Mechanical Engineering Fundamentals

(MEC103)

MECHANICAL ENGINEERING FUNDAMENTALS

Vipan Bansal

Department of Mechanical Engineering

(vipan10028@davuniversity.org)

POWER PRODUCING DEVICES

Vipan Bansal
Assistant Professor

Content

1) Fundamental Concepts of Thermodynamics
2) Laws of Thermodynamics
3) Pressure and its Measurement
4) Heat Transfer
5) Power Absorbing Devices
6) **Power Producing Devices**
7) Principles of Design
8) Power Transmission Devices and Machine Elements

Lecture No. - 2

Four Stroke Cycle Engine

- S.I. (Four Stroke Cycle Engine)
- C.I. (Four Stroke Cycle Engine)

Two Stroke Cycle Engine

- S.I. (Four Stroke Cycle Engine)
- C.I. (Four Stroke Cycle Engine)

2 Stroke Engine Cycle vs 4 Stroke Engine Cycle

Petrol Engine vs Diesel Engine

Four Stroke Cycle Engine

The cycle consists of four stroke of piston completed in two revolution of crankshaft. Each stroke is completed in 180° of crank rotation. The four strokes are:

- Suction Stroke
- Compression Stroke
- Expansion or Power Stoke
- Exhaust Stroke

Four Stroke Engines are of two types:

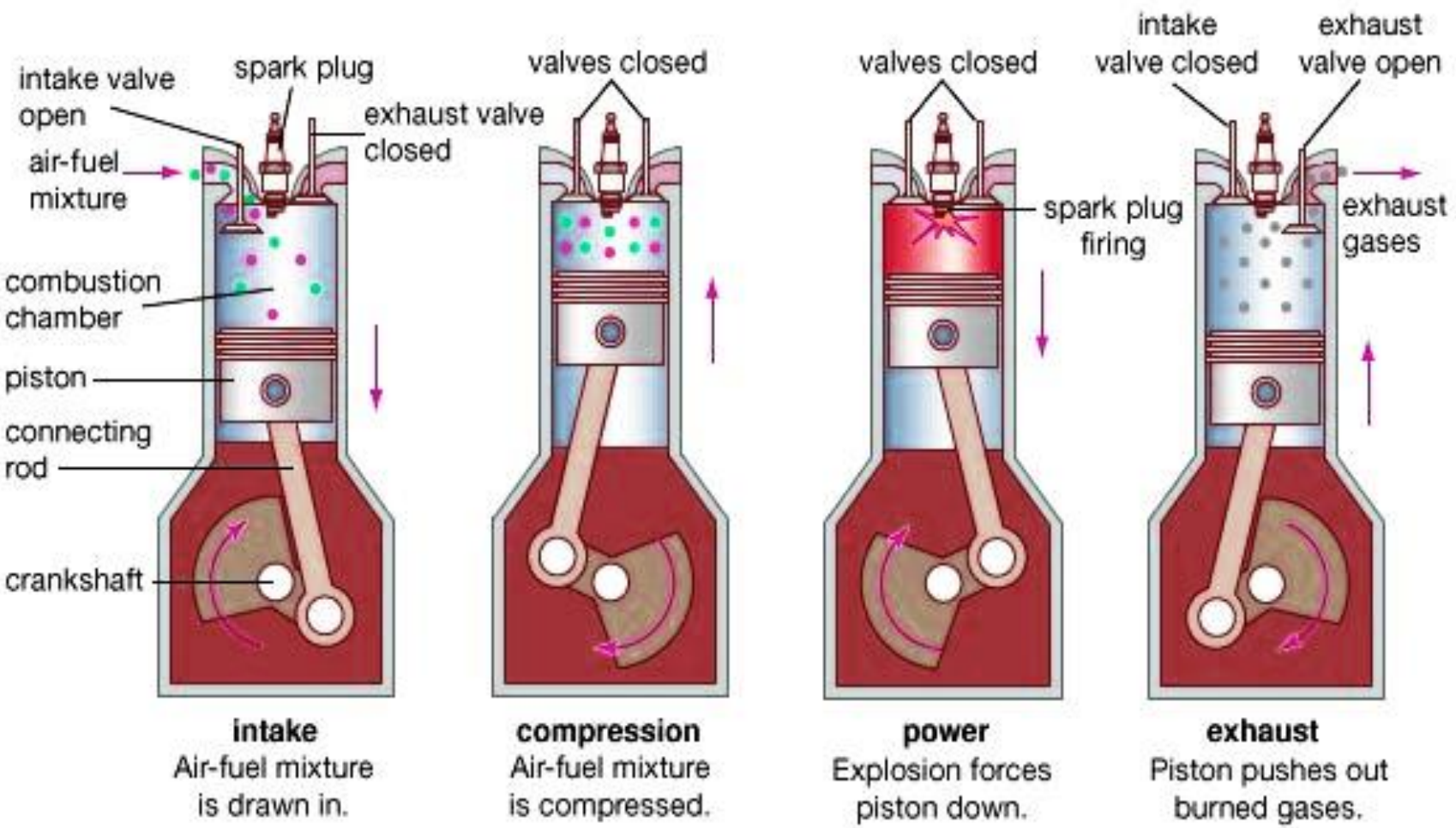
Spark Ignition (S.I.) Engines (Petrol/Gasoline Engines)

Compression Ignition (C.I.) Engines (Diesel Engines)

Four Stroke Spark Ignition (S.I.) Engines

(Petrol/Gasoline Engines)

- Four Stroke Spark Ignition (S.I.) Engines was developed by German Engineer, Otto in 1876.
- Petrol is a liquid fuel and is called by the name gasoline in U.S.A. that is way petrol engines are also called as Gasoline engines.
- Four stroke spark ignition engine find application in Cars, Motor Cycles, Agricultural Equipment's etc.


intake valve open
spark plug
exhaust valve closed
air-fuel mixture
combustion chamber
piston
connecting rod
crankshaft
valves closed
valves closed
spark plug firing
intake valve closed
exhaust valve open
exhaust gases
intake
Air-fuel mixture is drawn in.
compression
Air-fuel mixture is compressed.
power
Explosion forces piston down.
exhaust
Piston pushes out burned gases.

Working of Four Stroke S.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
1st Stroke	Suction Stroke (Intake)	Inlet Valve Open and Exhaust Valve Closed	Piston moves from T.D.C. to the B.D.C.	A mixture of air and fuel is forced by atmospheric pressure into the cylinder through the inlet valve. The moment of piston is obtained by momentum of flywheel or by starter motor.

Working of Four Stroke S.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
2nd Stroke	Compression Stroke	Both Inlet and Exhaust Valves Closed	Piston moves from B.D.C. to the T.D.C.	Compressing the fuel-air mixture into the cylinder head. As a result of compression, pressure and temperature of the charge increases. The rise of temperature and pressure depends upon the compression ratio.

Working of Four Stroke S.I. Engines

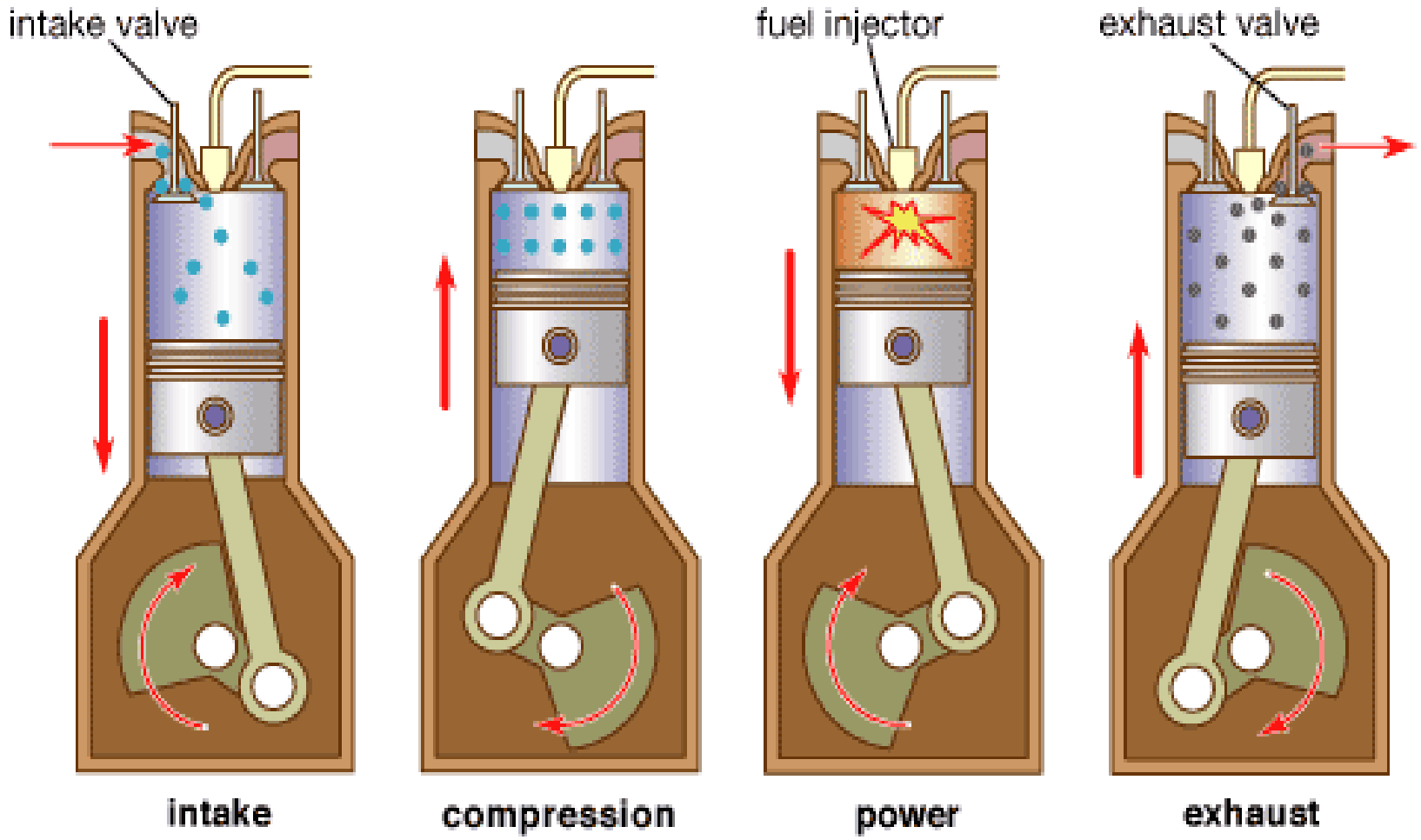
Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
3rd Stroke	Power or Expansion or Working Stroke	Both Inlet and Exhaust Valves Closed	Piston moves from T.D.C. to the B.D.C.	Just before the completion of compression stroke, the charge is ignited by the spark plug, produced in the spark plug. During the ignition the chemical energy of fuel converted into heat energy which raises the temperature up to 2000°C. The resulting pressure from the combustion of the compressed fuel-air mixture pushes the piston back down toward B.D.C. During this expansion, some of the heat energy produced is transformed into mechanical work.

Working of Four Stroke S.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
4th Stroke	Exhaust Stroke	Inlet Valve Closed and Exhaust Valve Open	Piston moves from B.D.C. to the T.D.C.	This stroke pushes out the product of combustion i.e. flue gases of ignited fuel-air mixture through the exhaust valve(s) into the atmosphere. This completes the cycle, and the engine cylinder is ready to suck the charge once again.

Four Stroke Compression Ignition (C.I.) Engines (Diesel Engines)

- Four Stroke Compression Ignition (C.I.) Engines was developed by German Engineer, Rudolf Diesel in 1892 and received a patent 1893.
- The working fluid of these engines is diesel. In C.I. engines, the fuel is ignited by suddenly exposed to compressed gas of high temperature and pressure rather than by a separate source of ignition such as spark plug as in the case of Petrol or Gasoline engine.
- Four stroke compression ignition engine find application in Buses, Trucks, Heavy Earth Moving Equipment's, and Trains etc.



Working of Four Stroke C.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
1st Stroke	Suction Stroke (Intake)	Inlet Valve Open and Exhaust Valve Closed	Piston moves from T.D.C. to the B.D.C.	The downward moment of piston creates vacuum in the cylinder due to which air is drawn into the cylinder. The moment of piston is obtained by momentum of flywheel or by starter motor.

Working of Four Stroke C.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
2nd Stroke	Compression Stroke	Both Inlet and Exhaust Valves Closed	Piston moves from B.D.C. to the T.D.C.	Compressing the air into the cylinder head as the piston moves in the upward direction. As a result of compression, pressure and temperature of the charge increases. The rise of temperature and pressure depends upon the compression ratio. Compression ratio in diesel engine is higher than that of petrol engine.

Working of Four Stroke C.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
3rd Stroke	Power or Expansion or Working Stroke	Both Inlet and Exhaust Valves Closed	Piston moves from T.D.C. to the B.D.C.	Just before the completion of compression stroke, a very fine spray of diesel is injected into compressed air the fuel ignited spontaneously. During the ignition the chemical energy of fuel converted into heat energy which raises the temperature up to 2000°C. The resulting pressure from the combustion of the fuel pushes the piston back in down toward B.D.C. During this expansion, some of the heat energy produced is transformed into mechanical work.

Working of Four Stroke C.I. Engines

Sequence of Strokes	Name of Stroke	Position of Valves	Position of Piston	Function
4th Stroke	Exhaust Stroke	Inlet Valve Closed and Exhaust Valve Open	Piston moves from B.D.C. to the T.D.C.	This stroke pushes out the product of combustion i.e. flue gases of ignited fuel-air mixture through the exhaust valve(s) into the atmosphere. This completes the cycle, and the engine cylinder is ready to suck the charge once again.

Two Stroke Cycle Engine

- Two Stroke Engines was developed by Scottish Engineer, Dugald Cleark in 1878 who in 1881 patented his design.

- In two stroke engines, the two strokes **named as upward and downward**, carried out all four operations i.e. suction, compression, expansion and exhaust.

Two Stroke Cycle Engine

The two stroke cycle consists of two stroke of piston completed in one revolution of crankshaft.

In other words, one working stroke is completed in one revolution of crank shaft.

Thus, theoretically for same size, two stroke engines should produce double the power as compared to four stroke engines but, it is not possible practically due to number of losses which are difficult to eliminate.

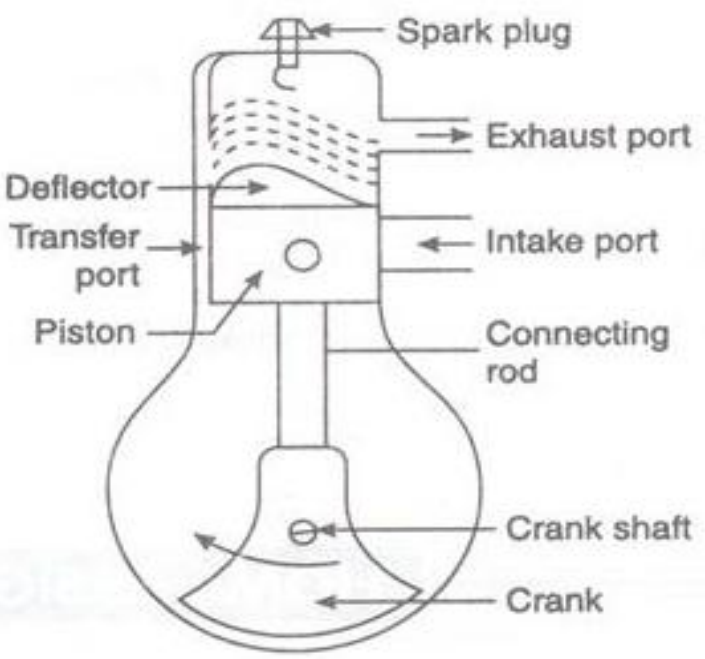
Two Stroke Engines are of two types:

Spark Ignition (S.I.) Engines

Compression Ignition (C.I.) Engines

Construction of Two Stroke Engines

The two stroke engines does not contain valves, but instead inlet and exhaust ports cut in the cylinder wall and there is also transfer port which connects the cylinder with crank case which is made air tight as shown in figure. Piston in two stroke engine is also acting as a valve covering and uncovering the ports at right time.



Working of Two Stroke S.I. Engines

Upward Stroke

During upward stroke, the piston moves upward from B.D.C. to T.D.C., compressing an air/fuel mixture in the engine cylinder.

At the same time at the bottom side of the piston, a partial vacuum is created in the crank case which pulls another fresh charge of air/fuel mixture into the crankcase through uncovering inlet port.

The exhaust and transfer ports are uncovered when the piston approaching towards T.D.C. Near the top of the stroke the compressed air/fuel above the piston is ignited by the spark plug and begins to burn.

Working of Two Stroke S.I. Engines

Downward Stroke

During downward stroke, the piston moves upward from T.D.C. to B.D.C.

The rapidly burning fuel expands and begins forcing the piston down, rotating the crankshaft thus doing useful work.

During this stroke the inlet port is covered by the piston and admitted charge is compressed in the crank case. As it continues travel downward it uncovers the exhaust port then transfer port. Exhaust gas begins to rush out of the cylinder. As soon as transfer port opens, the fresh air/fuel charge in the crankcase is forced into the cylinder and strikes to the deflector on piston crown rises the top of cylinder and pushes the remaining exhaust gases out.

The piston is at B.D.C. position now and cylinder is completely filled with fresh air fuel mixture although it is somewhat diluted with exhaust gases.

Application of Two Stroke S.I. Engines

Two stroke spark ignition engines find application in Mopeds, Scooters,

Lawn and garden equipment and Carts etc.

Working of Two Stroke Compression Ignition (C.I.) Engines

In C.I. engines only air is compressed inside the engine cylinder and fuel is separately injected by injector fitted on the top of the engine. There is no spark plug in the engine. The remaining working is same as described in Working of Two Stroke Spark Ignition (S.I.) Engines.

Application of Two Stroke C.I. Engines

Two stroke compression ignition engines find application in Mechanical

Compressors, Marine propulsion, and Generators etc.

S. No	2 Stroke Engine Cycle	4 Stroke Engine Cycle
1	It completes its cycle in one revolution of crank shaft.	It completes its cycle in two revolution of crank shaft.
2	Lighter flywheel is used as the power is produced after one revolution of crank shaft.	Heavier flywheel is used as the power is produced after two revolution of crank shaft.
3	Reciprocating piston itself acts as a valve.	There are two separate Mechanical valves i.e. Inlet and exhaust valve.
4	Moving parts are less as there is no cam, cam shaft and valve mechanism etc.	There are cam, cam shaft and valve mechanism etc.
5	It is compact and light in weight.	It is heavier in weight and requires more space for the same power produced.
6	Maintenance cost is less.	Maintenance cost is more.
7	It has low initial cost.	It has high initial cost.

S. No	2 Stroke Engine Cycle	4 Stroke Engine Cycle
8	It has simple design.	It has complicated design.
9	Crankcase is made air tight.	Crankcase is not made air tight.
10	More noise in 2 Stroke Engine Cycle.	Less noise in 4 Stroke Engine Cycle.
11	More Lubrication oil is consumed.	Less Lubrication oil is consumed.
12	Thermal efficiency of the 2 stroke engine is less.	Thermal efficiency of the 4 stroke engine is more.
13	Fuel consumption is less due to mixing of fresh charge with burnt gases.	Fuel consumption is more due full burning of fuel, due to fresh charge intake.
14	Mechanical efficiency of the 2 stroke engine is more.	Mechanical efficiency of the 2 stroke engine is less.
15	Examples of 2 stroke engine are: Marine propulsion, Mopeds, Scooters etc.	Examples of 4 stroke engine are: Buses, Trucks, Cars, Motor Cycles etc.

S. No	Petrol Engine	Diesel Engine
1	Petrol engine works on Otto cycle.	Diesel engine works on diesel cycle.
2	Air fuel mixture entered into the engine cylinder.	Only Air entered into the engine cylinder.
3	Spark plug is used to ignite the charge.	Fuel injector is used.
4	Compression ratio varies from 5:1 to 9:1	Compression ratio varies from 14:1 to 22:1
5	Due to low compression ration the temperature and pressure in petrol engine is low.	Due to high compression ration the temperature and pressure in diesel engine is high.
6	Easy Starting, due to low compression ratio.	Starting is difficult, due to high compression ratio.
7	Running cost of petrol engine is high.	Running cost of diesel engine is low.
8	Maintenance cost of petrol engine is low.	Maintenance cost of diesel engine is high.

S. No	Petrol Engine	Diesel Engine
9	Low vibration and noise.	High vibration and noise.
10	For same power and size, the petrol engine is smaller and lighter.	For same power and size, the diesel engine is larger and heavier.
11	Due to homogeneous combustion, they are high speed engine.	Due to heterogeneous combustion, they are low speed engine.
12	Pre-ignition possible	Pre-ignition not possible
13	Operating life of petrol engine is more.	Operating life of diesel engine is less.
14	Thermal Efficiency is low i.e. about 25%.	Thermal Efficiency is low i.e. about 40%.
15	It has low initial cost.	It has high initial cost.
16	Examples of petrol engine are: Cars, Motor Cycles, Scooters etc.	Examples of diesel engine are: Buses, Trucks Marine propulsion etc.

Question

Differentiate between 2 Stroke Engine Cycle and 4 Stroke Engine Cycle.

Differentiate between Petrol Engine and Diesel Engine.

THANK YOU