know, $V_s = n \times (\pi/4 \times B^2 \times L)$
(here n is no. of cylinder)/

Problem 2

b. Since B = L, so L = 0.086 m

c. Average piston speed Sp =?

We know, Sp = 2NL
= 2×3600×0.086 m
= 2×(3600/60)×0.086 m
= 10.32 m/s

d. Clearance volume of one cylinder: the clearance volume for one cylinder,

We know that $r = (V_d + V_c)/ V_c$

The clearance volume, $V_c = V_d/(r - 1) = 352.941\ cm^3$

$V_C = 352.941/6\ cm^3 = 58.82\ cm^3 \approx 59\ cm^3$

IC Engine Subsystems

Engine Subsystems

https://www.youtube.com/watch?v=ZQvfHyfgBtA

Engine Subsystems

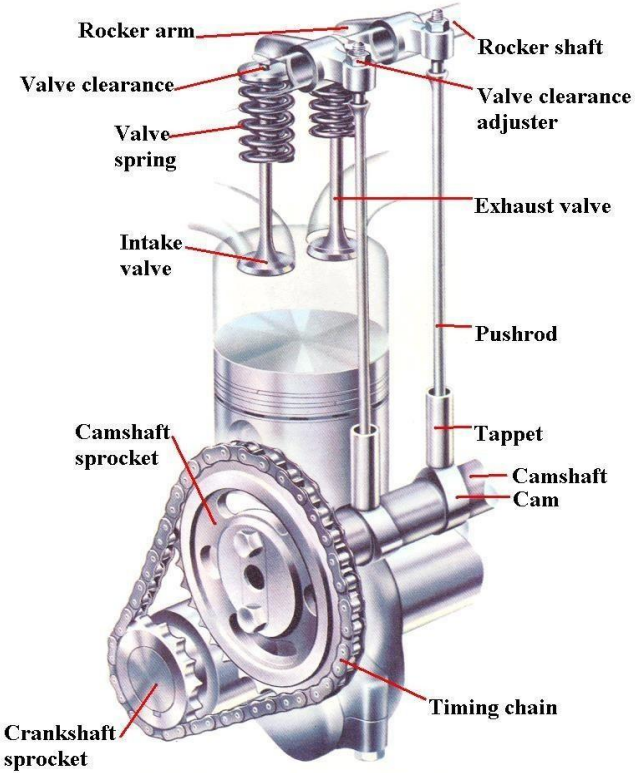
https://www.youtube.com/watch?v=vIJ50aUiBgM&t=9s

Engine Subsystems

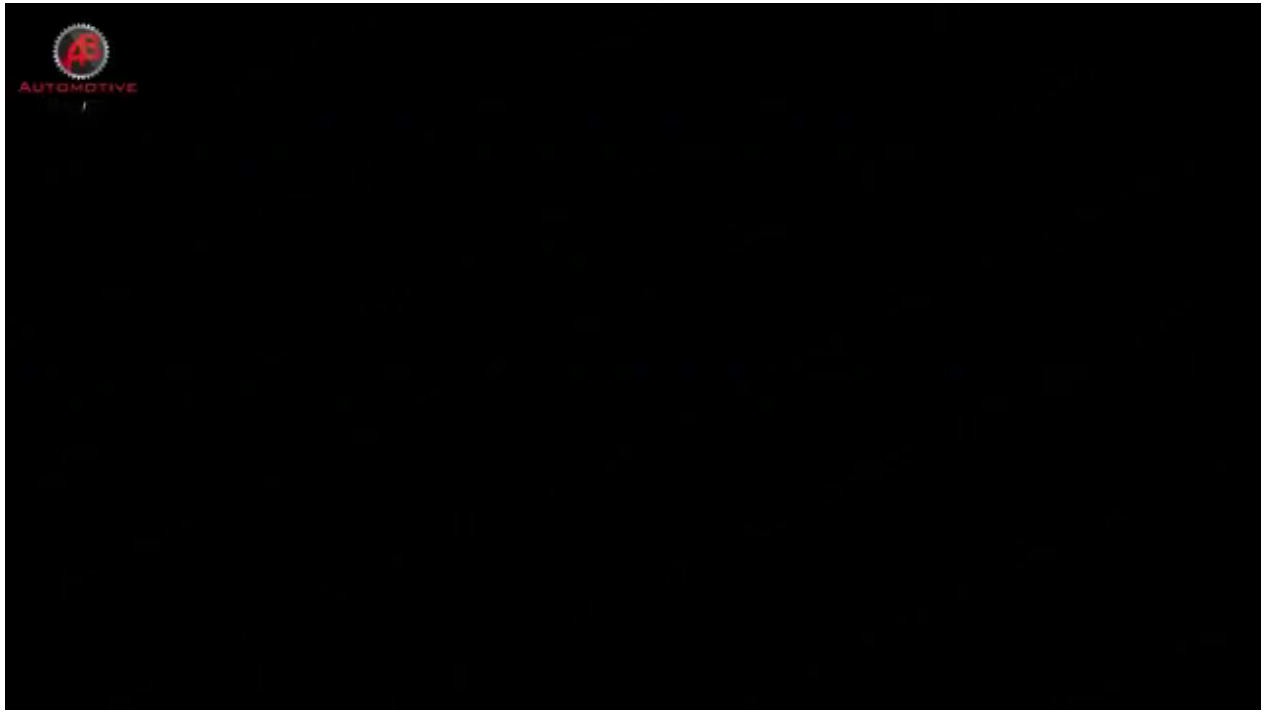
- Valve Operation
- Air Intake & Exhaust System
- Fuel Supply System
- Ignition System
- Lubrication System
- Cooling system
- Starting System

IC Engine: Valve Operation

- Cam: Mechanical component used to convert rotary motion into reciprocating motion
- Cams are fitted in a camshaft
- Camshaft is driven by crankshaft by chain-sprockets or timing gears
- **1** cam required for each valve
- Camshafts rotate at half the speed of the crankshaft
- Total engine rotation: 720°
- IVO : 0°to 180°
- EVO: 540°to 720°



Indicator and valve-timing diagram for a 4- stroke SI engine



https://www.youtube.com/watch?v=Te-OltNQRUk

Indicator and valve-timing diagram for a 4- stroke engine

Terminology:

TDC:	Top dead center
BDC:	Bottom dead center
IVO:	Inlet valve opens (10°-20° before TDC)
IVC:	Inlet valve closes (30°-40° after TDC)
IGN:	Ignition (20°-30° before TDC)
EVO:	Exhaust valve opens (30°-50° before BDC)
EVC:	Exhaust valve closes (10°-15° after TDC)

Valve overlap: The duration (10°+10°=20°) when both inlet and exhaust valves remain open.

Spark Advance: The ignition is initiated 20° -30° before TDC.

Indicator and valve-timing diagram for a 4- stroke engine

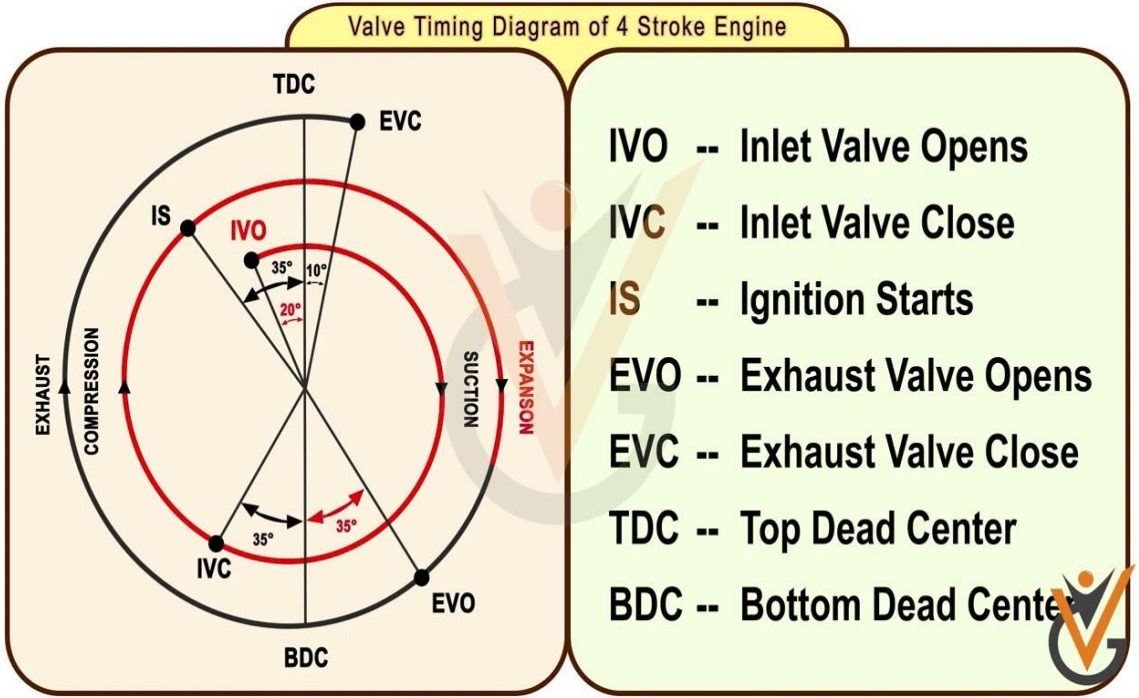


Figure: Valve timing for a four-stroke cycle engine.

Indicator and valve-timing diagram for a 4- stroke engine

- **Valve timing diagram:** The exact moment at which the inlet and outlet valve opens and closes with reference to the position of the piston and crank shown diagrammatically is known as valve timing diagram. It is expressed in terms of degree crank angle.
- ***Opening and closing of inlet valve***

  - Inlet valve opens 12 to 30° CA before TDC to facilitate full opening of the inlet valve by the time piston reaches TDC.

  -Inlet valve closes 10-60° CA after TDC due to advantage of the velocity of the Incoming gases, helping to continue filling the cylinder with additional air-fuel mixture even though the piston is moving back up the cylinder. This effect can be called ram effect. IVC one of the main factors in determining volumetric efficiency.

Indicator and valve-timing diagram for a 4- stroke engine

- ***Opening and closing of exhaust valve***
- Exhaust valve opens 25 to 55° CA before BDC to reduce the work required to expel out the burnt gases from the cylinder. This is called blowdown.
- Most of the power of the burning gases is delivered to the piston by about halfway through the power stroke so opening the exhaust valve at this point does not significantly reduce an engine's power output.
- Exhaust valve closes 10 to 30° CA after TDC to avoid the compression of burnt gases in next cycle. Kinetic energy of the burnt gas can assist maximum expelling of the gas. It also increases the volumetric efficiency.

Acknowledgement

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