(*) Classification of Engineering material.

Basically engineering material can be classified into two categories:-

(a) metal.
(b) Non-metal.

(*) metal:- metal is one which has free electron. These material ~~can be classified~~ has their characteristics appearance and they are ~~paste~~ capable of changing shape upon machining and gives good finish at room temperature they are usually solid and to some extend they malleable and ductile. metals are good conductor of heat and electricity.

Ex:- Copper, Silver, gold etc.

(*) Non-metal:- The material in the right portion of the periodic table are called non-metal. These metal are usually dull in appearance and poor conductor of electricity (except graphite). They does'nt form alloys but combine chemically to form compound.

Q. Difference between metal and Non-metal?

Ans:-

S.No	Properties	Metal	Non-metal.
1.)	Structure	All metal are having crystaline structure.	All non-metal having amorphic and mesoprophic structure.
2.)	State	Generally metals are solid at normal temperature.	State varies material to material. Some are gase state and some in solid at ~~room~~ normal temperature.
3.)	Valence electron and conductivity	valence electron are free to move within metal which makes them good conductor of heat and electricity.	valence electron are tightly bound with nucleus which are not free to move. This makes them bad conductor of heat and electricity.
(iv)	Density	high density	low density.
(v)	Strength	high strength	low strength.
(vi)	hardness	generally hard	hardness is generally varies.
(vii)	malleability	malleable	Non-malleable.
(viii)	Ductility	Ductile	Non-ductile.
(ix)	Brittleness	generally non-brittle in nature.	Brittleness varies material to material.

Q. Selection of material for engineering purposes:-

- the following factor should be considered for the selection of material for engineering purposes:-

(i) material properties:- The ~~suitability~~ suitability and long term performance of a material depends on its properties like strength, stiffness, ductility durability, and sustainability.

(ii) mechanical properties:- Structural applications require material with excellent mechanical properties. Studying how material perform under mechanical loading is important for reliability and durability of products.

(iii) Sustainability:- In Structural engineering the selection of material is crucial for ~~ensure~~ ensuring the safety, durability and sustainability of building and infrastructure.

(iv) Design optimization:- ~~collabo~~ Collaborating between design and material engineering team can help create product that use material more efficiently.

(v) Fatigue:- A material should have moderate fatigue resistance and good creep resistance in hot parts.

(vi) ~~corrosion~~ corrosion resistance:- A material should be corrosion resistance, ~~specif~~ specially in the cold and where gases condense to form corrosive liquids.

(viii) • Recycling :- The ability of material to be recycled at the end of their life span is an important factor to be considered.

(viii) price of material :- The price of material is an important factor to be considered.

(ix) manufacturability :- The ability of a material to be manufactured is an important factor to be considered.

(x) effect on the environment :- The effect of material on the environment is an important factor to be considered.

V.I.U.

Difference between Ferrous and Non-ferrous metal?

Ferrous metal	Non Ferrous metal
① It contains iron.	① It does not contains iron.
② It is magnetic.	② It is non-magnetic.
③ It is durable and Strong.	③ It is lighter and malleable
④ It is relatively less expensive.	④ It is relatively more expensive.
⑤ It is more likely to rust.	⑤ It has Corrosion high resistance.
(vi) weight of ferrous metal is more.	(vi) weight of non ferrous metal is less
(vii) eg: Cast iron, mild steel, high carbon steel, stainless steel	eg: Aluminium, copper, zinc, Brass etc.

Date 5/12/24

Physical properties of metal :-

• Following are the physical properties of metal :-

(i) metals can be hammered into thin sheets. It means they posses the property of malleability.

(ii) metals are ductile. They can drawn into thin wires.

(iii) metals are lustrous which means they have shiny appearance.

(iv) metals have high tensile strength. It means they can hold heavy weights.

(v) metals are sonorous. It means when we strike them they make a ringing sound.

(vi) metals are hard. It means can not be cut easily.

mechanical properties of metal :-

mechanical properties of metal are characteristic that describe a metal property ability to resist mechanical force and loads.

Some mechanical properties of metal are :-

(i) Hardness :- a metal ability to resist permanent deformation from an external force.

(ii) Ductility :- A metals ability to change the shape without breaking.

(iii) Toughness :- A combination of strength and ~~ductility~~ that measures how much a metal can deform and absorb energy before fracturing.

(iv) Strength:- A metals ability to withstand withstand external forces without bending and breaking.

(v) malleability:- It is the ability of a material that when a metal can be hammered, it is converted into thin sheets.

(vi) Elasticity:- It is the ability of a material to regained its shape and size after the removal of load. (force)

(vii) plasticity:- It is the ability of a material that it can not regain its shape and size after the removal of load and force.

(viii) Brittleness, Creep, Brittleness.

(ix) Creep.

(x) Stiffness.

Cast Iron:- It is a metal alloy that is mainly made of iron and carbon, with a carbon content of atleast two percent.

Cast Iron is primarily made of iron (Fe), Carbon(C) and silicon (Si), but may also content Contains traces of sulphur (S), magenese (Mn) and phosphorus (P), cast iron is known for its relatively low melting temperature, high density and stiffness.

Date 6/12/24

Types of Cast Iron:-

(i) grey cast iron:- Impure iron carbon system, if percentage of carbon in iron increases beyond 6.67 percent, a large amount of carbon will appear in three form (graphite flakes) this is called grey cast iron and it is used to make machine beds (two absorb small vibration of the machine, piston rings.

(ii) white Cast Iron:- white cast iron is a type of carbon iron alloy that contains iron carbon content greater than two percent in the form cement or iron carbide (Fe_3C). The name white cast is derived from its white surface which is caused by carbide impurities that allow cracks throughout the metal. when fractured it exhibits a silver like (white) fracture.
white cast iron has high compressive strength and wear resistance. white cast iron is usually considered too brittle to be used for many structural components due to its hardness and abrasion resistance property and low cost.

(iii) Malleable Cast Iron:- It is produced from white cast iron from heating it and holding it at 15 hundred to 1750 °F fahanneit (816 to 954) °c and then slowly cooling through a temperature range of (704 to 760) °c. Malleable cast iron may be produce with three

micro structure ; ferritic ; paralytic ; (martensitic) and ferritic pearlytic. Malleable cast iron have high strength and higer wear resistance.

Spheriodal ~~Cast~~ or Nodular Cast Iron :- These are ductile in nature. These cast iron are produced ~~by~~ Iron Carbon alloy with carbon content is same as in grey cast iron in the presence of magnesium or cerium (Ce) g Carbon comes out in the form of spheroids The Spheroids are ductile in nature.

Date 23/1/25

Heat treatment:- Heat treatment is a group of industrial, thermal, and metal working processes used to alter the physical and some times the chemical properties of a material. The most common application is metallurgical. Heat treatment are also used in the manufacture of many other materials such as glass. It involves the use of heating or chilling, normally to extreme temperature, to achieve the desired result such as hardening and softening of a material. Heat treatment techniques includes annealing, carburising, case hardening, normalising, tempering and quenching

Types

Normalising :- Normalising is heat treatment courses that is used to make a metal more ductile and tough after it has been subjected to thermal or mechanical hardening processes. Normalising involves heating a metal material to an elevated temperature and then allowing it to cool back to room temperature by exposing it to room temperature air, after it is used. This heating and cool slow cooling alter the micro structure of the metal which in turn reduces its hardness and increases its ductility. The cooling medium in this process is air.

Annealing :- It is a heat treatment process that changes the physical and some times the chemical properties of a material to increase ductility and reduces the hardness to make it more workable

Types of annealing :-

(i) Full annealing :- Full annealing is used on ferrous metal like iron and steel. The metal is heated above its upper critical point and held at that temperature and cooled slowly. This process improves ductility and refines the grand structure

Recrystallisation

(ii) Stress relief annealing :- This process replaces strained grands with a new grand structure. It improves workability by reducing hardness at enhancing ductility.

(iii) Stress relief annealing :- This process is used to reduce the stress within material after they are made. The material is heated and then cooled slowly.

(iv) Diffusion annealing :- This process involves heating steel above its upper critical temperature show that iron and carbide can diffuse with each other

(v) Iso thermal annealing :- This process uses a complex thermal cycle to achieve granularity controlled results. The steel grands changes into its pearlite phase at its lower critical temperature.

(vi) spherodizing annealing :- This process is used for high carbon steel to create a micro-structure of spherical cementite particle with in a ferite matrix.

(vii) Beta annealing :- This process produces a beta phase annealing through

Carburising :- It is a heat treatment process in which iron or steel absorbs carbon while the metal is heated in the presence of carbon carrying material, such as charcoal, or carbon-monoxide the intent is to make the metal harder and more wear-resistance. Longer carburising times and higher temperature (850 to 950°c Typically increases the depth of carbon diffusion when the iron or steel is pulled rapidly by quenching, the higher carbon content on the outer surface becomes hard due to the transformation from austenite to martensite; while the core remains soft and tough as a ferritic for pearlite micro structure.

It is applied to low carbon work piece; workpiece are in contact with a high carbon gas, (liquid, solid), it produces a hard work piece surfaces, work piece pore, largely written their toughness and ductility.

Aim of heat treatment :- The aim of heat treatment is to change the physical, mechanical, magnetic or electrical properties of a metal or alloy. Heat treatment is a key process in modern manufacturing and metallurgy. It involves heating, soacking and cooling of a metal at specific rates and temperature to achieve a desired micro structure

Case Hardening :- case hardening or surface hardening is a heat treatment process of hardening the surface of a metal while allowing the core material remains soft, thus forming a thin layer of harder metal at the surface. Case hardening involves packing the low carbon iron with a substance high in carbon, then heating this pack to encourage carbon migration into the surface of the iron. This forms a thin surface layer of a higher carbon steel, with the carbon content gradually decreasing & deeper from the surface

Nitriding :- It is heat treatment process that strengthen the surface of a metal by Introducing nitrogen into it. It is used on low alloy steel but, can also be used on titanium, aluminium, and molybdenum.

In this process, nitrogen is diffused into the metals surface. The nitrogen reacts with alloy elements like aluminium, chromium, molybdenum to form hard nitrides. This creates a case hardened surface that is more resistance to wear, fatigue, and scuffing, it improves the surface hardness, fatigue and wear resistance of a work piece, It also increase fatigue strength

Types of Nitriding :-

(I) Gas nitriding :- It uses ammonia or ammonia hydrogen to introduce nitrogen into the metal

(II) plasma nitriding :- It uses a low pressure plasma of Ionised gases to introduce nitrogen into the metal.

(III) Salt Bath nitriding :- It involves immersing the metal into a salt bath containing cyanide salt at a temperature of about 570°C

(IV) Cynading :- It is heat treatment process strengthens and hardens the surface of a metal part. It is a chemical-thermal treatment that uses cynaide salt.

In this process the metal is heated in a bath of molten cynaide salt. The cynaide breaks down, releasing carbon and nitrogen. The carbon and nitrogen seep into the metal surface. The metal is quenched in water or oil to cool it and complete the hardening process.

Cynading is mainly used on low carbon steels it is typically used on small parts such as bolts, nut, screw, and small gears.

It increases the metal hardness wear resistance and bending endurance. The process is highly toxic and harmful to health and the environment. It is rarely used in mass production

Benefits of heat treatment :-

- more durable product.
- Steel become tougher, stronger.
- Easier to weld.
- Become more flexible.
- increase its wear resistance.

(i) Increase in overall life time of the part.
(ii) Improve hardness.
(iii) ~~Become more flexible.~~ Affect heat and
(iv) electrical conductivity.
(v) Develops desireable chemical properties.

Heat treatment process step :-

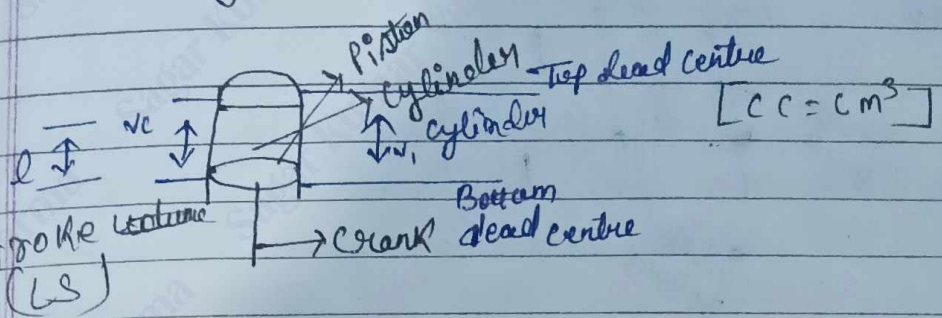
In simple terms, heat treatment is the process of heating the metal holding it at that temperature, and then cooling it back. During the process. The metal part will undergo change in its mechanical properties.

- This is because the high temperature alter the microstructure of the metal and microstructure plays an important role in the mechanical properties.

Date 9/12/24

L:5 Engine Terminology

petrol engine → γ_k → 6-12
Diesel engine → γ_k → 12-22



[cc = cm^3]

Compression ratio = $\frac{V_1}{V_2}$ ↑ $\frac{V_1}{V_c}$

Heat is a form of energy which form due to Kinetic energy of molecules.

Bore = Inside diameter of engine cylinder

(*) Internal Combustion Engine :- (IC Engine)

In this type of Engine combustion of fuel takes place inside the engine cylinder, releasing the heat.

eg :- gas engine, petrol engine, Diesel engine.

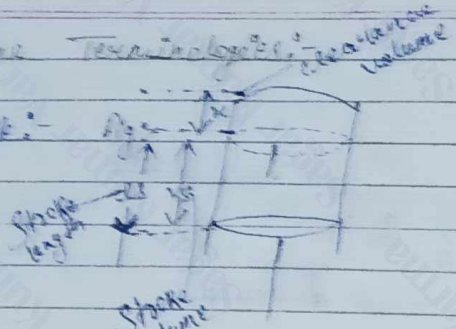
(*) External Combustion engine :- [EC Engine]

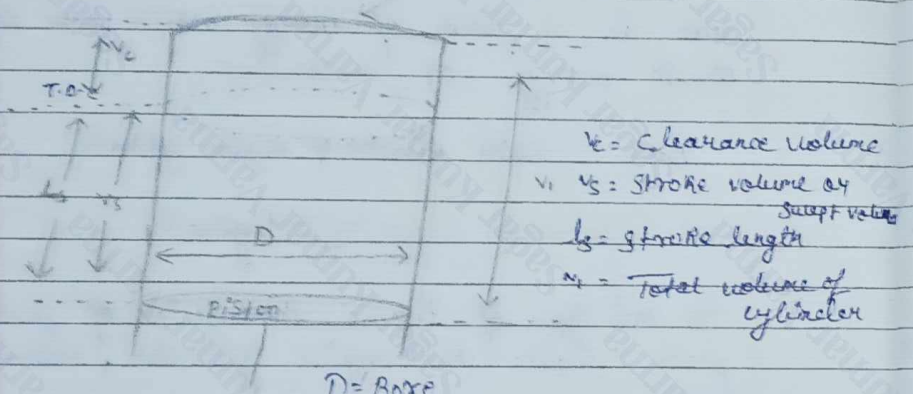
In this type of Engine Combustion of fuel takes place outside the engine cylinder, releasing the heat

Eg :- Steam turbine engine, Closed cycle gas turbine.

Engine Terminologies:-

i) Stroke:-





V_c = Clearance volume
V_s = Stroke volume or Swept volume
L_s = Stroke length
V_1 = Total volume of cylinder

D = Bore

It is defined as the distance travelled by the piston from top dead centre (T.D.C) to Bottom dead Centre (B.D.C).

Stroke = 2 × r of Crank

* Bore:- It is defined as the inside diameter of cylinder.

- Piston speed:- It is defined as the distance travelled by the piston in one minute

Piston speed = $2 \times L \times N$ where L_s = length of stroke

$2 \times L_s \times N$

N = engine speed (in rpm)

piston speed is also called as an average speed of piston.

* Mean effective pressure:- (M.E.P)

It is defined as the average pressure needed to act on the piston as it moves one displacement in order to produce work (W). This pressure is required in order to calculate mean effective pressure. It is theoritical parameter that is utilised in the process of measuring the effectiveness of an internal combustion engine.

* Compression Ratio:- It is defined as the ratio of the volume, when piston is at (B.D.C) to the volume when piston is at T.D.C (Top dead centre).

Compression ratio = $\frac{\text{volume contained in the cylinder before compression (when piston is at B.D.C)}}{\text{volume contained in the cylinder after compression (when piston is at T.D.C)}}$

Indicated power:- Indicated power is defined as the power actually developed inside the engine cylinder. Indicated power and indicated Power are the same it is denoted by I.P and its S.I unit is watt (W).

Indicated power is given as

$$I.P = \frac{P_m L A N K}{60}$$

where, P_m = Actual mean effective pressure
L = Length of Stroke
A = Area of piston
N = Speed of the engine (rpm)
K = Number of Cylinder
$N = N$ for two Stroke engine
$N = \frac{N}{2}$ for four Stroke engine.

Brake power :- Brake power and brake horse power are same, the only difference is the unit of measurement. Brake power is measure its watt (w) where as brake horse power is measured in horse power (hp) brake power is defined as the net output power available at the Crank Shaft theoritically the indicated power produced due to combination of fuel fed in the engine cylinder should be given to Crank Shaft used for running the vickle but practically same part of indicated power produced is lost during its transmission from engine cylinder to Crank Shaft, Hence for brake power is always less than indicated power

i.e

$$B.P < I.P$$

Brake power is given by

$$B.P = \frac{2\pi NT}{60}$$

where,
N = Speed of the engine (rpm)
T = Torque (N-m)

Viva-I # Frictional Powers- Frictional power and fictional power are the same and the only difference in the unit of measurement. Frictional power is measured in watt (w) where as frictional horse power is measured in (hp).
Friction Power is define as the portion of indicated power which is lost

(i) In over coming frictional effect within the engine such as friction between rings and cylinder walls and friction between cylinder and piston walls etc.

(ii) In operating fuel pump, lubrication pump, valves etc.

Frictional power is also defined as the different between indicated power and brake ~~parts~~ power Mathematically $[F.P = I.P - B.P]$

Mechanical efficiency :- mechanical efficiency is defined as the ratio of brake power indicated power.

$$\eta_{mech} = \frac{B.P}{I.P}$$

(*) Indicated Thermal efficiency:- Thermal efficiency based on indicated power is called as indicated thermal efficiency. Indicated thermal efficiency is defined as the ratio of heat equivalent to one Kilowatt hour to heat in fuel per indicates power hour.

Mathematically

$$\eta ith = \frac{\text{Heat equivalent to one Kw hour}}{\text{Heat in fuel per I.P hour}}$$

$$\eta ith = \frac{3600}{\left(\frac{mf \times C.V}{IP}\right)} = \frac{I.P \times 3600}{mf}$$

where,

mf = mass of fuel consume (Kg/hr)
C_v = Clorific value of fuel (KJ/Kg)
I.P = Indicated Power (Kw)

(*) Brake Thermal efficiency:- Thermal efficiency based on brake power is called as Brake thermal efficiency. Brake thermal efficiency is defined as the ratio of heat equivalent to one Kilowatt hour.

$$\eta bth = \frac{\text{Heat equivalent to one Kw hour}}{\text{heat}}$$

where,

mf = mass of fuel consume (Kg/hr)
C_v = Clorific value of fuel (KJ/Kg)
I.P = Indicated power

(*) Classification of an internal combustion engine:

I.C engine may be classified as:-

1) According to cycle of operation.
   (a) Two stroke cycle engine.
   (b) Four stroke cycle engine.
2) According to cycle combustion.
   (a) otto cycle (b) Diesel cycle.
   (c) Dual cycle.
3) According to arrangement of cylinder.
   (a) Horizontal engine (b) vertical engine.
   (c) V-Type engine (d) Radial engine.
4) According to type of fuel used.
   (a) oil engine (b) petrol engine (c) gas engine
   (d) Kerosine engine (e) diesel engine.
5) According to speed (rpm) of engine.
   (a) low speed (b) medium speed (c) high speed.
6) According to method of ignition.
   (a) Spark ignition S.I engine (b) Compression ignition C.I engine.

7.) According to method of cooling the engine cylinder?

(a) air cooled engine (b) water cooled engine

8.) According to no of cylinder.

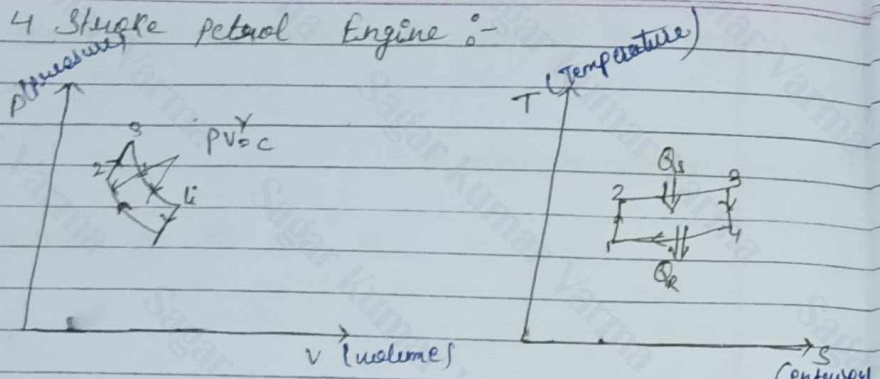
(a) single cylinder engine (b) multi cylinder engine.

Comparison between four stroke and two stroke engine.

Four stroke cycle engine	Two stroke cycle engine
1.) Cycle is completed in four stroke of the piston or in two revolution of the crank shaft.	1.) Cycle is completed in two stroke of the piston or in one revolution of the crank shaft.

Date 14/1/25

(V) 4 Stroke petrol Engine :-



Process :- 1-2 = Reversible Adiabatic or isentropic compression process.

Process 2-3 :- Constant volume Heat addition process

Process 3-4 :- Reversible Adiabatic or isentropic expansion process.

4-1 :- Constant volume Heat rejection Process.

Comparison between Spark Ignition (SI) and Compression ignition engine :-

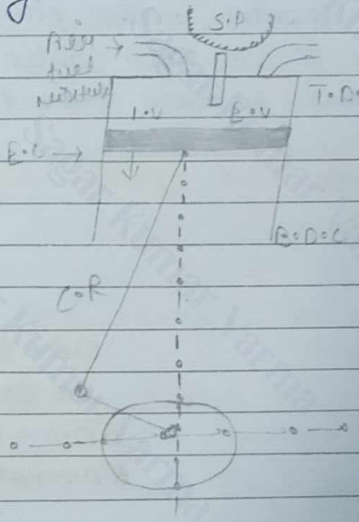
- Four stroke petrol engine work on otto cycle.
- In these engines the mixture of air and fuel is drawn in the engine cylinder.
- As ignition start after initiating spark by spark plug, petrol engines are also called as a spark ignition (S.I.) engines.
- Spark plug is also turned as operating plug.
- The cycle is completed in two revolutions of crank, during which four strokes are performed.
- Each stroke consist of 180° of crank shaft rotation.

The different stroke are briefly explained in the following manner.

1) Suction Stroke :

(i) Here piston moves from TDC to BDC, the inlet valves opens and proportionate mixture of air and fuel is called as charge.

(ii) The stroke is represented by line 5-1 in fig 1.17 The exhaust valve remain closed during this stroke.



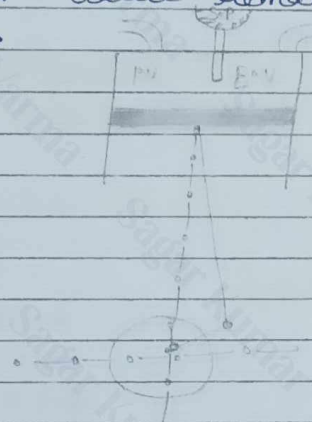
I.V = Inlet valve
E.V = Exhaust valve
E.C = Engine Cylinder
S.P = Spark plug

(a) Suction Stroke

Compression ratio:-

i) Here, piston from BDC to TDC and compresses the air fuel mixture drawen in the engine cylinder during Sanction stroke. The compression stroke is represented by 1-2. The pressure and hence temperature of mixture increases in the cylinder.

ii) just before the end of compression stroke, the operating plug (i.e spark plug) initiates a spark. The spark ignites the mixture and its combustion takes place at constant volume line (2-3). Both inlet valve and exhaust valve remain closed during this Stroke.



C.R = Connecting Rod
C = Crank
T.D.C = Top dead Center
B.D.C = Bottom dead Center

Compression Ratio.

Expansion or working Stroke:-

i) Due to combustion of air-fuel mixture inside the cylinder the hot gases are produced. These hot gases expand in volume due to their high pressure and temperature. This gas force drives the piston from TDC to B.D.C. This work is obtained during this Stroke. Therefore this stroke is known as working stroke or power Stroke. The expansion of gases is represented to 3-4.

ii) The flywheel mounted on the engine shaft stores the excess energy produced during this stoke ~~is drawn~~ at and supplies it during the idle strokes namely Suction, Compression ratio and exhaust.

iii) Both the valves remain closed during this Stroke. But, when the piston just reaches BDC the exhaust valve gets opened.

Exhaust Stroke:-

i) After obtaining the work from the hot gases during expansion stroke, these gases become useless and now they are referred as exhaust gases. During exhaust stroke, the piston moves from BDC to TDC. This upward movement of piston exert a force on these exhaust gases and thus, they are expelled out to ~~atmosphere~~, through exhaust valve.

The removal of exhaust gases from the engine cylinder is called as scavenging. This stroke is represented by line 1-5.

(a) working stroke

(b) exhaust stroke

Actual indicator diagram of four stroke petrol engine :-

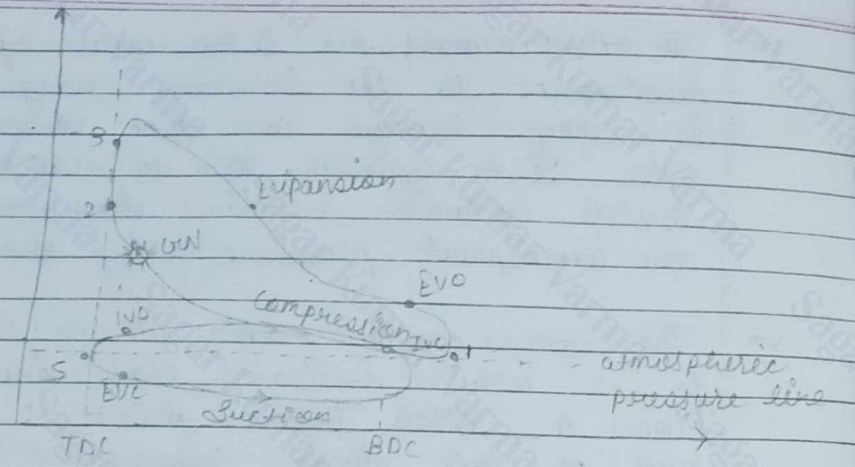
In actual indicator diagram, the suction stroke is shown by line 5-1, which lies below the atmospheric pressure line. The air-fuel mixture coming from carburetor has more pressure than the pressure inside the cylinder. This pressure difference makes the air fuel mixture to flow into the engine cylinder.

In other words, the inlet valve offer some resistance to the incoming charge. That is why charge can not suddenly enter into cylinder. Due to which pressure inside cylinder remains some what below the atmospheric pressure during suction stroke.

The compression ~~ratio~~ stroke is shown by 1-2 which indicates that, inlet valve closes a little beyond point 1. Before the end of this stroke, compressed air fuel mixture is ignited by spark plug and combustion at constant volume takes place.

The expansion ~~of~~ stroke is shown by 3-4 in which, exhaust ~~stroke is shown~~ valve opens a little before 4 (before BC) and burnt gases start ~~from~~ escaping through exhaust valve.

Exhaust stroke is shown by 4-5, which lies above stroke is shown in atmospheric line. This indicates that, pressure inside the cylinder is more than atmospheric pressure. This pressure difference makes the burnt gases to flow outside the cylinder.

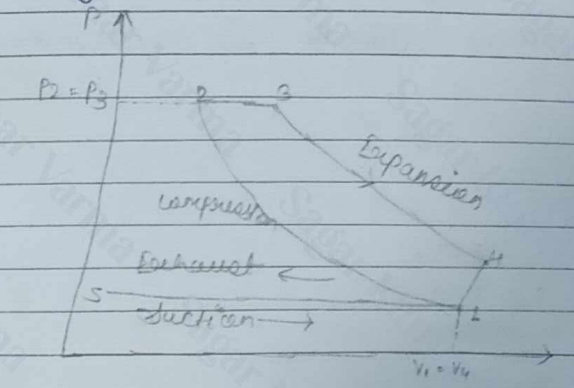


Actual indicator diagram of petrol engine

Four stroke Diesel engine :-

- Four stroke diesel engine works on diesel cycle. (Combustion at constant pressure)
- Here fuel is ignited by being injected into the engine cylinder containing air compressed to very high pressure and high temperature. Temperature of compressed air is sufficiently high to ignite the fuel. Therefore, diesel engines are called as Compression Ignition (C.I) engines.
- Diesel engine cycle for four stroke is completed in two revolution of crank, during which, four strokes are performed.

- The four stroke is briefly explained in the following manner :-



- Theoretical indicator diagram of diesel engine.

1) Suction Stroke :-

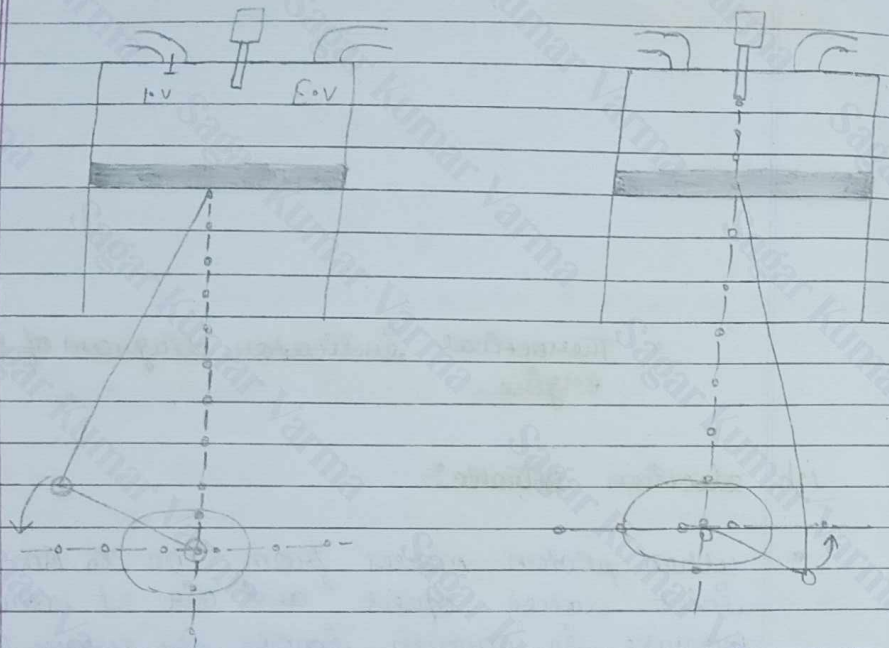
- When piston moves from TDC to BDC the inlet valve opens and air at atmospheric pressure is drawn inside the engine cylinder
- The exhaust valve remains closed, during this stroke.
- This stroke is represented by line 5-1.

2) Compression stroke :-

- At the beginning of compression stroke, the piston at BDC. When piston starts ~~from~~ moving from BDC to TDC, the air sucked

during suction stroke is compressed to high pressure and high temperature.

- This stroke is represented by 1-2.



(a) Suction Stroke (b) Compression stroke

- Both the inlet valve and exhaust valve remains closed, during this stroke.

3) Expansion or working stroke:-

- After the completion of compression stroke, small quantity of fuel (diesel) is injected into the cylinder in the form of fine sprays by fuel injector.

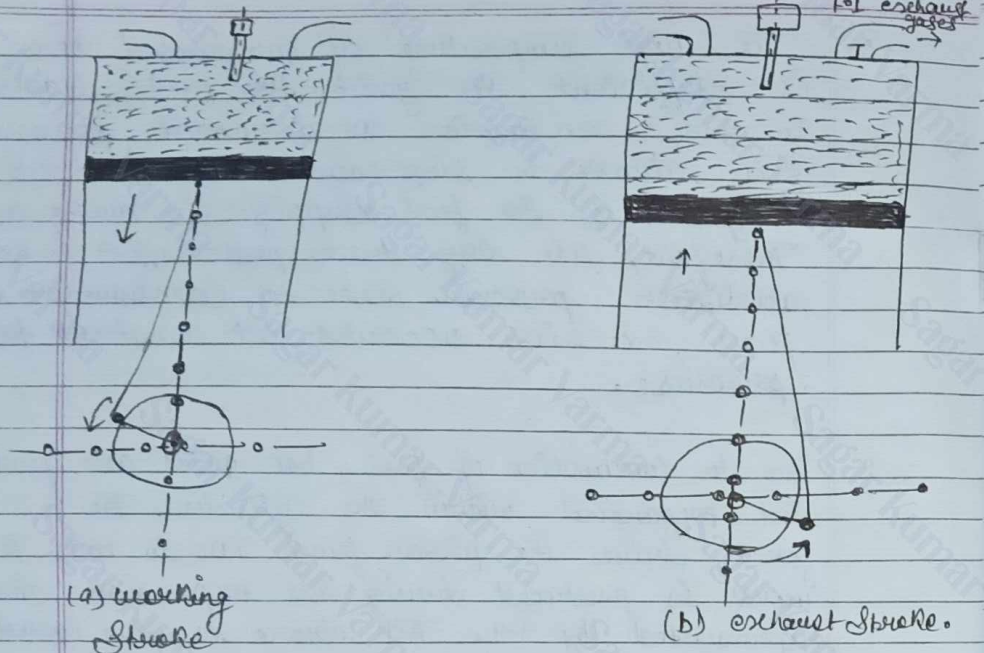
- The high temperature of compressed air is sufficient to ignite the fuel, leading to its combustion at constant pressure. This stroke is represented by line 2-3 in. At point 3, the fuel supply is made cut off. Therefore, we say that, process 2-3 is heat addition process, due to combustion of fuel, which occours at constant ~~temp~~ pressure.

- Due to combustion of fuel, hot gases are produced and expanded within the cylinder. The gas force drives the piston from TDC to BDC. Thus, work is produced during this expansion stroke, represented by 3-4. This stroke is also called working stroke or power stroke.

4) Exhaust stroke:-

- After the completion of working stroke, the piston moves from BDC to TDC and the pressure inside cylinder increases upto the set value. This makes the exhaust valve to open. Exhaust gases are driven out of cylinder and released into the atmosphere, through exhaust valve.

- When piston reaches TDC, the exhaust valve closes and cycle is completed. This stroke is represented by line 1-5.



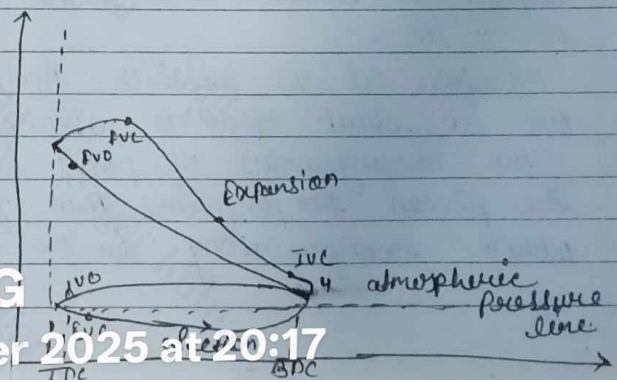
(*) Actual Indicator Diagram of four stroke diesel engine:-

- Suction Stroke is shown by 5-1, which lies below the atmospheric pressure line. This pressure difference makes the fresh air to flow into the engine cylinder. The inlet values offers some resistance to the incoming air, That is why, the air cannot enter suddenly into the engine cylinder.

- As a result, pressure inside the cylinder remains some what below the atmospheric pressure during suction Stroke.

- The compression stroke is shown by 1-2 which shows that, inlet value closes a little beyond point 1 (after BDC). At the end of this stroke, there is increase in pressure inside the engine cylinder, just little before end of compression stroke (before TDC) fuel values opens and fuel (diesel) is injected into the cylinder. Fuel is ignited, due to high temperature of compressed air. The Ignition suddenly increases volume and temperature of product of combustion at constant temperature shown by 2-3.

- The expansion stroke is shown by 3-4, in which, exhaust value opens a little before point 4 (before BDC). Now the exhaust gases are expelled out of to the atmosphere through the exhaust value. The exhaust stroke is shown by 4-5, which lies above the atmospheric pressure line. This pressure difference makes the exhaust gases to flow out of cylinder. The



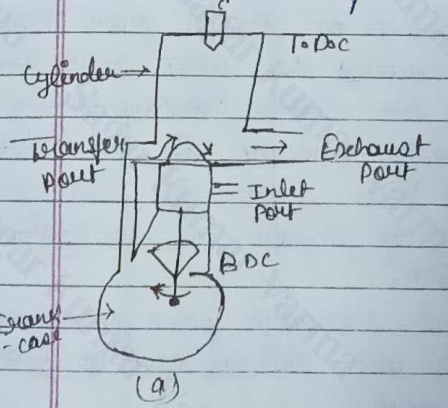
Two Stroke Petrol Engine.

- In case of two stroke engines, no valves are provided.
- Instead of valves, there is inlet port, exhaust port and transfer port.
- The casting of two stroke engine is divided into two parts. The top side where spark plug is located, is termed as cylinder. The bottom side having a spherical shape is called as Crank Case. The cylinder and crank case together from the engine cylinder.
- In two stroke engines, one cycle is completed in ~~two~~ strokes, one revolution of crank and one working for power stroke is obtained in each cycle.
- Thus, we get one working or power stroke in one revolution.
- Cycle of two stroke engine is completed in two strokes, namely (1st stroke) and (2nd stroke)

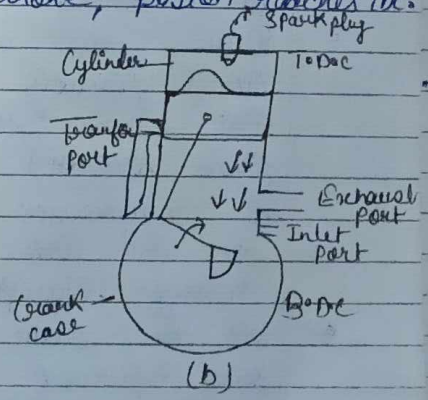
1.) First stroke (1st Stroke)

- During 1st stroke, the piston moves from BDC to TDC.
- Therefore let us consider that the piston is at BDC at start of this stroke.
- The arrangements of ports is such that, the piston performs two function simultaneously, while reciprocating in the cylinder.

- When the piston start moving from BDC to TDC, it covers the transfer port and exhaust port, it means that transfer and exhaust port get closed. During this movement of piston, the charge (mixture of air and petrol), which is already present in the cylinder, gets compressed.
- At the same time, during this piston movement, vaccum is created in the Crank case and as soon as, the inlet port is uncovered (opened), fresh charge of air-fuel mixture is sucked in the Crankcase
- At the end of this stroke, piston reaches TDC.



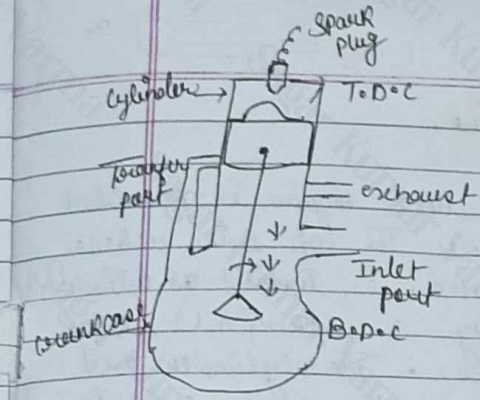
(a)

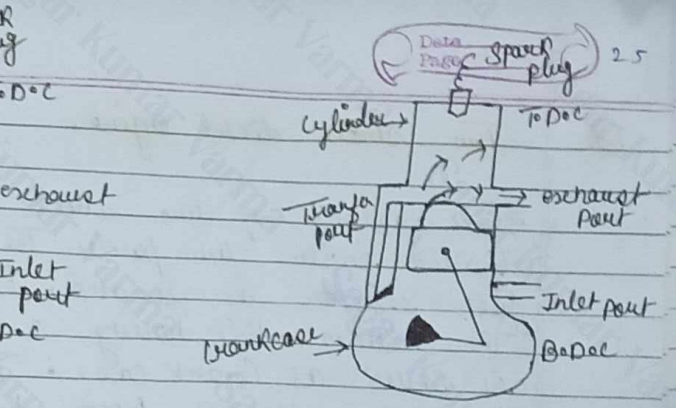


(b)

2) Second stroke (2nd stroke)

- During second stroke, the piston moves from TDC to BDC.
- A little before completion of compression stroke, the compressed charge (mixture of air and petrol) is ignited by means of spark produced by spark plug.
- Due to combustion of mixture, high pressure high temperature hot gases are produced. on expansion, these gases exert a pressure force on the piston, which drives the piston in downward direction, toward BDC producing useful work. Thus, working or power stroke is obtained.
- During this movement of piston from TDC to BDC, firstly it covers the inlet port and the same time, the charge (sucked during first stroke) already present in the crankcase is compressed and this charge is transferred on the top side of piston in the cylinder through transfer port.
- At the same time, exhaust port gets uncovered and exhaust gases are driven out of cylinder through exhaust port.





(*) Port (valve) Timing diagram for 2 stroke petrol engine.

- EPO: exhaust port opens (40°-50°) before BDC
- TPO: Transfer port open (30°-40°) before BDC
- TPC: Transfer port closes (30°-40° after BDC)
- EPC: exhaust port closes (40°-50° after BDC)
- IGN: Ignition (15°-20° before TDC)