Winter – 15 EXAMINATION

Subject Code: **17408** **Model Answer** Page No: 1/26

Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

……

	Marks
1. a) Attempt any SIX of the following-	12
i) Define scavenging.	2
Answer : Scavenging: Scavenging is process of removing the exhaust gases (combustible products) from the cylinder with help of incoming fresh charge in two stroke engine. During the downward movement of the piston the mixture in the crankcase is compressed and pushed into the cylinder through the transfer port, which pushes out the exhaust gases through the exhaust port at the same time filling the cylinder with new charge, is called cross- flow scavenging.	2
ii) State any two merits of vertical I.C. Engine.	2
Answer: Merits of vertical I.C. Engine: *(Any Two-1 mark each)* 1. The piston doesn't wear the cylinder lining during motion 2. As the crankcase is at the bottom lubricating oil can be stored in it. 3. Splash lubrication system can be used as the oil is stored in the sump. 4. The lubricating oil of the bearing and other engine parts can be collected in the crankcase. 5. Weight of the piston is carried by the crank. 6. Piston and cylinder liner have more life as compared to the horizontal engine. 7. The consumption of lubricating oil is less. *(Note: Any other merits may be considered).*	2
iii) State any two applications of I.C. Engine.	2
Answer: Applications of I.C engine: *(Any Two -1 mark each)* 1) In Automotive – i) Two stroke engine – Mopeds, Scooters. ii) Four stroke engine – Light vehicles, Heavy vehicles. 2) Marine Application – Ships, Boat 3) Locomotive s – Railway 4) Stationery engines – For lifting water, Generator, Material handling system	2

iv) List four moving parts of an I. C. Engine.	2
Answer: Four Moving parts of IC engine are: *(Any Four -1/2 mark each)* 1. Piston 2. Valve 3. Camshaft 4. Crankshaft 5. Connecting rod 6. Valve springs 7. Timing gears 8. Timing chain 9. Rocker arms 10. Push rods 11. Bearing	2
v) State the types of cooling system.	2
Answer: Types of cooling system: 1. Air cooling system 2. Water cooling system	2
vi) Define the term, mechanical efficiency.	2
Answer: Definition: **Mechanical efficiency:** It is the ratio of brake power available at the crankshaft to the indicated power generated inside the cylinder. It is calculated in percentage. Mechanical efficiency, $\eta_{mech} = \frac{B.P.}{I.P} \times 100$	1 1
vii) State the function of cylinder liner.	2
Answer: Functions of cylinder liner are as follows: *(Any two -1 mark each)* 1. It forms the sliding surface for the piston rings. 2. The cylinder liner receives heat of combustion through the piston and piston rings and transmits the heat to the coolant. 3. The cylinder liner prevents the compressed gas and combustion gas from escaping.	2
viii) State the function of fuel injector.	2
Answer: Function of fuel injector: *(Any two of the following-1 mark each)* 1) The injected fuel must be broken in to very fine droplets i.e. good atomization should be obtained. 2) The fuel should be supplied into the combustion chamber within precisely defined period of cycle. 3) The rate of injection should be such that it results in desired heat released pattern. 4) The quantity of fuel metered should vary according to speed and load requirements. 5) The amount of fuel injected per cycle should be metered very accurately. 6) The spray pattern must be such that it results in rapid mixing of air and fuel. 7) The beginning and the end of injection should be sharp. 8) In case of multi cylinder engine the distribution of metered fuel should be same to all cylinders.	2

b) Attempt any TWO of the following: 8

i) Compare two stroke and four stroke engine.(minimum four points) 4

Answer: Comparison of two stroke and four stroke engine: *(Any four -1 mark each)* 4

Sr	Two Stroke Engine	Four Stroke Engine
1	One working stroke for each revolutions of the crankshaft.	One working stroke for every two revolutions of the crankshaft.
2	Turning moment on the crankshaft is more even due to working stroke for each revolution of the crankshaft .hence lighter flywheel is required and engine runs balanced.	Turning moment on the crankshaft is not even due to one working stroke for every two revolutions of the crankshaft. Hence heavy flywheel is required and engine runs unbalanced
3	Engine is light	Engine is heavy
4	Engine design is simple	Engine design is complicated
5	Less cost	More cost
6	More mechanical efficiency due to less friction on few parts.	Less mechanical efficiency due to more friction on many parts.
7	Less output due to mixing of fresh charge with burnt gases.	More output due to full fresh charge intake and full burnt gases exhaust.
8	Engine runs hotter.	Engine runs cooler
9	Engine is air cooled	Engine is water/air cooled
10	Engine requires less space.	Engine requires more space.

ii) Classify I.C. Engine on the basis of : 4
1) Cycle of operation 2) Fuel 3) Cooling methods 4)Ignition

Answer: **The I.C. Engines are classified as follows:**

1. **Cycle of operation:** 1
   a) Otto cycle engine
   b) Diesel cycle engine
   c) Duel combustion cycle engine or semi- diesel cycle engine.
2. **Type of Fuel used:** 1
   a) Petrol engine (or Gasoline engine)
   b) Diesel engine
   c) Gas engine
3. **Cooling method:** 1
   a) Air cooled engine
   b) Water cooled engine
   c) Evaporation cooling engine.
4. **Ignition:** 1
   a) Spark ignition (S.I.) engine
   b) Compression ignition (C.I.) engine

iii) Explain working of four stroke petrol engine with neat sketch.	4

Answer: Working of four stroke petrol engine: *(Any One Diagram-2 marks, Description-2 marks)*

1. Suction stroke: During this stroke, inlet valve is open and exhaust valve is closed. The piston moves from TDC to BDC and crank shaft rotates through 180˚. The downward movement of the piston sucks air-fuel mixture in the cylinder from the carburetor through the open inlet valve.

2. Compression Stroke: During compression stroke, the piston moves upward (from BDC to TDC), thus compressing the charge. Both the inlet and exhaust valves remain closed during the compression stroke. 2

3. Power stroke or Working stroke: At the end of the compression stroke the charge (air-fuel mixture) is ignited with the help of a spark plug located on the cylinder head. The high pressure of the burnt gases forces the piston towards BDC. Both the valves are in closed position. Of the four strokes only during this stroke power is produced.

4. Exhaust Stroke: At the end of power stroke the exhaust valve opens and the inlet valve remains closed. The piston move from BDC to TDC position which pushes the burnt gases outside the combustion chamber. Crankshaft rotates by two complete revolutions through 720˚. 2

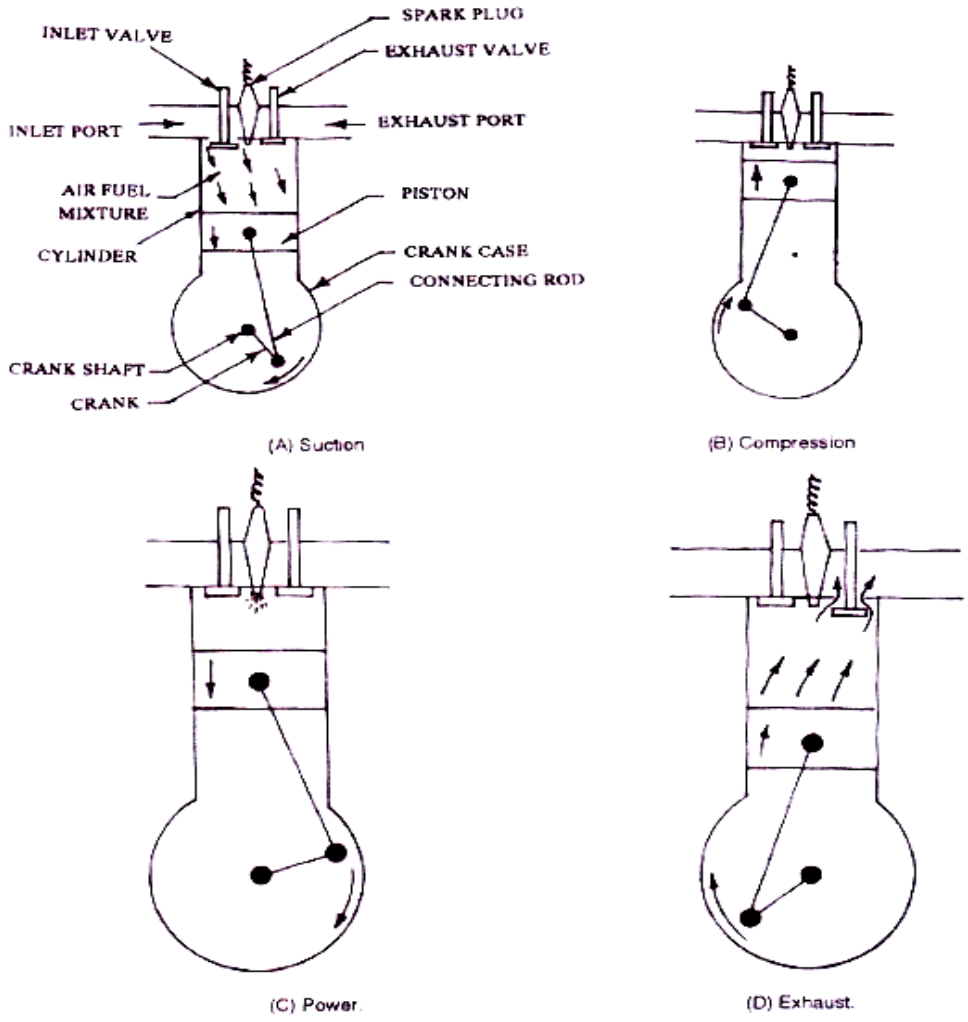


Figure: Working of 4-Stroke SI engine.

2. Attempt any FOUR of the following	16
a) Explain the working of two stroke engine with neat sketch.	4
Answer: Working of 2 stroke SI engine: *(Diagram-2 marks, Description-2 marks)*	2

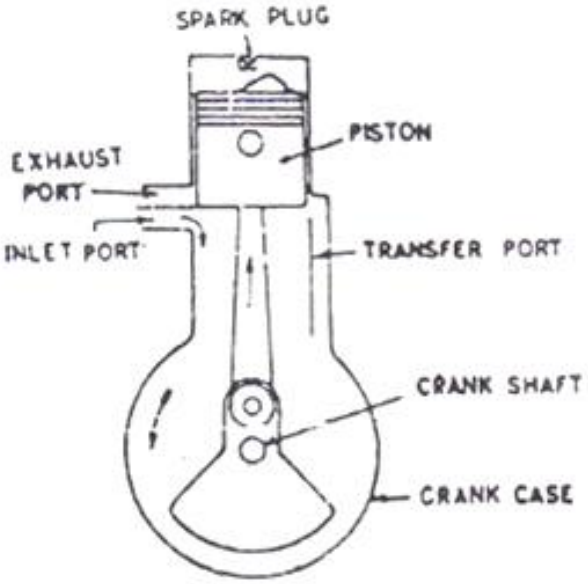


Figure: Working of 2 stroke SI engine

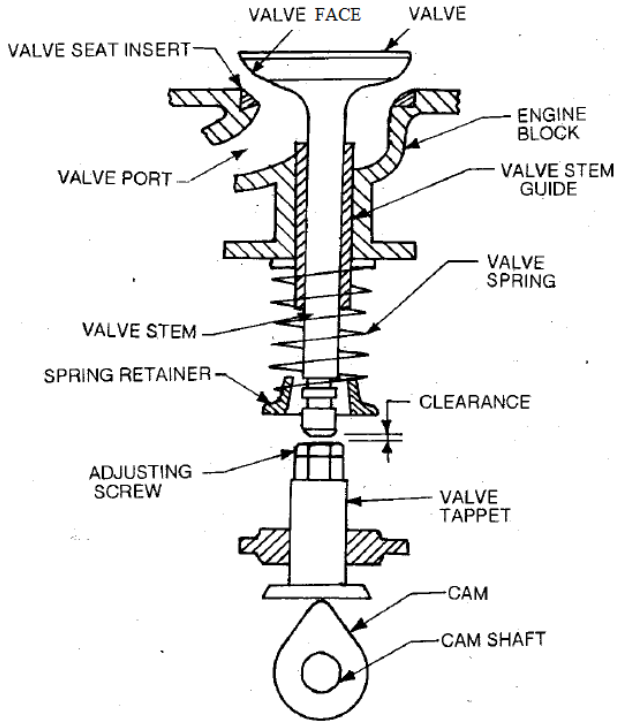
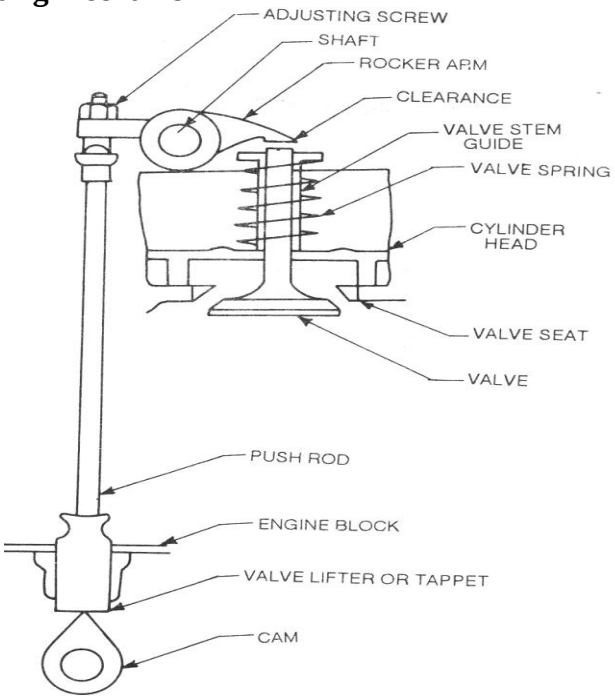
Upward movement: The air fuel mixture from the carburetor enters the cranks case through the inlet port during the upward movement of the piston. At the same time the mixture in the cylinder is compressed, which is ignited when the piston is just at T.D.C. The combustion takes place and the piston moves imparting motion to the crankshaft. 2

Downward Movement: During the downward movement of the piston the mixture in the crankshaft is compressed and pushed into the cylinder through the transfer port, which pushes out the exhaust gases through the exhaust port, at the same time filling the cylinder with a new charge. This process is called cross-flow scavenging. Thus the whole cycle is completed in two strokes, i.e. one revolution of the crank-shaft.

b) Enlist the engine components.	4

Answer: Engine Components: *(Any four-1 mark each)* 4

1	Cylinder head	12	Piston ring
2	Rocker arm	13	Gudgeon pin / piston pin
3	Valve	14	Connecting rod
4	Vale spring	15	Crankshaft
5	Push rod	16	Inlet manifold
6	Camshaft	17	Exhaust manifold
7	Cylinder block	18	Crankshaft journal
8	Cylinder liner	19	Oil sump/crankcase
9	Spark plug	20	Oil pump
10	Injector	21	Strainer
11	Piston	22	Crankpin

c) Draw the neat sketch of over-head valve mechanism and its applications.	4
Answer: *(Diagram-2 marks, labeling 1-mark ,application1-mark)* **i) Straight poppet overhead valve mechanism**  Figure: Straight poppet Overhead valve operating mechanism **OR** **ii) Overhead valve operating mechanism**  Figure: Overhead valve operating mechanism	3

OR

iii) Overhead camshaft - operated inverted bucket type

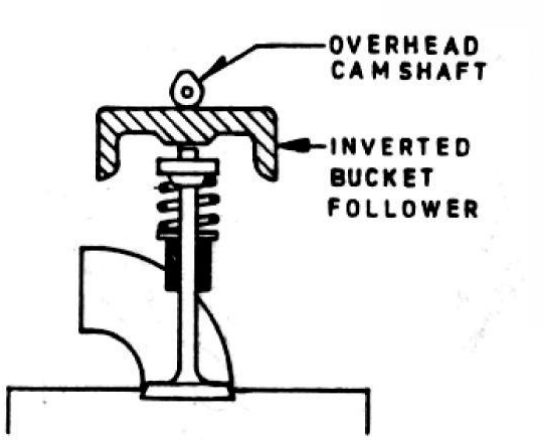


Fig. Overhead camshaft-operated mechanism with inverted bucket type follower (Single row valves)

OR

iv) Overhead camshaft - operated inverted bucket type

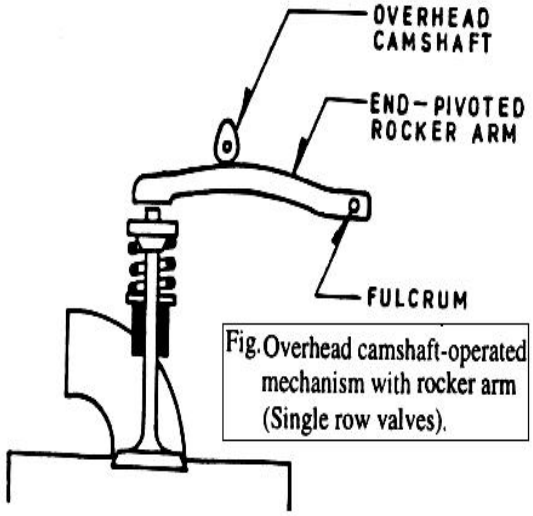


Fig. Overhead camshaft-operated mechanism with rocker arm (Single row valves).

Applications: Four stroke I.C. Engines — 1

d) State the material by which following engine components manufactured. — 4
i) Piston ii) Connecting rod iii) Camshaft iv) Piston pin

Answer: Materials for Engine components: *(1 mark each material)* — 4

i) **Piston:** Gray cast iron, Aluminium alloy

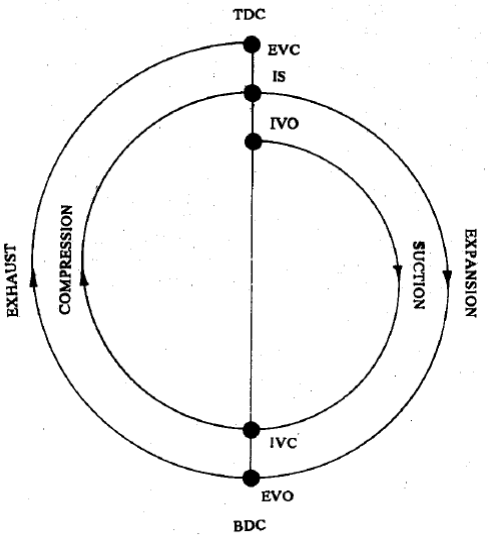
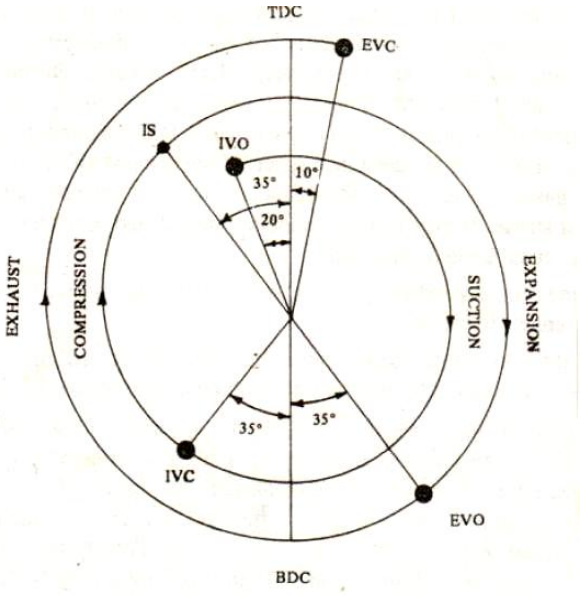
ii) **Connecting rod:** Forged steel, Aluminium alloy

iii) **Camshaft:** Alloy steel, hardenable Cast Iron

iv) **Piston pin:** Alloy steel, low carbon steel.

e) Compare theoretical and actual valve timing diagram for four stroke petrol engine. 4

Answer: **Comparison of theoretical and actual Valve timing diagram:** *(Any four-1 mark each)* 4

Sr. No.	Theoretical valve timing diagram	Actual valve timing diagram
1.	The inlet valve opens exactly at the beginning of suction stroke (TDC) and closes at the end of the stroke (BDC)	The inlet valve starts opening 10^0 to 30^0 before beginning of suction stroke (TDC) and closes after 30^0 to 40^0 at the end of the stroke (BDC)
2.	The exhaust valve opens exactly at the beginning of exhaust stroke (BDC) and closes at the end of the stroke (TDC).	The exhaust valve starts opening 30^0 to 60^0 before beginning of exhaust stroke (BDC) and closes after 8^0 to 10^0 at the end of the stroke (TDC)
3.	Inertia of the valve operating mechanism is not considered.	Inertia of the valve operating mechanism is considered.
4.	Time for the charge to fill completely into the cylinder is not considered	Time for the charge to fill completely into the cylinder is considered
5.	Time for the exhaust gases to escape out of the cylinder is not considered	Time for the exhaust gases to escape out of the cylinder is considered
6.	The inlet valve is closed when the piston reaches TDC	The inlet valve is closed when the piston reaches a point in its next stroke at which the pressure in the cylinder equals the pressure outside.
7.	The valves are closed or opened instantaneously	The valves are opened or closed slowly.
8	There is no valve overlap	There is valve overlap
9.	 Figure: Theoretical Valve timing diagram of 4 stroke SI engine	 Figure: Actual Valve timing diagram of 4 stroke SI engine

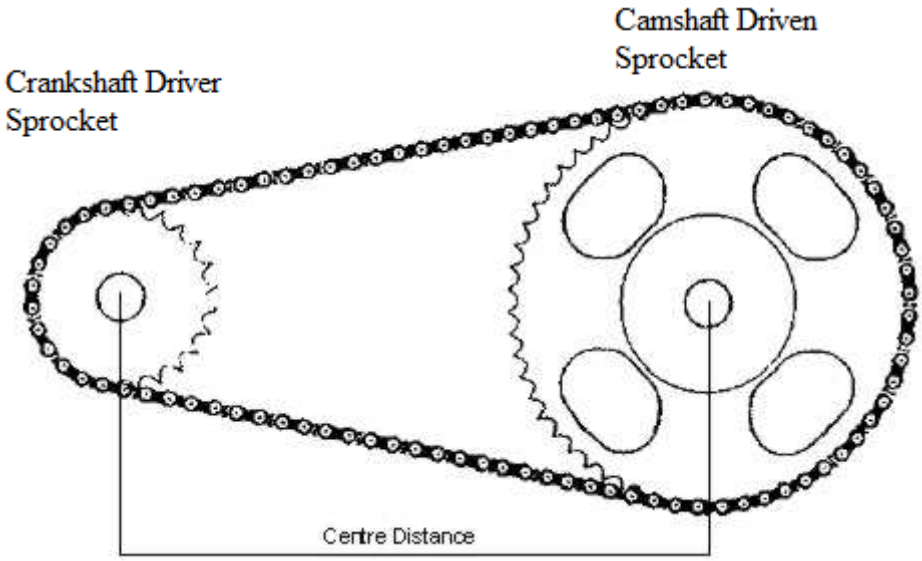
f) List the types of camshaft drives. Draw the neat sketch of any one.	4

Answer: *(List-1 mark, diagram-2 marks, Labeling-1 mark)*

Types of camshaft drives are:

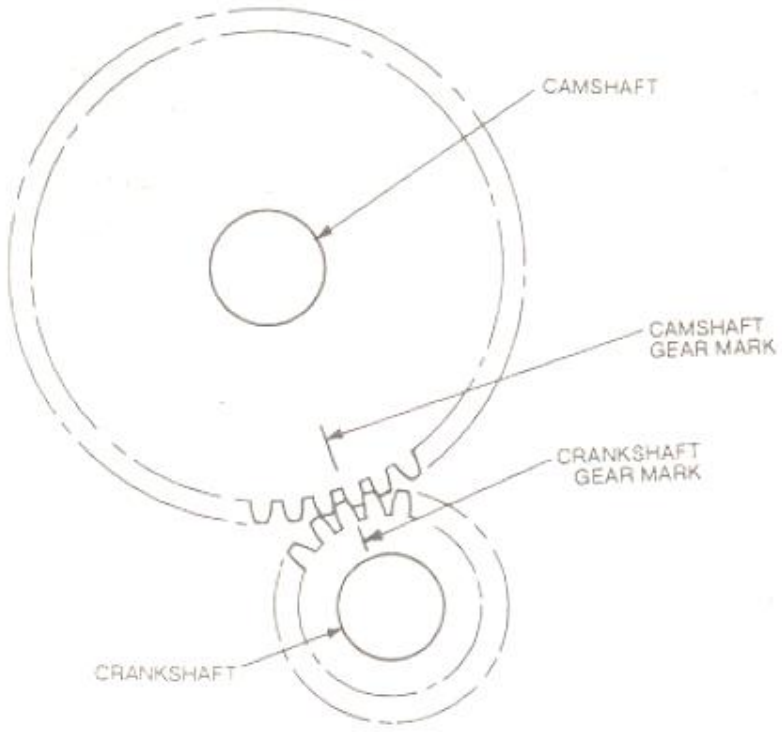
a) chain drive b) Gear drive c) Toothed belt drive 1

a) Chain Drive:



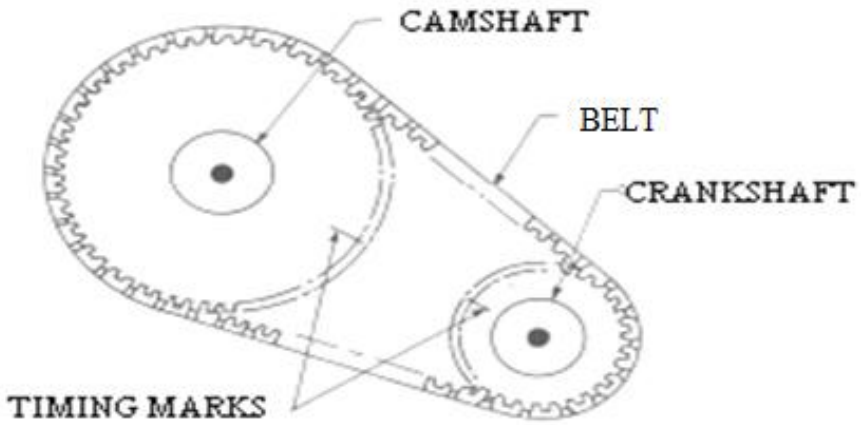
OR

b) Gear Drive:



OR

c) Toothed Belt Drive:



3. Attempt any FOUR of the following: 16

a) Draw the neat sketch of piston and label all parts. 4

Answer: *(Diagram-3 marks, Labeling-1 mark)* 4

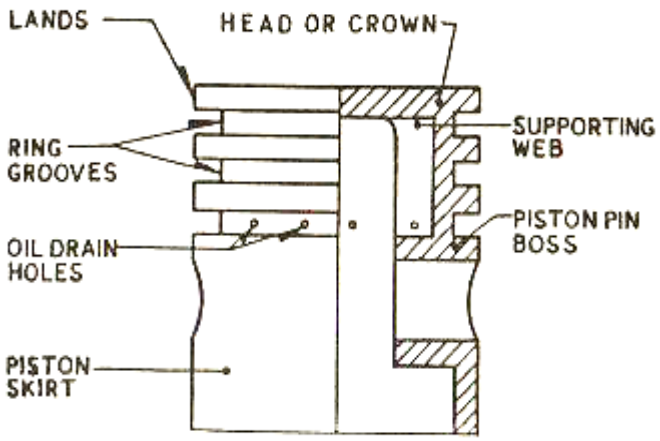


Figure: Piston

b) Explain with neat sketch, the working of electric fuel pump. 4

Answer: Working of electric fuel pump: *(Diagram-2 marks, explanation-2 marks)* 2

Figure shows the S.U. electric fuel pump. It consists of a diaphragm which is operated electrically. By turning on the ignition switch, the solenoid winding generates magnetic flux, which pulls the armature and the diaphragm moves up. The upward movement of the diaphragm creates suction, and the fuel is drawn into the chamber through the inlet valve. But as soon as the armature moves up it disconnects the electric supply, the magnetic flux dies and the armature falls down, causing the diaphragm to move to create pressure in the pump chamber. This causes the outlet valve to open and inlet valve to close. The fuel goes out to the carburetor. The downward movement of the armature again sets electric supply to the solenoid, and the same process is repeated, the pump continues to operate until the ignition switch is turned off.

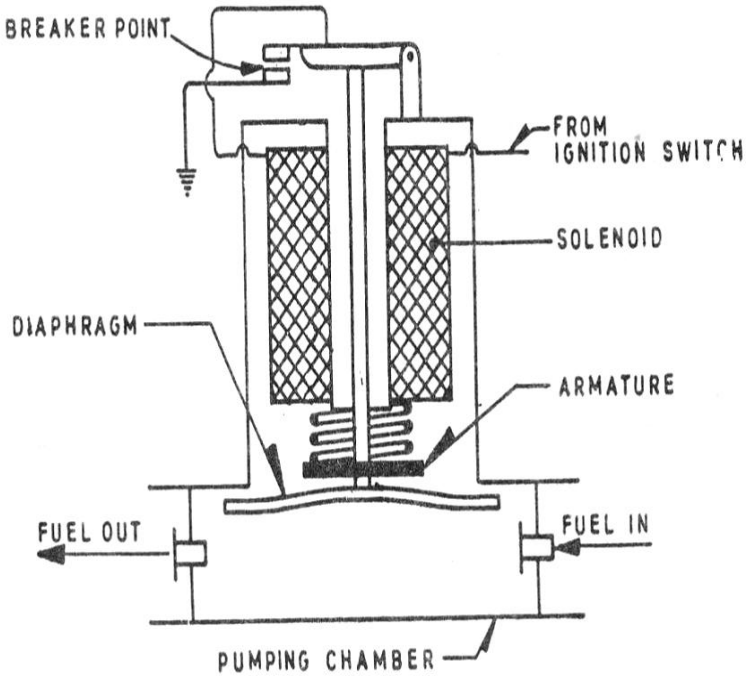


Figure: Electric fuel pump — 2

c) Explain the construction working of simple carburetor. — 4

Answer: *(Diagram-2 marks, explanation-2 marks)*

During suction stroke air is drawn through the venturi. When air passes through the venturi, velocity of air increases and pressure decreases. The pressure in float chamber is atmospheric pressure and the same is maintained with the help of vent. This pressure differential is called as carburetor depression. So the fuel from the float chamber is feed to a discharge jet. The jet or nozzle delivers a spray of gasoline into the airstream which is passing through venturi same time it mixes with the air. This air fuel mixture enters into the cylinder through the intake manifold. The rate of fuel flow into the venturi tube depends upon the engine speed and load of engine. — 2

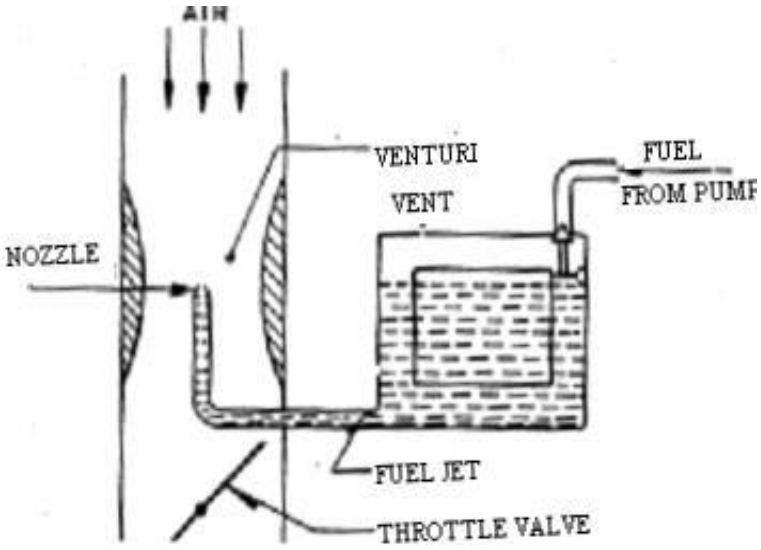
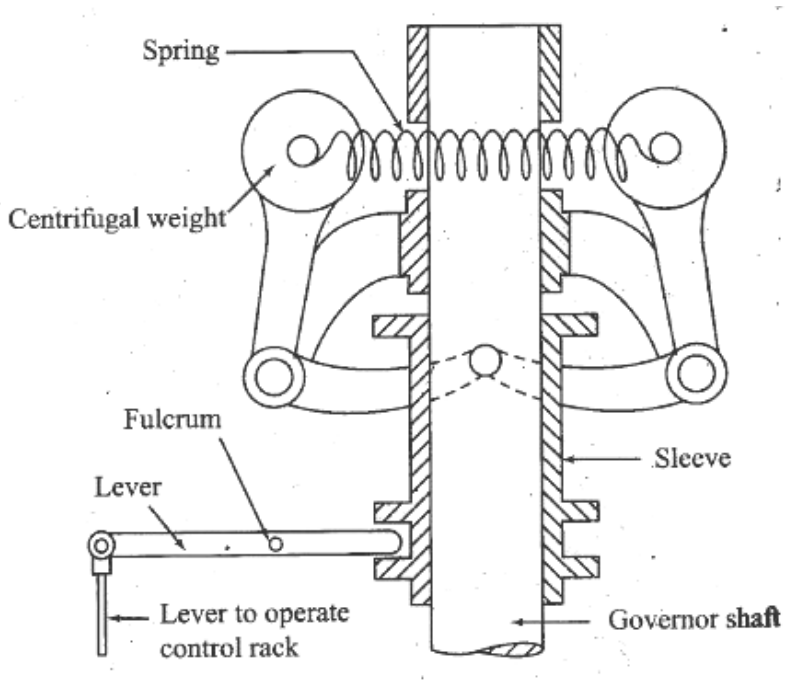


Fig. Simple carburettor. — 2

d) Explain the working principal of mechanical governor of FIP.	4
Answer: Working principal of mechanical governor of FIP*(Diagram-2marks,explanation-2 marks)*  The working principle of mechanical governor is illustrated in figure. When the engine speed tends to exceed the limit the weights fly apart. This causes the bell crank levers to raise the sleeve and operate the control lever in downward direction. This actuates the control rack on the fuel-injection pump in a direction which reduces the amount of fuel delivered. Lesser fuel causes the engine speed to decrease. The reverse happens when engine speed tends to decrease.	2 2
e) Explain the diesel fuel injector with neat sketch.	4
Answer: Diesel Fuel Injector: *(Diagram-2 marks, explanation-2 marks)* The injector assembly consists of - i) a needle valve ii) a compression spring iii) a nozzle iv) an injector body When the fuel is supplied to lift the injection pump it exerts sufficient force against the spring to lift the nozzle valve, fuel is sprayed into the combustion chamber in a finely atomized particles. After, fuel from the delivery pump gets exhausted; the spring pressure pushes the nozzle valve back on its seat. For proper lubrication between nozzle valve and its guide a small quantity of fuel is allowed to leak through the clearance between them and then drained back to fuel tank through leak off connection. The spring tension and hence the valve opening pressure is controlled by adjusting the screw provided at the top.	2

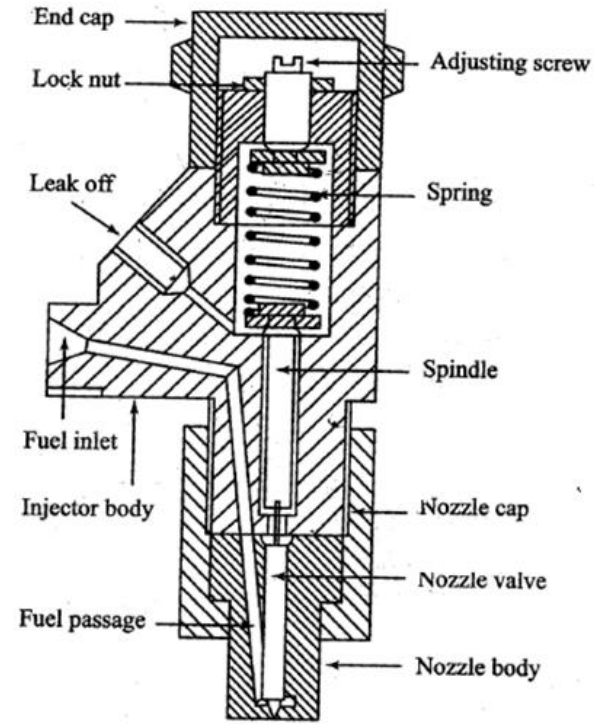


Figure: Diesel Fuel Injector

2

f) State different types of air-cleaners and explain any one of them. 4

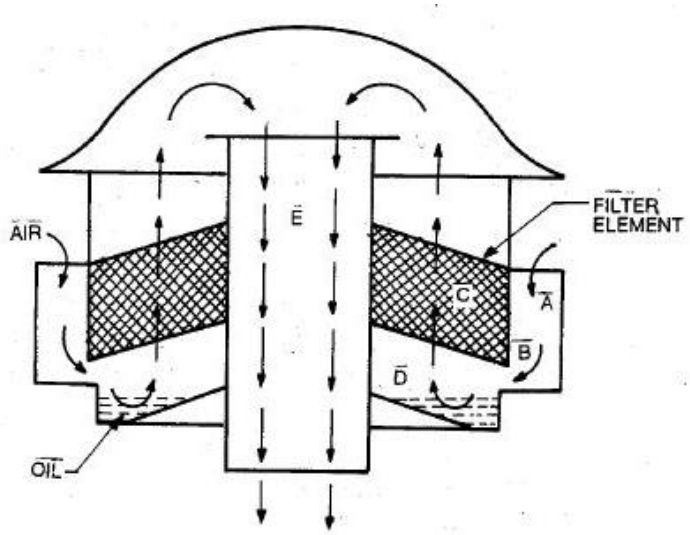
Answer: Types of air cleaner: *(type-1 mark, Diagram-2 marks, explanation-1 marks)*

The air cleaners generally used are of following types-

1. Oil bath type air cleaner.
2. Dry type air cleaner
3. Oil wetted type air cleaner
4. Paper pleated type air cleaner
5. Centrifugal type air cleaner.

1

1. Oil bath type air cleaner:

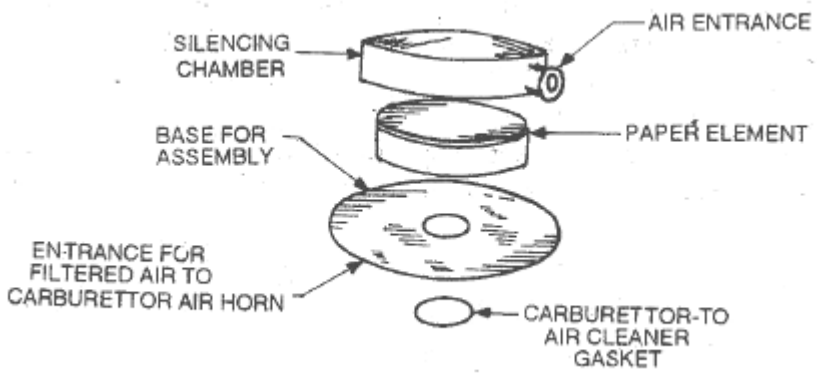


2

It is a heavy duty air cleaner. It is designed to be placed on the top of the carburetor and to be clamped to the air horn. It consists of a filter element saturated with oil. At the bottom there is a separate oil pan. The operation of air cleaning is carried out in two stages. In the first stage, the air strikes on the oil surface and then reverse upward into the filter element. The dust particles impinge on the oil surface and absorbed by it. In the second stage, the partly cleaned air passes through the filter element in which the remaining dust particles are retained. Finally, the cleaned air passes to the carburetor through the passage way. 1

OR

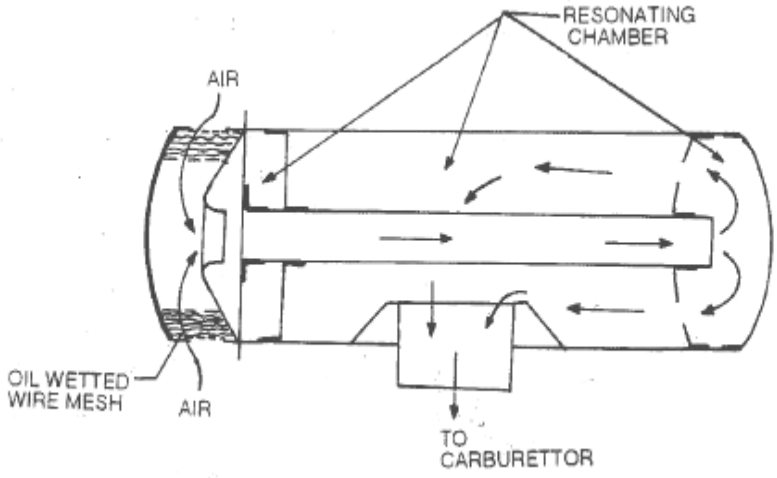
2. Dry type air cleaner: It is light duty air cleaner. It does not contain oil path. It consists of cleaning element only and not the oil bath. The cleaning element is a specially pleated paper element, over which is put a fire mesh screen to provide strength. This cleaning element is enclosed in silencing chamber. 1



2

OR

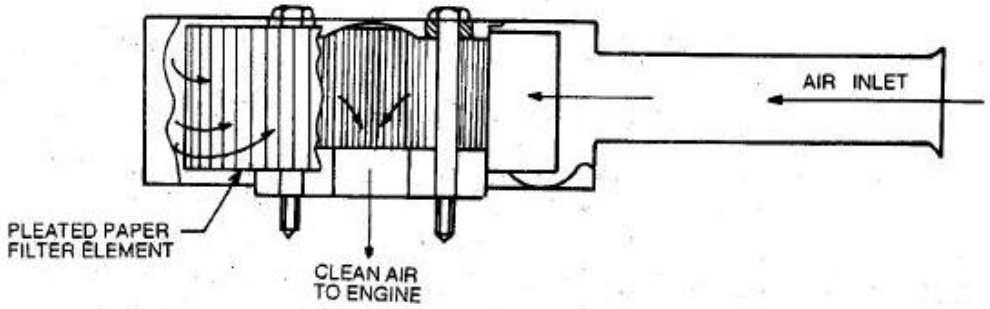
3. Oil wetted type air cleaner: It consists of a filtering element generally wire mesh, coated with an oil film. The air passes through this element and the dust particles of the air adheres to the oil film. 1



2

OR

4. Paper pleated type air cleaner: It consists of filtering element of resin-impregnated paper. It is made in the form as shown in figure. It has high filtering efficiency. By pleating the paper element, a large filtering surface is provided and yet restriction of air flow is a minimum. 1

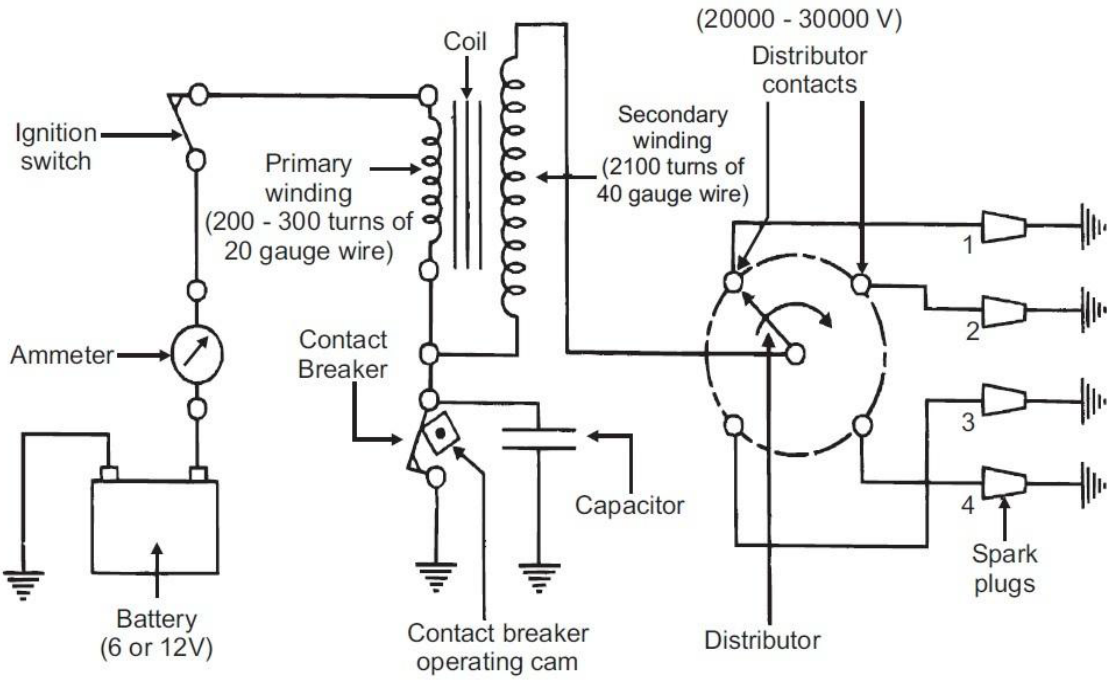


2

4. Attempt any FOUR of the following: 16

a) Explain the working of battery ignition system with neat sketch. 4

Answer: Battery ignition system: *(Diagram-2 marks, explanation-2 marks)*

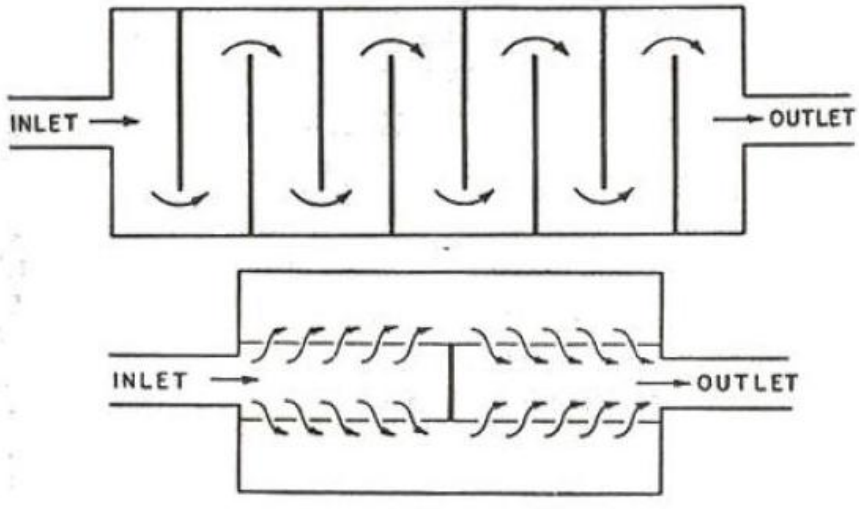


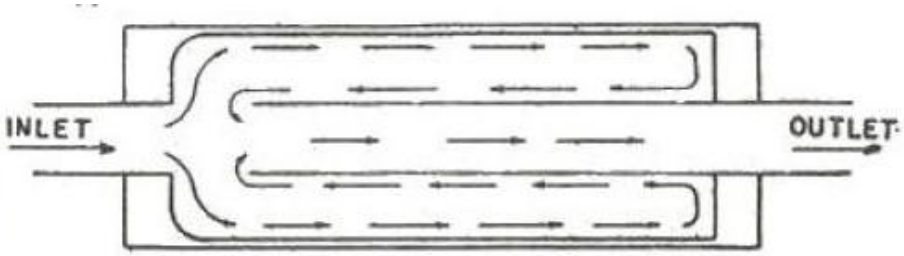
2

Figure : Schematic Diagram of Coil/Battery Ignition System

Figure shows line diagram of battery ignition system for a 4-cylinder petrol engine. It mainly consists of a 6 or 12 volt battery, ammeter, ignition switch, auto-transformer (step up transformer), contact breaker, capacitor, distributor rotor, distributor contact points, spark plugs, etc.

Working: When the ignition switch is closed and engine is cranked, as soon as the contact breaker closes, a low voltage current will flow through the primary winding. It is also to be noted that the contact breaker cam opens and closes the circuit 4-times (for 4 cylinders) in one revolution. When the contact breaker opens the contact, the magnetic field begins to collapse. Because of this collapsing magnetic field, current will be induced in the secondary winding and because of more turns of secondary, voltage goes up to 28000 - 30000 volts. This high voltage current is brought to centre of the distributor rotor. Distributor rotor rotates and supplies this high voltage current to proper spark plug depending upon the engine firing order. When the high voltage current jumps the spark plug gap, it produces the spark and the charge is ignited-combustion starts-products of combustion expand and produce power. 2

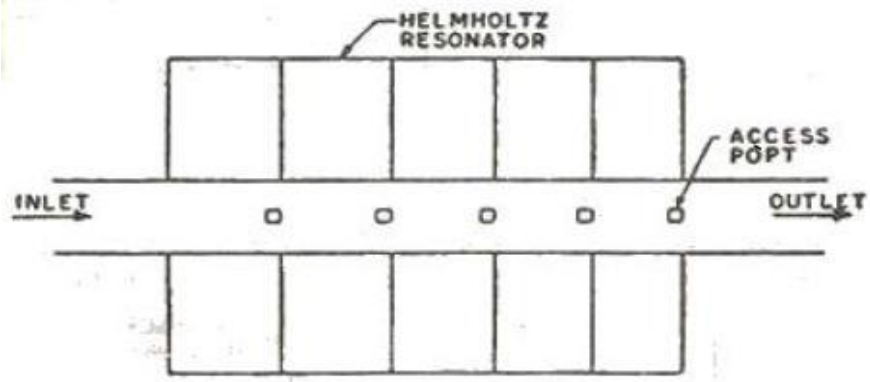
b) State the importance of firing order in multi-cylinder engine and write the firing order of 4 and 6 cylinder engine.	4
Answer: Importance of firing order in multi-cylinder engine: 1. It is desirable to have the power impulses equally spaced and from the point of view of balancing. 2. If all cylinders fired at once, power distribution would be very jerky, so the engine is set up to have the cylinders firing in sequence for a smoother power delivery. 3. If the pistons move in a certain rhythm, then they have to receive their sparks in a certain rhythm too, due to this engine will run smoothly. The optimum firing order of an engine ensures – (i) Reduced Engine vibrations (ii) better engine cooling and (iii) decreased back pressure. **Firing orders for 4 cylinder engine:** 1-3-4-2 **OR** 1-2-4-3 **OR** 1-4-3-2 **Firing orders for 6 cylinder engine:** 1-5-3-6-2-4 **OR** 1-4-2-6-3-5 **OR** 1-3-2-6-4-5 **OR** 1-2-4-6-5-3	2 1 1
c) State the types of silencers and explain any one with neat sketch.	4
Answer: Types of silencer: *(silencer types-1 mark, Diagram-2 marks, explanation-1 mark)* The silencers are usually of the following types: 1. Baffle type 2. Wave cancellation type 3. Resonance type 4. Absorber type **1. Baffle type silencers:** It consists of a number of baffles spot welded inside the cylindrical body. The purpose of these baffles is to close the direct passage of the exhaust gases, thus the gases travel a longer path in the muffler.  2. **Wave cancellation type:** In this type of muffler, the exhaust gases entering the mufflers are divided into two parts to flow in the muffler. The lengths of these paths are so adjusted that after they come out of the muffler, crests of one wave coincide with the troughs of the second wave, thus cancelling each other and reducing the noise to zero theoretically. This is achieved if the lengths of the two paths differ by half the wavelength. But this is not practically achieved, because the noise created by exhaust gases is a combination of different frequencies at different engine speeds. However, appreciable noise is reduced.	1 1 2



Wave cancellation type muffler.

3. Resonance Type:

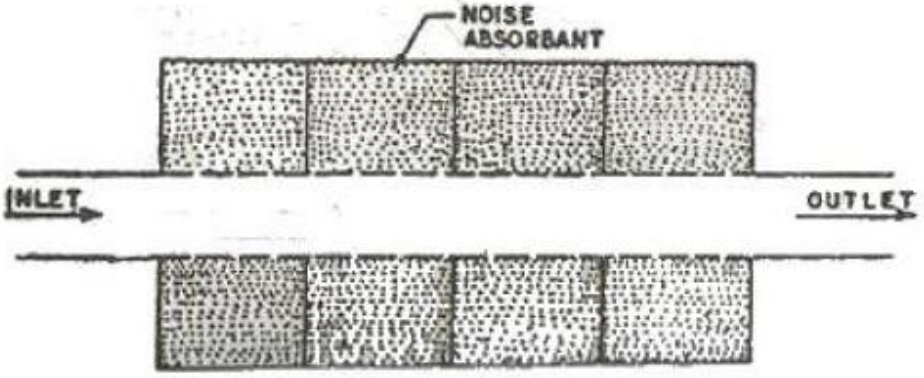
It consists of a number of Helmholtz resonators in series through which a pipe having access port passes. Helmholtz is the name of a person who originated the idea of this type of muffler. The exhaust gases flow through this pipe. The resonators eliminate the fundamental and higher harmonics of the engine noise.



Resonance type muffler.

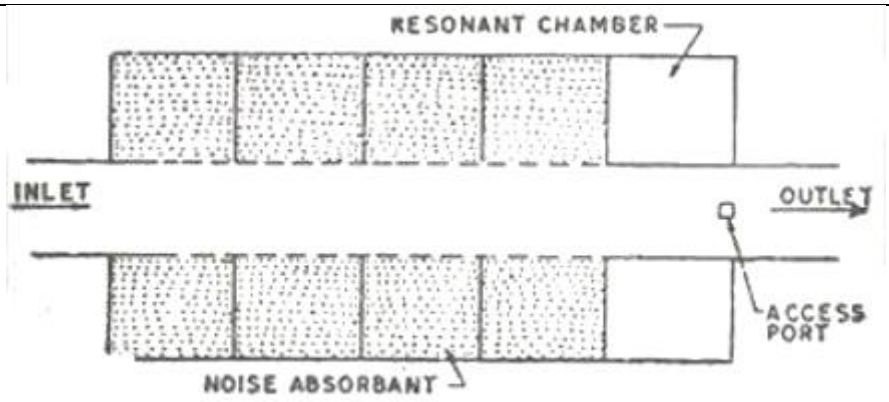
4. Absorber type :

It consists of a perforated tube, around which a sound absorbing material, like fibre glass or steel wool is placed. The exhaust gases pass through the perforated tube. The sound absorbing material reduces the high pressure fluctuation of the exhaust gases thus reducing the noise intensity.



5. Combined Resonance and absorber type :

Sometimes, a resonance chamber is provided at one end or in the middle of the straight through absorber type muffler, to reduce the pressure and noise still further. In some designs, the resonance chamber is a separate unit called a resonator, which is connected in series to the muffler.



Combined resonance and absorber type muffler.

d) State the limitation of cooling system. 4

Answer: Limitations of cooling system: *(Any four, 1-mark each)* 4
1. This is a dependent system in which water circulation in the jackets is to be ensured.
2. Power absorbed by the water pump is more and it affects the output of the engine.
3. Cost of the system is considerably high.
4. System requires considerable maintenance.
5. The failure of the system results in serious damage to the engine.

e) State the need of cooling system and compare various cooling system. 4

Answer: Need of cooling system: 2

The cooling system is needed to keep the engine from not getting so hot as to cause problems and yet to permit it to run hot enough to ensure maximum efficiency of the engine.

During the process of converting the thermal energy to mechanical energy, high temperatures are produced in the cylinders because of combustion process. A large portion of this heat is transferred to the cylinder head and walls, piston and valves. Unless this excess heat is carried away and these parts are adequately cooled, the engine will be damaged. So the adequate cooling system must be provided to prevent the damage of mechanical parts as well as to obtain maximum performance of the engine.

Comparison of Air cooling and Water cooling system: *(Any four, 1/2 mark each)* 2

Sr	Air cooling system	Water cooling system
1	In this system cooling medium used is air	In this system cooling medium used is water
2	The engine design is simple	The engine design is complex
3	The air cooled engine is less sensitive to climate condition. No antifreeze solution is needed. Due to greater temperature difference between cooling air and cylinder.	The engine performance becomes more sensitive to climate conditions. Cold water starting requires antifreeze solution which may deposit on cylinder wall on water side and result in reduced heat transfer.
4	Air cooling system has no maintenance.	It requires maintenance; slight leakage of radiator may result in engine breakdown.
5	The warm up performance is better, this results in low cylinder wear.	The warm up performance is poor ,this results in greater cylinder wear.

6	Size of engine is small and weight is less as there are no water jacket, radiator and water pump	Size and weight of engine is increased as due to use of radiator and water pump.	
7	Air cooled engine must be installed in front side of the vehicle.	Water cooling engine can be installed anywhere on the vehicle.	
8	Volumetric efficiency is lower due to high cylinder head temperature	Volumetric efficiency is greater than air cooled Engine.	
9	Examples: Bikes, Scooters, etc..	Examples: Cars, Bus, Trucks, etc.	

f) Describe construction of radiator and the types of radiator cores. 4

Answer: (*construction of radiator-2 marks, types of core -2 marks***)**

Construction of radiator: A radiator consists of an upper (or header) tank core and the lower (or collector) tank. Besides, an overflow pipe in the header tank and drain pipe in the lower tank are provided. Hot coolant from the engine enters the radiator at the top and is cooled by the cross – flow of air, while following down the radiator. The coolant collects in the collector tank from where it is pumped to the engine for cooling. 2

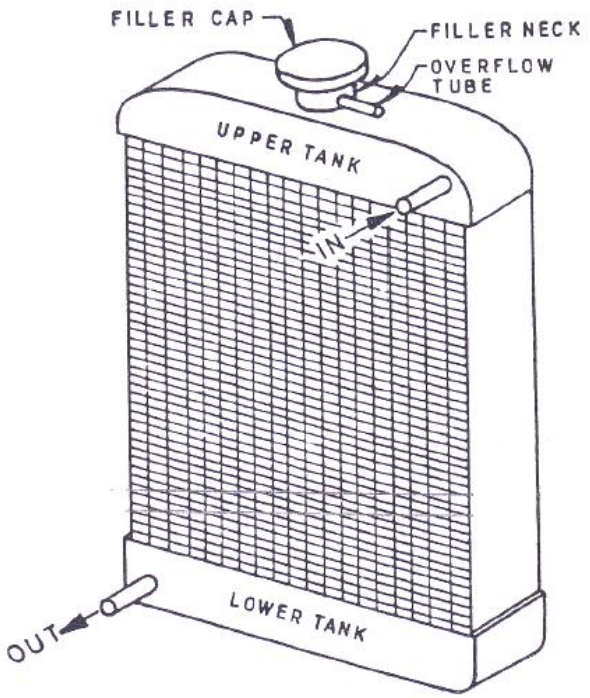
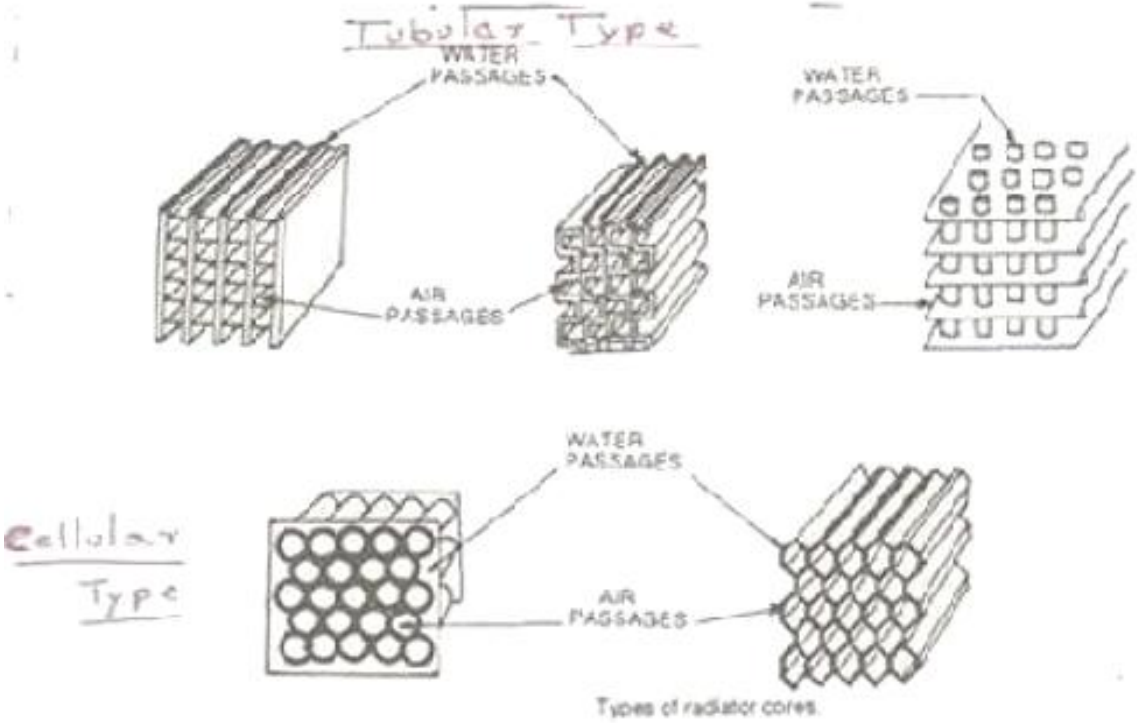


Figure:- Radiator

Types of Radiator Cores:

There are two basic types of radiator cores 2

1. Tubular type
2. Cellular type.



Types of radiator cores

5. Attempt any FOUR of the following: 16

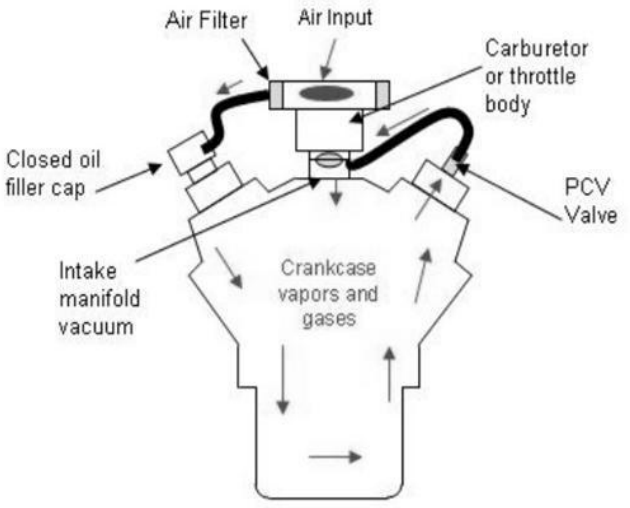
a) State the need and describe the working of crank case ventilation (P.V.C.). 4

Answer: *(Any one need-1mark, diagram-2 mark, description-1 mark)*

Need of Positive Crankcase Ventilation System:

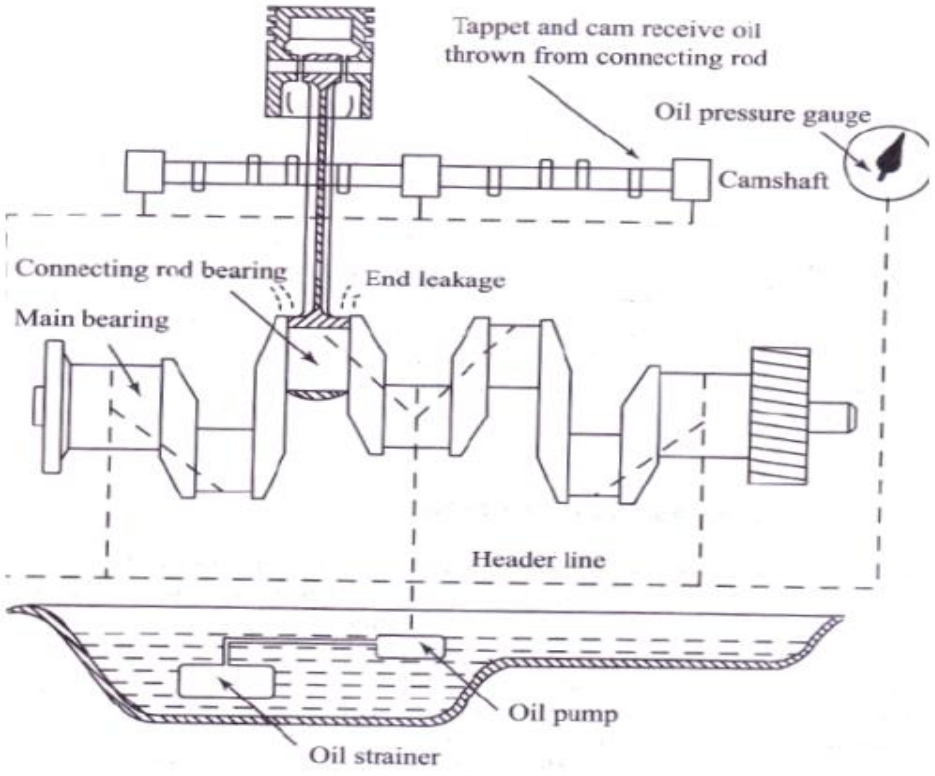
1) To prevent environment pollution.
2) To reduce the HC emission and improve the fuel economy. 1
3) To keep crankcase clean and prevent oil contamination.
4) To relieve any pressure build-up in the crankcase.

Working of Positive Crankcase Ventilation System:-



2

Figure: PCV system.

The figure shows the intake manifold return PCV system. It has a tube leading from the crankcase or else the rocker arm cover through a flow control valve into the intake manifold usually just below the carburetor. To provide proper ventilation of the interior of the engine, fresh air is usually drawn through a rocker arm cover opposite that containing the PCV system	1
b) Draw the neat sketch of wet sump (pressure) lubrication system	4
Answer: *(Diagram-3 marks, labeling 1-mark)*  Figure:- Wet Sump Pressure Lubrication System	4
c) State the properties of lubricating oil.	4
Answer: Properties of lubricating oil: *(any four-1 mark each)* 1) Viscosity 2) Flash Point 3) Resistance to corrosion 4) Physical stability 5) Pour point 6) Adhesiveness 7) Chemical Stability 8) Cleanliness 9) Resistance agents extreme pressure	4
d) List various components of lubricating system and state their function.	4
Answer: Components of lubricating system: The main components of lubrication system are- i) Oil pump ii) Oil filter iii) Pressure regulator iv) Oil pressure gauge	1

Functions:

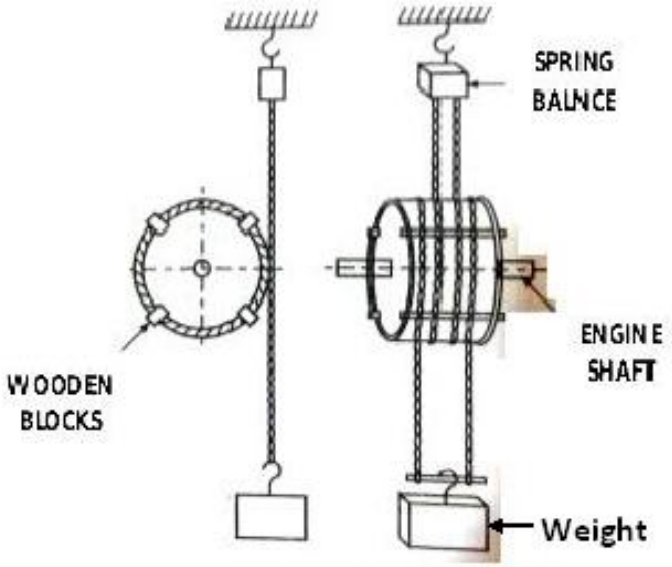
i) Oil pump: To supply oil under pressure to the various engines parts
ii) Oil filter: To remove the impurities from oil & consequently to avoid permanent damage to any or more running part of engine.
iii) Pressure regulator:- Maintain the predefined pressure value inside the lubricating system.
iv) Oil pressure gauge:- To indicate the oil pressure in the lubricating system and bring it to notice that whether pressure falls below the predefined value.

3

e) Describe construction and working of rope brake dynamometer. 4

Answer: Rope brake dynamometer*: (construction - 2mark, working -2marks)*

Construction: Dynamometer is a device for measuring force and torque and hence power. It may work on the principal of absorption Transmission, in which case it is known as Transmission Dynamometers. It consists of a number of turns of rope wound around the rotating drum attached to the output shaft. One side of the rope is connected to a spring balance and the other to a loading device. The power absorbed is due to friction between the rope and the drum. The drum there for requires cooling. 1



ROPE BRAKE DYNAMOM ETER 1

Working:-

1. Start the engine for warm up.
2. Increase the speed of engine simultaneously adding the weights on the loading device.
3. Follow the same process till the engine reaches to a constant speed. At this condition the power developed by an engine is equal to the power absorbed by the rope brake dynamometer. 2
4. The brake power can be calculated as follows:

$$BP = \pi DN (W-S)/60 \text{ (watt)}$$

Where ,

D = Brake drum diameter (m)
W = Weight (N)
S = spring scale reading.(N)
N= RPM of engine.

f) Define the terms: i) Indicated power ii) Brake power iii) Mechanical efficiency iv) Indicated thermal efficiency	4
Answer: **i) Indicated Power:** It is the power developed by the engine above the piston in the combustion chamber by burning of fuel. **ii) Brake power:** The brake power is the power obtained at the engine flywheel and is measured with the help of dynamometer, it is measured in kW **iii) Mechanical Efficiency:** It is the ratio of brake power to indicated power. It is measured in percentage. **iv) Indicated Thermal Efficiency:** It is the ratio of indicated power to input fuel energy (i.e. product of mass of fuel and calorific value of fuel)	1 1 1 1
6 Attempt any TWO of the following :	16
a) Explain Morse test and Willam's line method for frictional power.	8
Answer: **Morse test to determine the Frication Power:** In this method the BP of whole engine is first of all measured at a certain speed and load with the help of dynamometer. Then from total number of cylinders of the engine one of the cylinders is cut out by short circuiting the spark plug or by disconnecting the injector. The output is measured by keeping the speed constant. The difference in the outputs is measure of the indicated power of disconnecting cylinders. Thus for each cylinder the IP is obtained and then is added together to find the total IP of the engine. Where BP= Brake power IP= Indicated power FP = Frictional power Let F.P. of cylinder 1,2,3,4 be F1, F2, F3, F4 respectively. Then total FP of engine = F1+F2+F3+F4 Let IP of cylinder 1 2 3 and 4 be $I_{1,}$ I_2 I_3 & I_4 respectively. The total IP of engine is given by, $= I_1 +_{,} I_2 + I_3 + I_4$ The total BP of engine when all cylinders are working BP= Total IP – Total FP $B = (I_1 +_{,} I_2 + I_3 + I_4) – (F1+F2+F3+F4)$----------1 When cylinder 1 is cut off, the BP developed by the remaining three cylinders, $B_{1=} (0 +_{,} I_2 + I_3 + I_4) – (F1+F2+F3+F4)$----------2 Subtracting (2) from (1) we get $B- B_1 = I_1$ Therefore, IP of cylinder 1, $I_1 = B-B_1$	4

Similarly ,

IP of cylinder 2, $I_2 = B\text{-}B_2$

IP of cylinder 3, $I_3 = B\text{-}B_3$

IP of cylinder 4, $I_4 = B\text{-}B_4$

Total IP of Engine = $I_1+I_2+I_3+I_4$

Friction Power F.P. = I.P – B.P

Willian's Line Method :

At a constant engine speed the load is reduced in increments and corresponding B.P. and gross fuel consumptions readings are taken. A graph is then drawn of fuel consumption against B.P. as in Fig. The graphs draw is called the Willian's line (analogous to Willian's line for a steam engine) and extrapolated back to cut the B.P. axis at the point L. The reading OL is taken as the power loss of the engine at that speed. The fuel consumption at zero B.P. is given by OM; and if the relationship between fuel consumption and B.P. is assumed to be liner then a fuel consumption OM is equivalent to a power loss of OL. — 2

Frictional power loss ….. F.P.= OL × SCALE

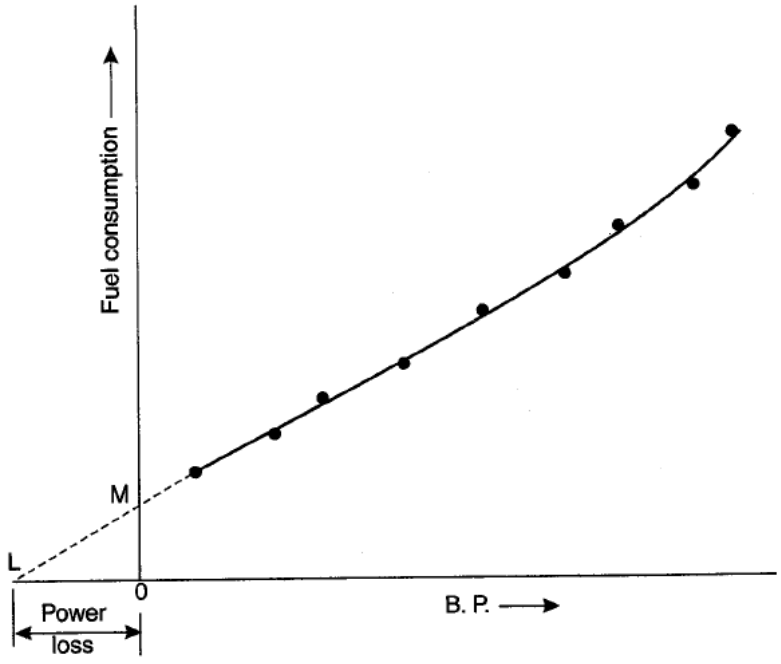


Fig. Willan's line method. — 2

b) During a test on a two stroke petrol engine following readings were noted. — 8

i) The engine is motored by an electric motor and frictional power loss recorded – on wattmeter is 1.5kW.
ii) Net brake load = 210 N
iii) Dia. Of brake wheel = 210 cm
iv) Engine speed =595 rpm
v) Fuel consumptions = 2.01 kg/hr.
vi) Calorific value of fuel = 44000 Kj/kg

Find mechanical efficiency and brake thermal efficiency.

Answer:

Given data :

No of stroke = 2

F.P. = 1.5 kW

Net Brake load = w = 210 N

Dia of brake wheel= 210cm = 2.1 m

Radius of Drum = R = $\frac{D}{2} = \frac{2.1}{2}$ =1.05m

Speed = N= 595rpm .....Two stroke

Fuel cunsumption $= m_f = 2.01 kg/hr = \frac{2.01}{60 \times 60} = 0.00055\, kg/\sec$

C.V. = 44000 kJ/kg

(i) Mechanical efficiency

$$B.P. = \frac{2\pi N T}{60}$$ 1

$$T = \text{Net brake load} \times \text{Radius of Drum}$$

$$= 210 \times 1.05 = 220.5 N.m$$ 1

$$B.P. = \frac{2 \times 3.14 \times 595 \times 220.5}{60} = 13732.005 \frac{Nm}{Sec} = 1373.005 \frac{J}{sec}$$

$$= 13.73 KJ/sec$$ 1

$$I.P = B.P. + F.P$$

$$I.P = 13.73. + 1.5$$

$$= 15.23 \text{ kJ/sec}$$ 1

$$\eta_{mech} = \frac{B.P.}{I.P.} \times 100\%$$ 1

$$= \frac{13.73}{15.23} X\ 100$$

$$\eta_{mech} = 90.15\%$$

Mechanical efficiency = 90.15 % 1

ii) Brake thermal efficiency

$$\eta_{Bth} = \frac{B.P.}{m_f \times c.v.} \times 100\%$$ 1

$$= \frac{13.73}{0.00055 \times 44000} \times 100$$

$$\eta_{Bth} = 56.73\%$$ 1

Brake thermal efficiency = 56.73%

c) An I.C. engine uses 6 kg fuel having calorific value 44000 kJ/kg. in one hour. The brake power developed is 18kW. The temperature of 11.5 kg of cooling water found to rise through 25^0 C per minute. The temperature of 4.2 kg of exhaust gas with specific heat 1 kJ/kg K was found to rise though 220^0 C. Draw heat balance sheet for the engine. — 8

Answer: Given Data:-

m_f =6 kg/ hr

C.V. = 44000kJ/kg

B.P. = 18 kW = 18 X 60 = 1080 kJ/min

Mass of cooling water = m_w= 11.5 kg/ min

Temp.rise of cooling water $\Delta t_{water} = 25^0 C$

Mass of Exhaust gas $\dot{m}_{eg} = 4.2kg/hr = 4.2/60 = 0.07kg/\min$

Specific heat of exhaust gas $Cp_{eg} = 1 kJ/kgk$

Temp.rise of exhaust gas $\Delta t_{eg} = 220^0 C$

Solution:

m_f =6/60= 0.1 kg/ min. — 1

$\text{Input Heat} = \dot{m}_f \times C.V$
= 0.1 x 44000=4400 KJ/min — 1

Heat Converted into BP= 1080 kJ/min — 1

$\text{Cooling water heat} = \dot{m}_w \times cp_w \times \Delta T_w$
= 11.5 X4.187 X 25
=1203.76 KJ/min — 1

$\text{Heat carried by Exhaust gas} = \dot{m}_{eg} \times cp_{eg} \times \Delta T_{eg}$
= 4.2 x 1x 220
= 924 KJ/ min. — 1

Heat unaccounted = heat input – (heat to BP + heat to cooling + heat to exhaust)
= 4400 - 3207.76= 1192.24 KJ/min — 1

Heat balance sheet

Parameter	Value (KJ/min)	Percentage %
Input Heat	4400	100
Heat goes to B.P.	1080	24.54
Heat goes to cooling water	1203.76	27.36
Heat goes to Exhaust Gas	924	21
Unaccounted Heat loss	1192.24	27.1

— 2