SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF AEROSPACE ENGINEERING

19AST101 – INTRODUCTION TO AEROSPACE ENGINEERING
I YEAR II SEM
UNIT-III GAS DYNAMICS
TOPIC: Operating principles of piston engines

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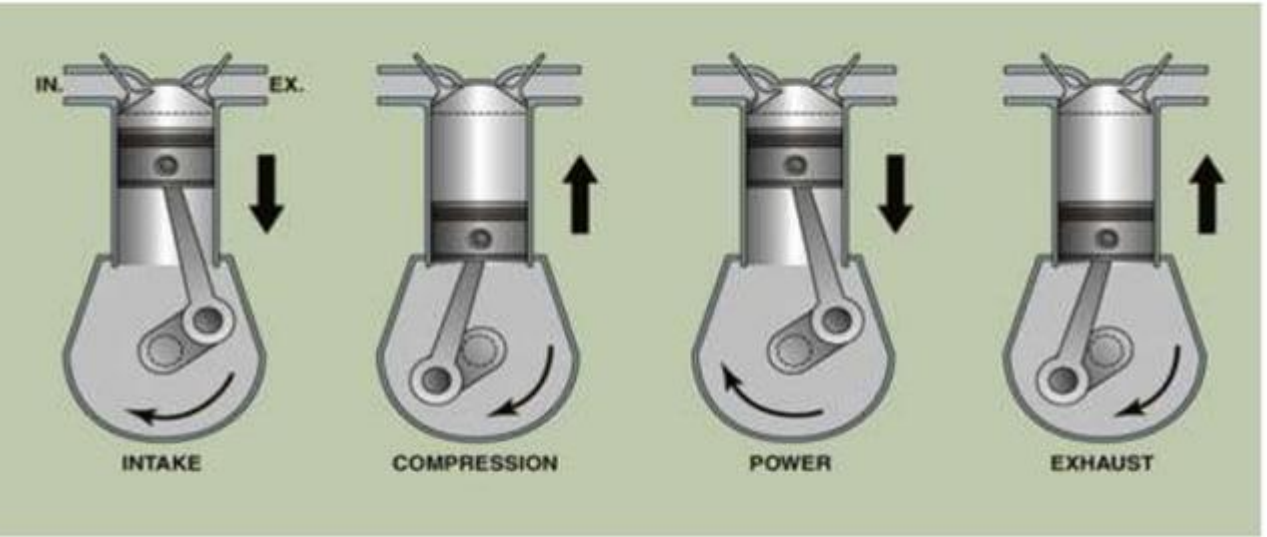
- Internal Combustion

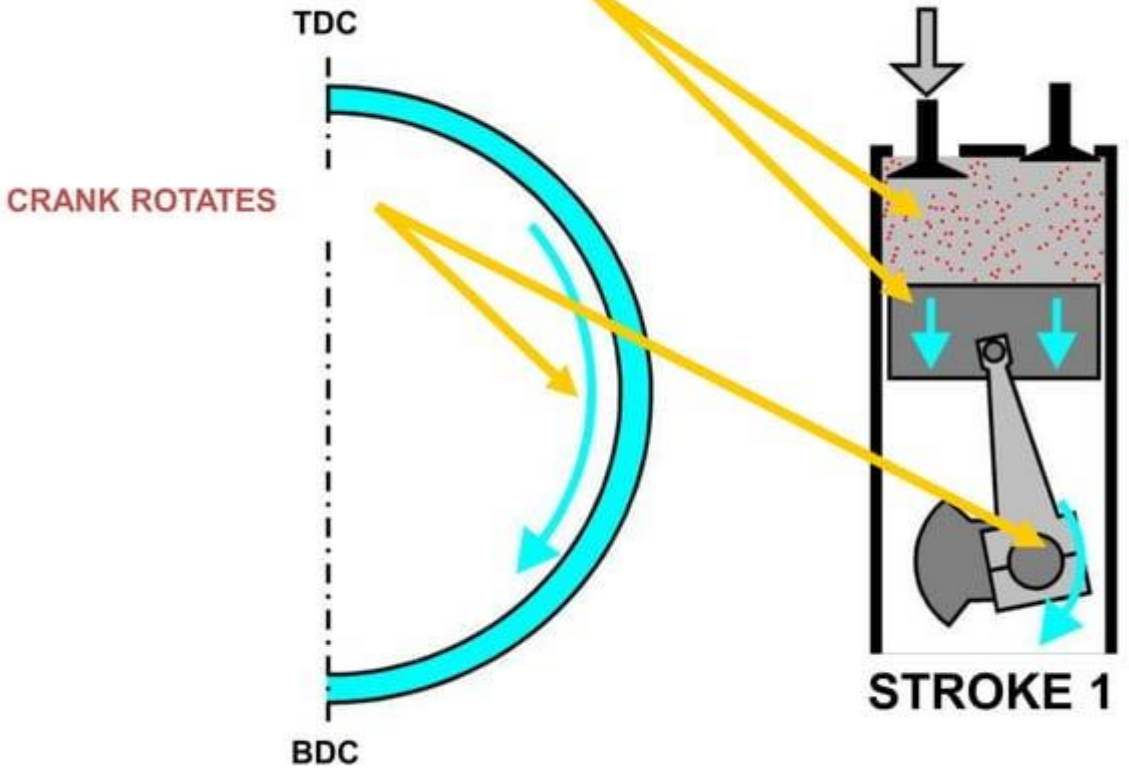
- Air and fuel gets sucked in.
- Compressed.
- Ignited

- Same as in a jet engine except it is all done in a cylinder


IN.
EX.
INTAKE
COMPRESSION
POWER
EXHAUST

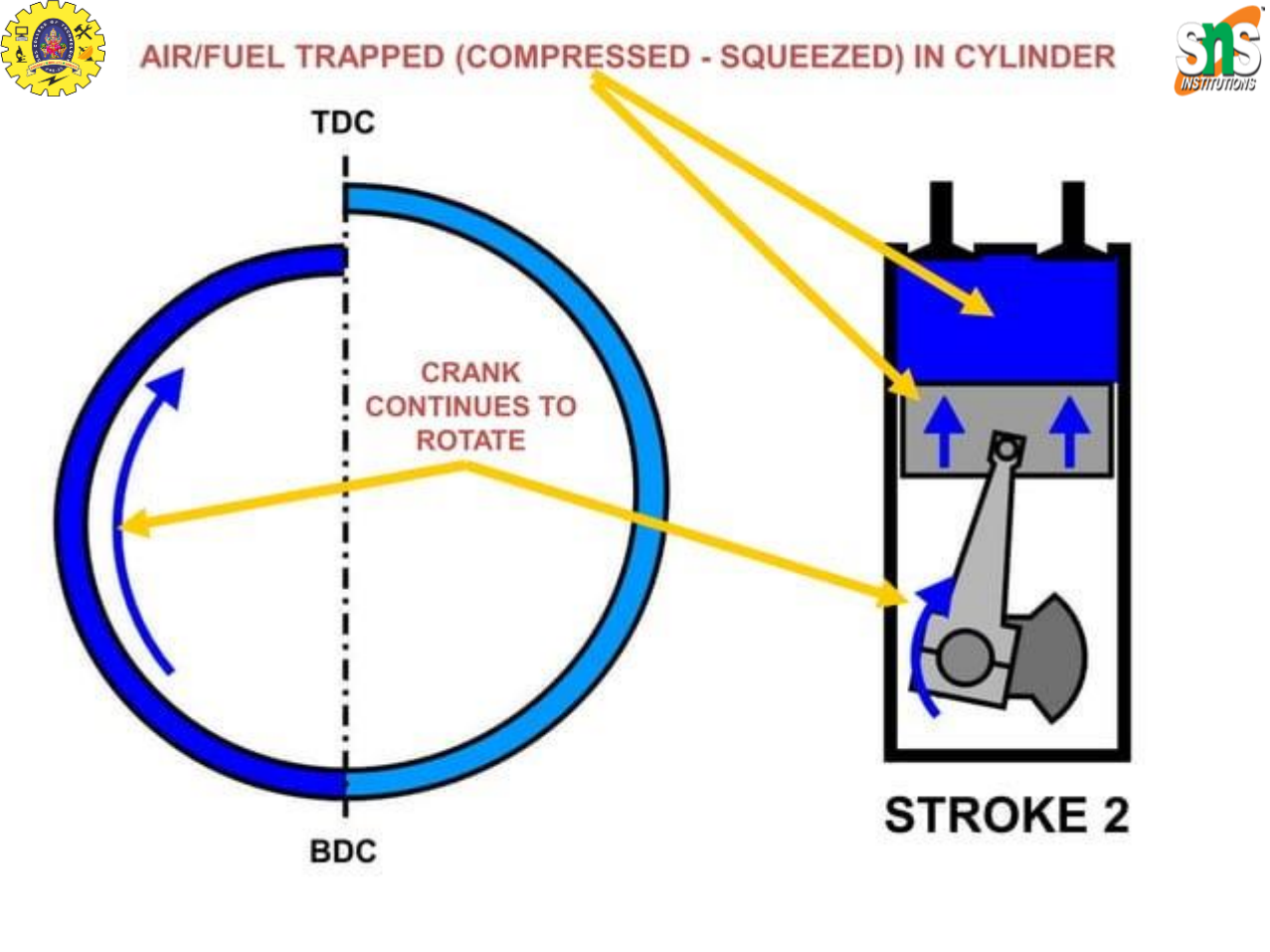
- As the name implies, the four-stroke cycle consists of four strokes, intake, compression, power, and exhaust. One complete four-stroke cycle requires two revolutions of the crankshaft. The four-stroke cycle is sometimes referred to as a constant volume cycle because the burning fuel inside the cylinder increases the gas pressure with almost no change in volume.
- Valve opening and closing timing is always determined by crankshaft position. The timing of each event is specified in terms of crankshaft travel, and is measured in degrees of rotation, during the stroke that the event occurs

AIR/FUEL DRAWN (INDUCED - SUCKED) INTO CYLINDER



Intake Stroke

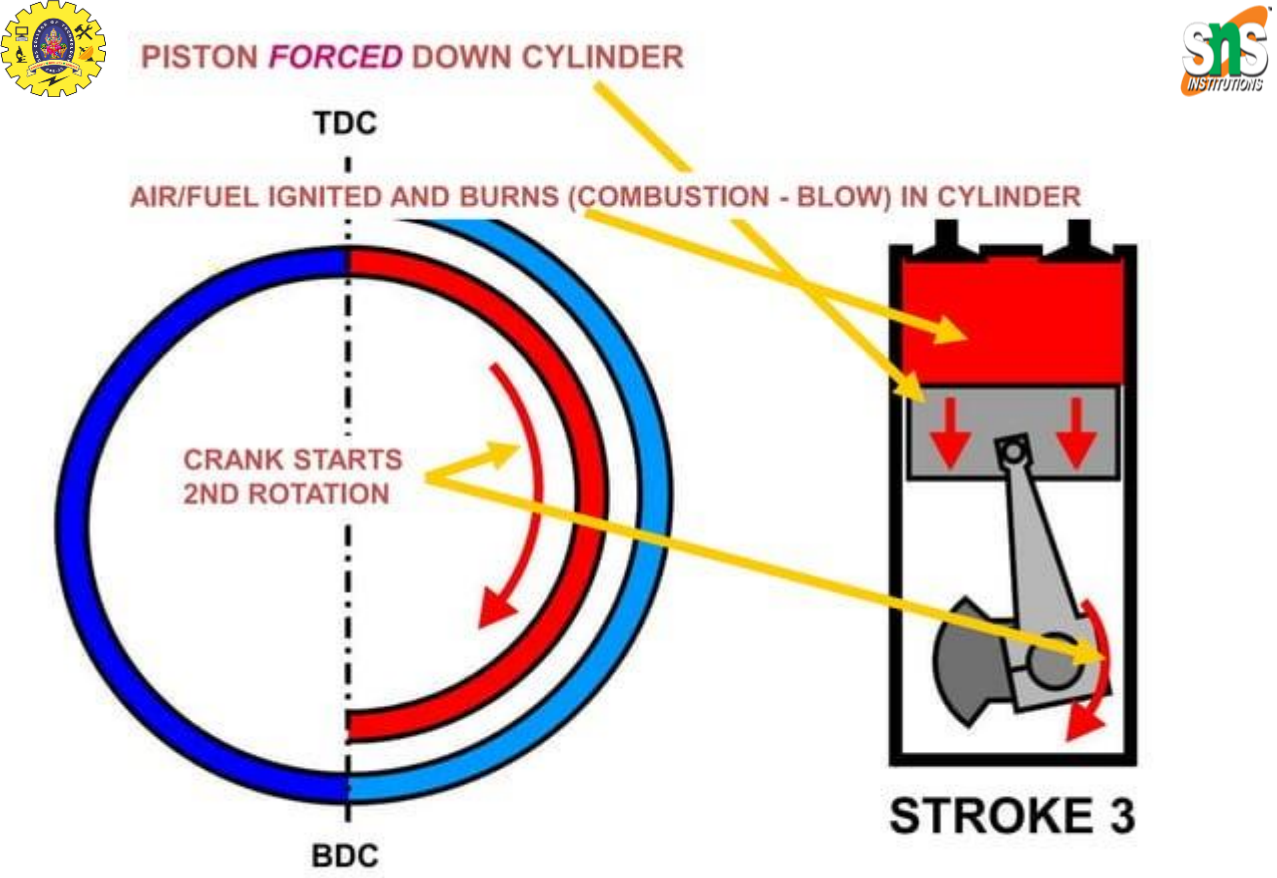
- The intake stroke begins with the piston at top dead centre and the intake valve open.
- During this stroke, crankshaft rotation pulls the piston downward thereby reducing the pressure within the cylinder.
- Lower pressure inside the cylinder allows air that is under atmospheric pressure to flow through the carburettor where it is mixed with the correct amount of fuel.
- The resulting fuel/air mixture then passes through an intake manifold pipe, down through an intake port, and past an intake valve into the cylinder.
- The quantity, or weight, of fuel and air that enters the cylinder is determined by the throttle position.


AIR/FUEL TRAPPED (COMPRESSED - SQUEEZED) IN CYLINDER
TDC
CRANK
CONTINUES TO
ROTATE
BDC
STROKE 2

Compression Stroke

- Once a piston reaches bottom dead centre on the intake stroke, the piston reverses direction and begins the compression stroke.
- Depending on the specific engine, the intake valve typically closes about 50 to 75 degrees past bottom dead centre on the compression stroke.
- Delaying the closing of the intake valve until the piston is past bottom dead centre allows the momentum of the incoming gases to charge the cylinder more completely.
- After the intake valve closes, the piston's continued upward travel compresses the fuel/air mixture.

- As the piston approaches top dead centre, an electric spark provided by two spark plugs installed in each cylinder head ignites the mixture.
- The exact time ignition occurs varies depending on the requirements of the specific engine, but is typically from 20 to 35 degrees before top dead centre.
- By igniting the mixture before the piston reaches top dead centre, complete combustion and maximum pressure are ensured when the piston begins its power stroke.

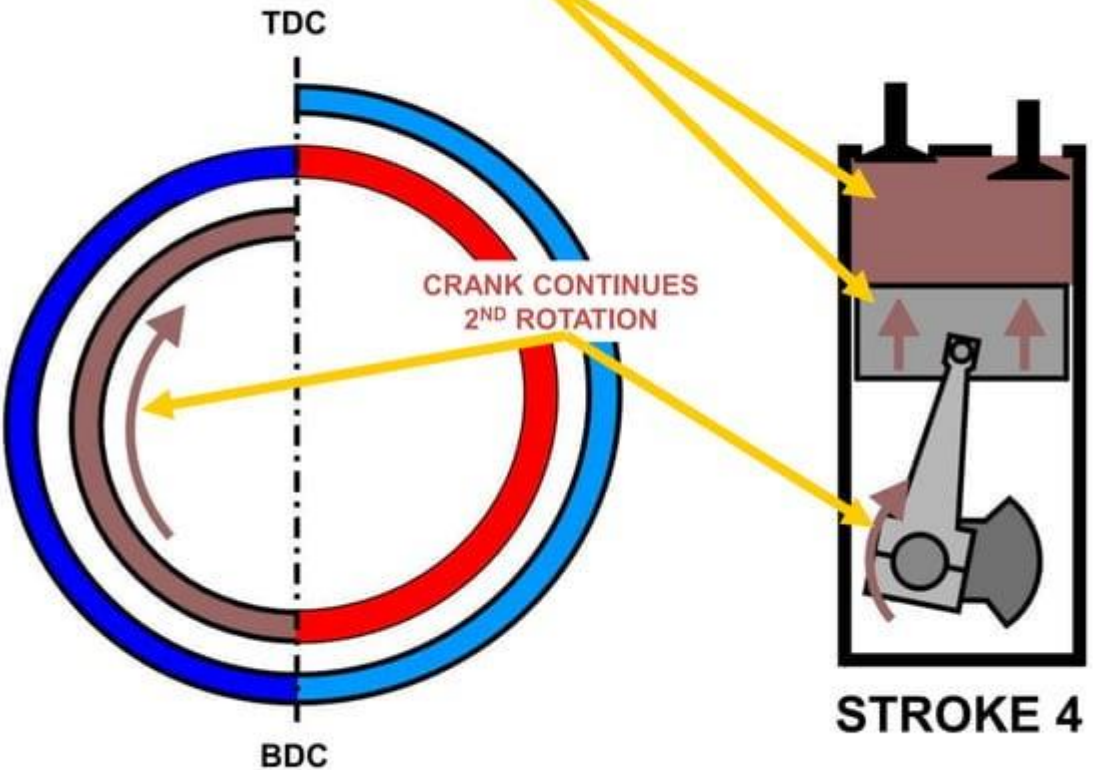

PISTON FORCED DOWN CYLINDER
TDC
AIR/FUEL IGNITED AND BURNS (COMBUSTION - BLOW) IN CYLINDER
CRANK STARTS
2ND ROTATION
BDC
STROKE 3

Power Stroke

- During the power stroke, the piston is pushed downward by the rapidly expanding gases within the cylinder.
- The temperature of these gases can exceed 3000 degrees Fahrenheit while pushing down on the piston with a force in excess of 15 tons.
- However, as the burning gases expand, they cool considerably, exiting the cylinder at a reasonable temperature.
- The linear motion produced by the back and forth movement of a piston is converted to rotary motion through the use of a connecting rod and crankshaft.
- The rotary motion is then used to drive a propeller or a gear case.

- To aid in scavenging the exhaust gases out of a cylinder, the exhaust valve opens well before bottom dead centre on the power stroke while there is still pressure in the cylinder.
- This positive pressure helps expel the exhaust gases out the exhaust port after the desired expansion of the hot gases has been obtained.

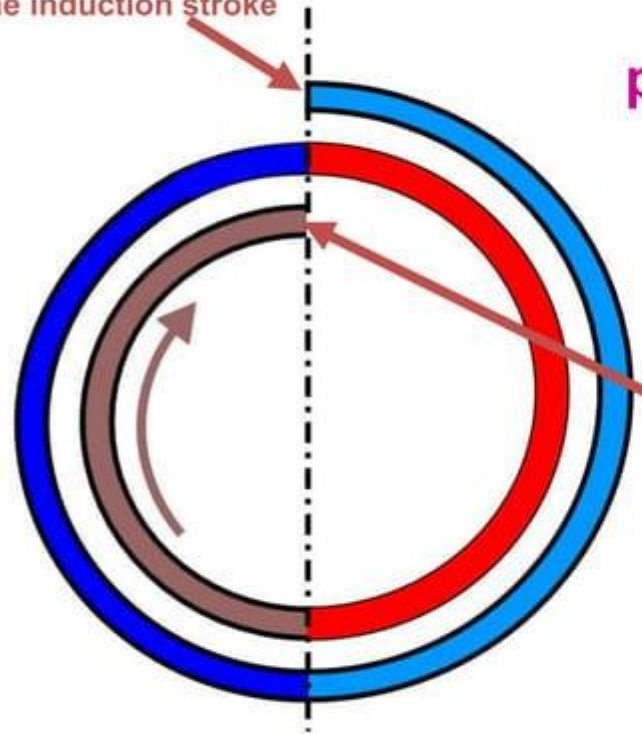
BURNT AIR/FUEL PUSHED OUT OF CYLINDER (EXHAUST – BLOW)



Exhaust Stroke

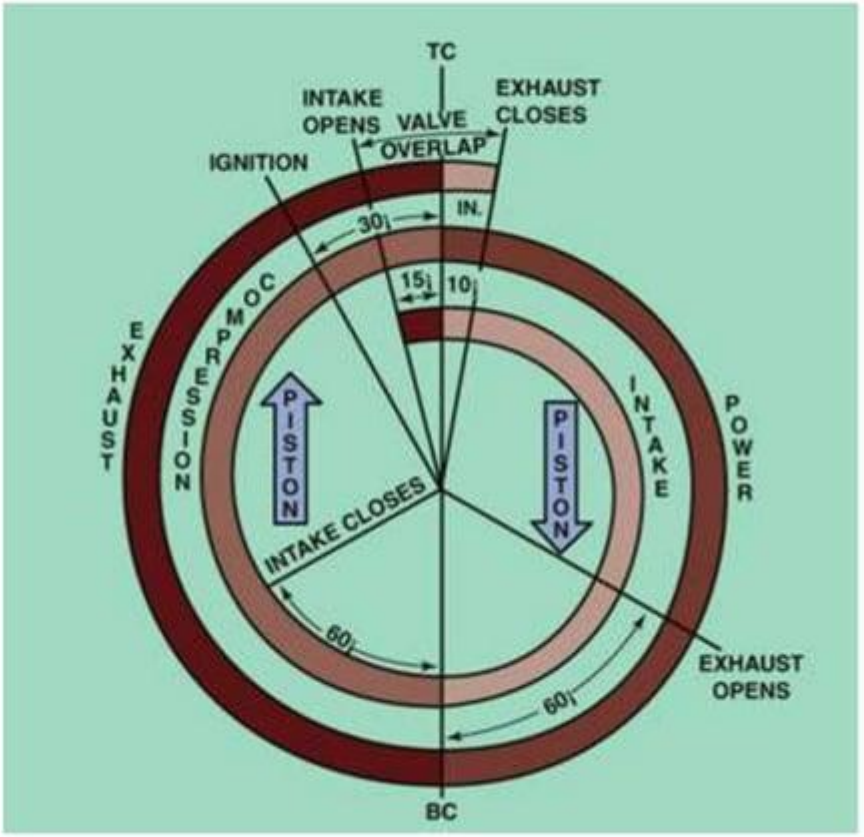
- As a piston travels through bottom dead centre on the power stroke and starts upward on an exhaust stroke, it begins to expel the burned exhaust gases out of the exhaust port.
- The speed at which exhaust gases leave a cylinder tends to cause the pressure within the cylinder to drop, leaving an area of low pressure.
- This low pressure speeds the flow of fuel and air into the cylinder as the intake valve begins to open.
- In order to maximize usage of the reduced cylinder pressure, the intake valve on a typical engine is timed to open anywhere from 8 to 55 degrees before top dead centre, on the exhaust stroke.

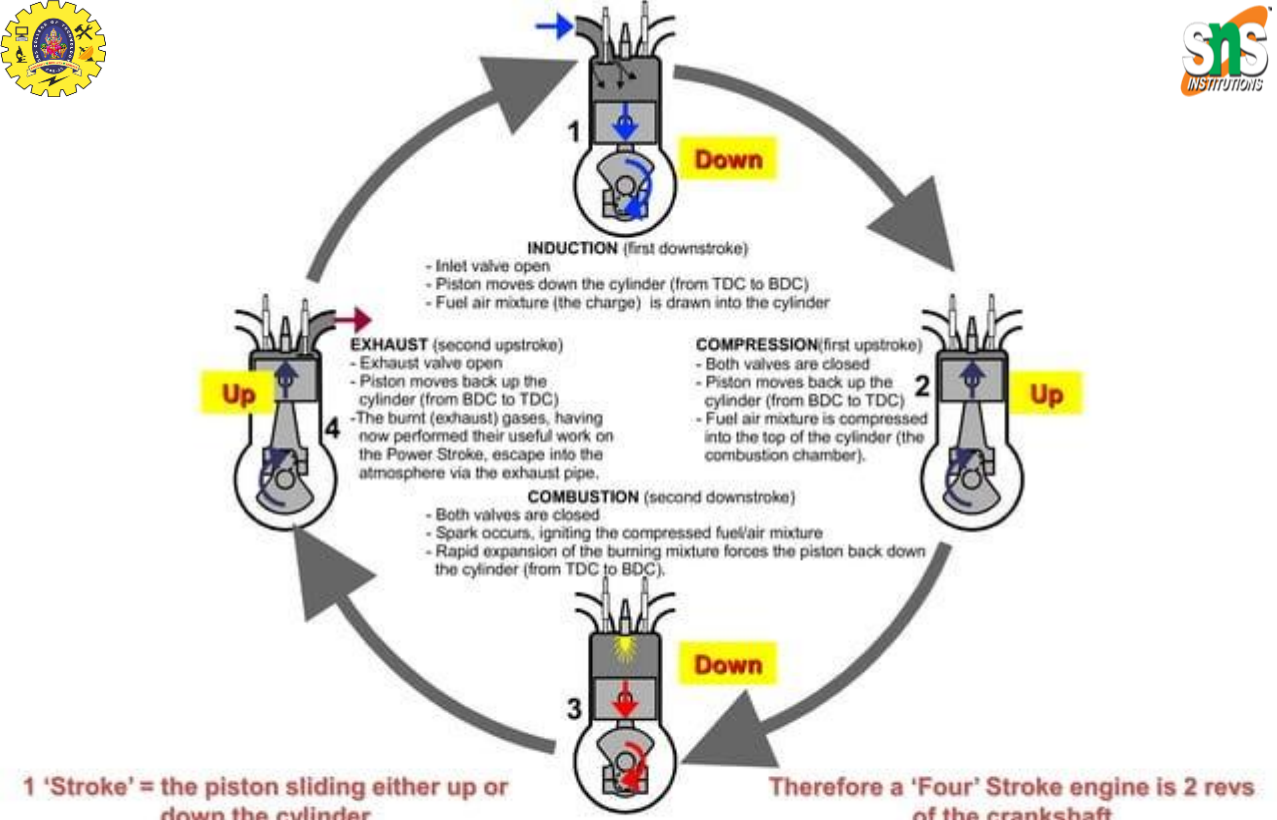
It is of course the start of the induction stroke



And the whole process starts again

When the end of the exhaust stroke is reached


TC
INTAKE VALVE
OPENS
EXHAUST
CLOSES
OVERLAP
IGNITION
30j
IN.
15j
10j
EXHAUST
COMPRESSION
PISTON
INTAKE CLOSES
PISTON
INTAKE
POWER
60j
60j
EXHAUST
OPENS
BC



1 'Stroke' = the piston sliding either up or down the cylinder

Therefore a 'Four' Stroke engine is 2 revs of the crankshaft

- This happens in every cylinder.
- No matter how many there are, the same cycle will occur.

All heat engines convert heat energy into mechanical energy by taking in a specific volume of air and heating it though the combustion of a fuel.

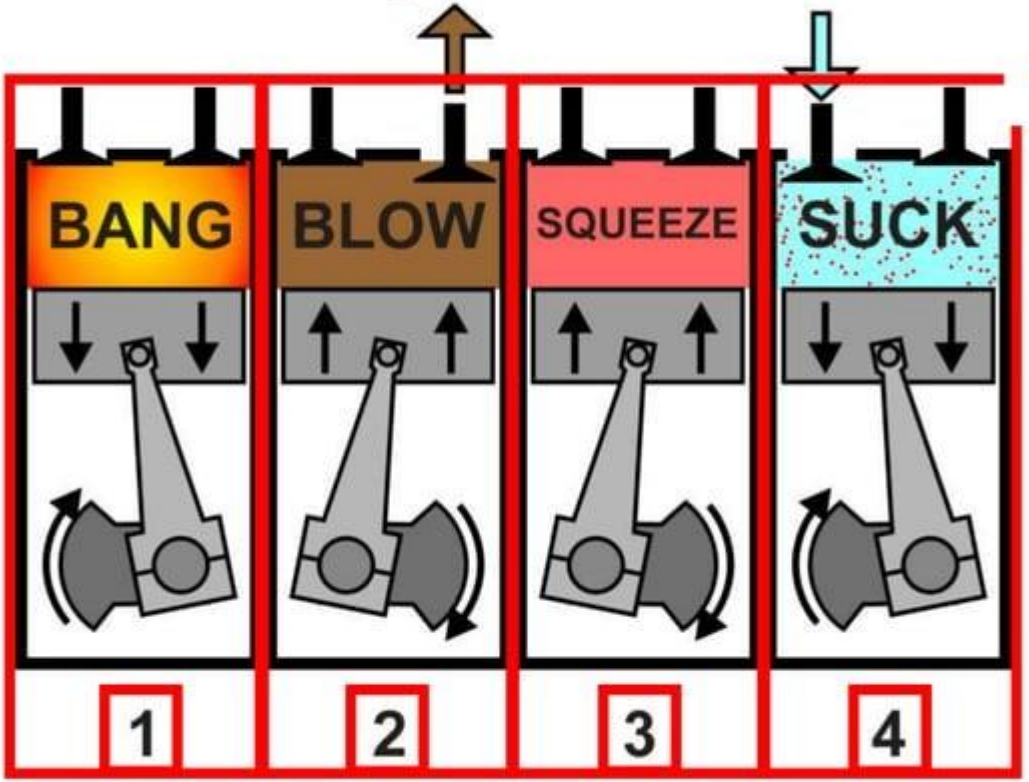
- The most common type of heat engine is the reciprocating engine.
- Reciprocating engines derive their name from the back and forth, or reciprocating movement of the pistons.
- It is this reciprocating motion that produces the mechanical energy needed to accomplish work.

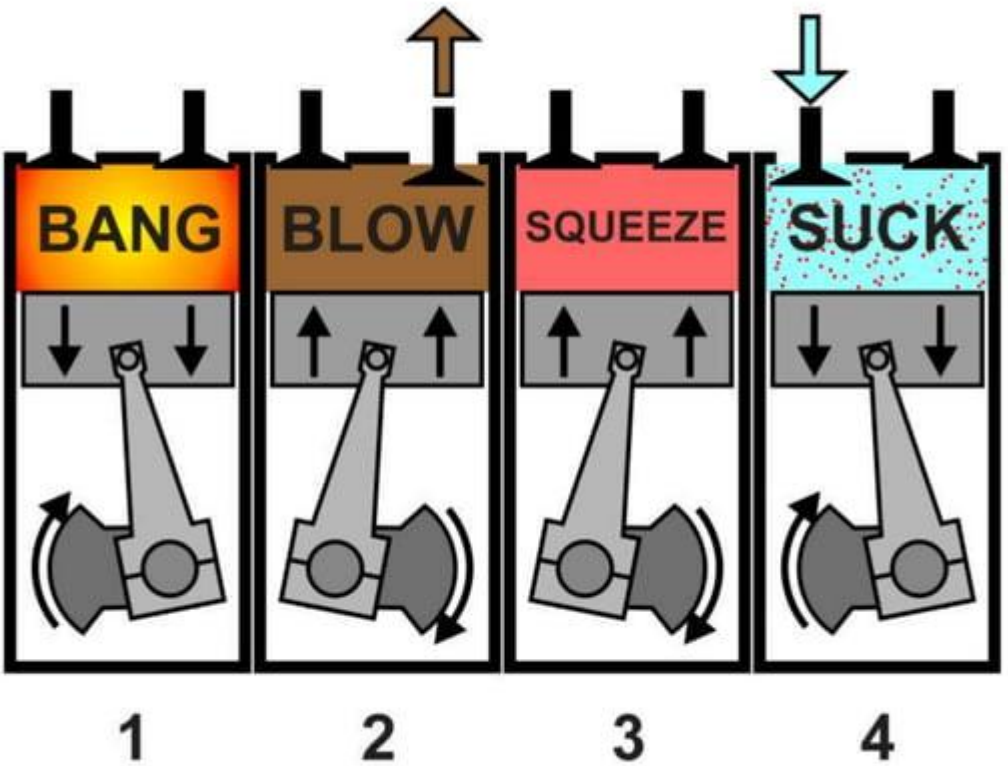
Many types of reciprocating engines have been designed for aircraft since the Wright brothers first used a four-cylinder in-line to make aviation history.

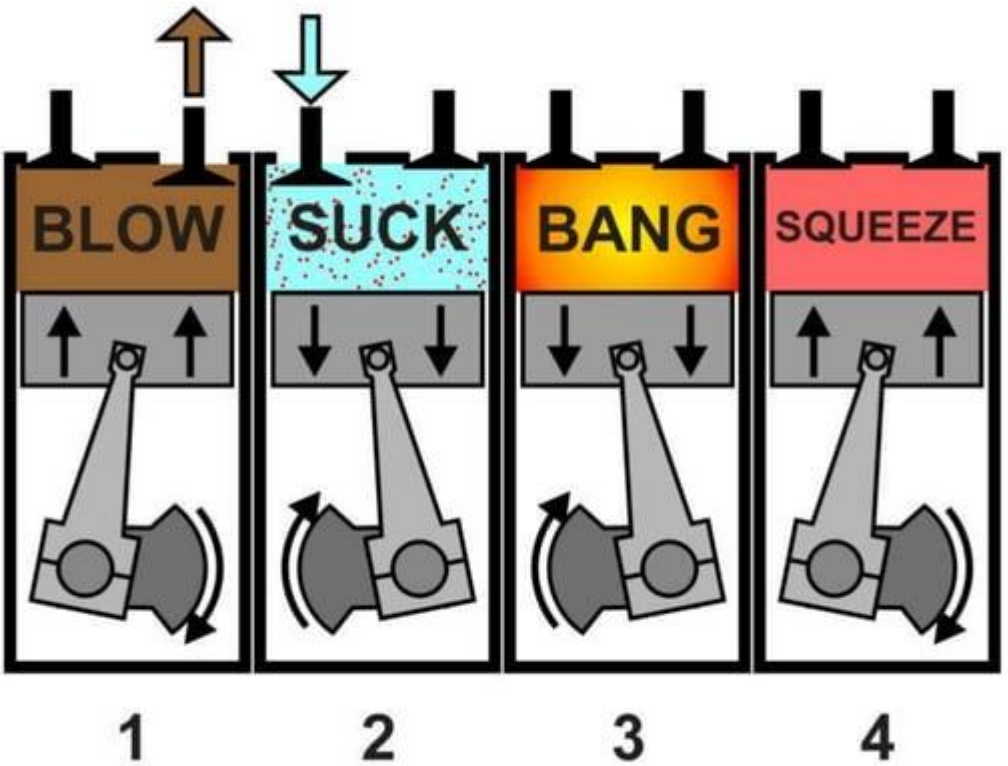
- The most common means of classifying reciprocating engines is by cylinder arrangement with respect to the crankshaft, and the method of cooling.

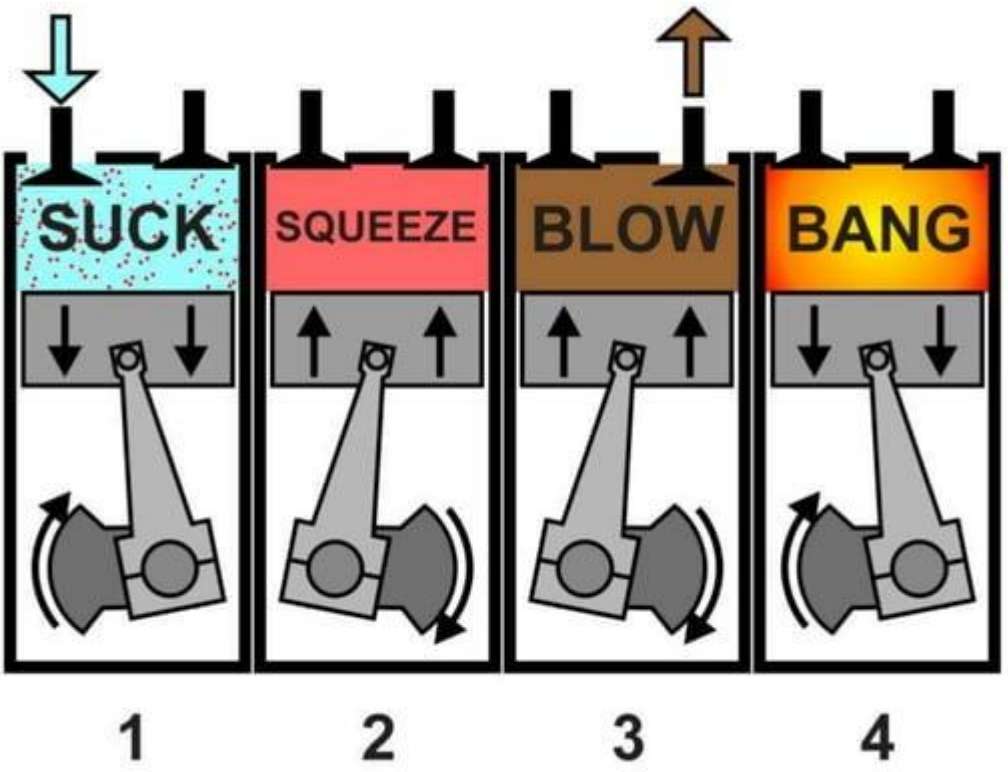
- Suppose there are 4 engines, the firing order for each is shown next.

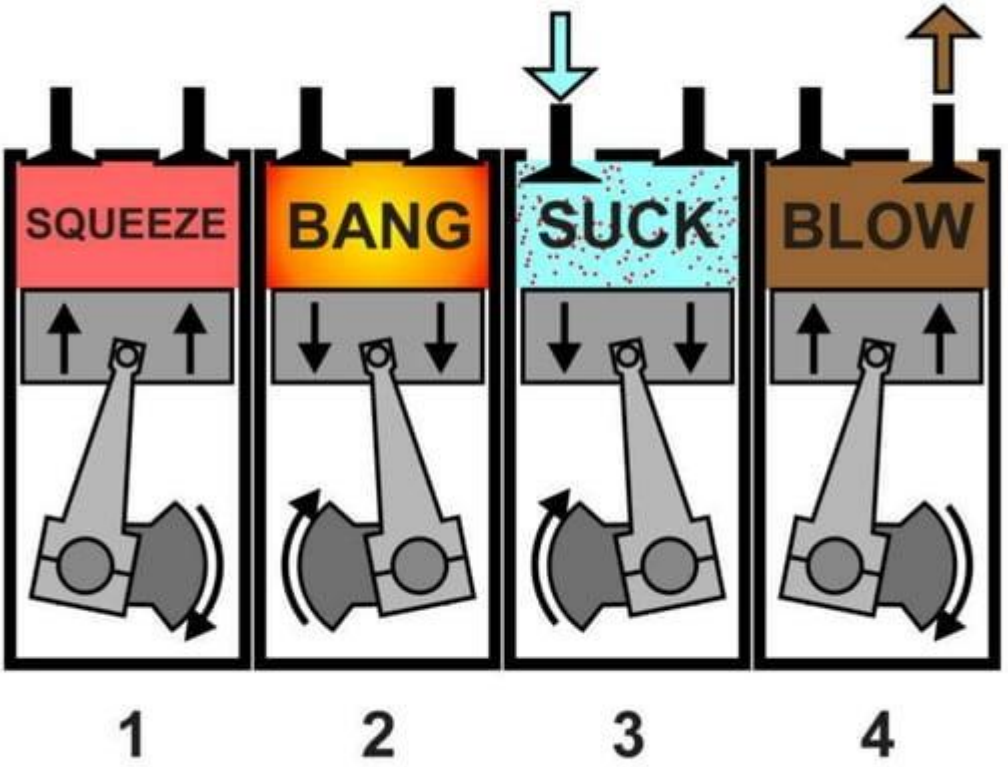
And the firing order is:- 1 – 3 – 4 - 2




BANG
BLOW
SQUEEZE
SUCK
1
2
3
4


BLOW
SUCK
BANG
SQUEEZE
1
2
3
4


SUCK
SQUEEZE
BLOW
BANG
1
2
3
4


SQUEEZE
BANG
SUCK
BLOW
1
2
3
4

THANK YOU