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:	12
a) State any four specification of HMV Engine.	2
Answer: **Specification of HMV Engine:***(Any four)* **Specifications of Engine for Ashok Leyland Comet:** **Manufacturer:** Ashok Leyland Limited, India. **Type:** Overhead valve, vertical diesel engine, 6 cylinder inline. **Bore :** 103.38 mm **Stroke :** 120.7 mm **Cubic capacity:** 6079 cc **Compression Ratio:** 16:1 **Brake Power:** 82.1 kW at 2400 rpm **Torque:** 369 Nm at 1600 rpm *(**Note**: Credit should be given to any other suitable example)*	2
b) Give any two demerits of vertical engine.	2
Answer**: Demerits:***(Any two)* 1. It gives vertical vibration to vehicle chassis frame. 2. Due to high vibration in foundation bolt, it may get fatigue failure. 3. Due to high inertia of reciprocating parts, it produces dynamic stresses on foundation bolt. It may transmit shock to the passengers. 4. More height required for engine compartment.	2
c) State any four application of I.C. Engine.	2
Answer: **Applications of I.C engine:** 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

d) Define I.C. engine.	2
Answer: **Definition** of I. C. engine: The I. C. engine means Internal combustion engine in which combustion i.e. burning of fuel in presence of air takes place inside the combustion chamber (closed volume).	2
e) Write two advantages of pressure cap.	2
Answer: **Advantages of pressure cap:** *(Any two)* 1. To prevent pressure from becoming excessive and causing leaks in the cooling system. 2. Overheating of engine is avoided. 3. The engine can operate at higher temperature without boiling the coolant.	2
f) Define volumetric efficiency.	2
Answer: **Definition:** Volumetric efficiency is an indication of the breathing ability of the engine and is defined as the ratio of the air actually induced at ambient condition to the swept volume of the engine. $\eta_v = \frac{\text{Volume flow rate of air intake system}}{\text{Rate at which volume displaced by the piston}} = \frac{V_{actual}}{V_{swept}}$	2
g) State material and function of connecting rod.	2
Answer: **Connecting rod:***(material- 1 mark, function- 1 mark)* **Material** *(Any one)*: Forged steel, Aluminum alloy **Function** *(Any one)***:** 1) It converts the reciprocating motion of the piston into rotary motion of crankshaft. 2) It connects piston to the crankshaft.	1 1
h) List any two requirements of fuel injection system.	2
Answer: **Requirements of fuel injection system:***(Any two)* 1) **Metering** – The fuel injection system must measure the fuel supplied to the engine very accurately as fuel requirements vary from low to high engine speeds. 2) **Time**- Fuel injection system must supply the fuel at the proper time according to engine requirement. 3) **Pressure**- The fuel injection system must pressurize the fuel to open the injection nozzle to inject fuel into the combustion chamber. 4) **Atomize**- The fuel must be atomized when it is supplied to the combustion chamber since atomized fuel will burn easily. 5) **Distribution**- In case of multi cylinder engine the distribution of metered fuel should be same to all cylinders. 6) **Control, start and stop injection**- The injection fuel must start and end quickly.	2

B) Attempt any TWO: 8

a) Distinguish between 2- stroke and 4-stroke cycle engine. (minimum four points) 4

Answer: *(Any four points)*

Sr. No.	Two Stroke Engine	Four Stroke Engine
1.	One working stroke 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	High cost
6.	High mechanical efficiency due to less frication on few parts.	Low mechanical efficiency due to more frication on many parts.
7.	Less output due to mixing of fresh charge with burnt gases.	More output due to full fresh charge intake & 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
11	Engine consists ports	Engine consists valves

4

b) Classify I.C. engine on basis of 4
i) Method of charging
ii) Camshaft layout
iii) Cylinder arrangement
iv) Ignition

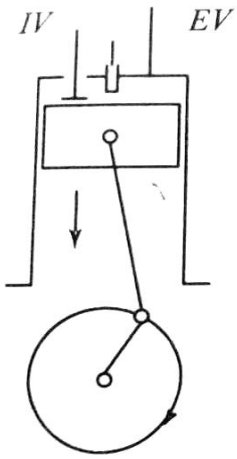
Answer: Classification of I.C. engine on basis of:

1. Method of charging:
a) Naturally aspirated engines 1
b) Supercharged aspirated engines

2. Camshaft Layout:
a) Overhead Valve camshaft arrangement engine
b) Under head Camshaft arrangement engine 1
c) Double overhead camshaft arrangement engine

3. Arrangement of cylinder
a) Vertical engine
b) Horizontal engine 1
c) Radial engine
d) V-engine
e) Opposed cylinder engine

4. Ignition:
a) Spark ignition (S.I.) engine 1
b) Compression ignition (C.I.) engine

c) Explain working principle of C.I. engine with neat sketch.	4
Answer**: Working principle of CI engine**: **1. Suction stroke:** During this stroke, inlet valve is open and exhaust valve is closed. Only air is sucked into cylinder during this stroke. The piston moves from TDC to BDC and crank shaft rotates through 180˚. **2. Compression Stroke:** The air inducted in the cylinder is compressed to the clearance volume. Both the valves are closed during this stroke. The piston moves from BDC to TDC and crank shaft rotates through 360˚. **3. Power stroke or Working stroke:** At the end of the compression stroke the fuel (diesel) is injected into the hot compressed air. The rate of injection is such a that pressure remains constant instead of change in piston position. After injection of the fuel is complete the hot gases expand. The piston moves from TDC to BDC position and crank shaft rotates through 540˚. **4. Exhaust Stroke:** The inlet valve remains closed and the exhaust valve opens. 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˚.  Figure: Working principle of four – stroke C. I. engine	2 2
2. Attempt any FOUR:	16
a) Give engine nomenclature.	4
Answer: I.C. Engine nomenclature. *(any four)* 1. **Top dead Centre** (T.D.C.): The piston is in its top most position i.e. the position closest to the cylinder head. 2. **Bottom dead Centre** (B.D.C.):The position farthest from the cylinder head. 3. **Bore:** Diameter of the engine cylinder is referred to as the bore. 4. **Stroke**: Distance travelled by the piston moving from T.D.C. to the B.D.C. is called stroke. 5. **Clearance volume**: The volume of cylinder (including the combustion chamber) above the piston when it is in the T.D.C. position. 6. **Piston displacement :**This is the volume swept by the piston in moving from T.D.C. to B.D.C. this is also called swept volume If ‘d’ is the cylinder bore and ‘S’ the stroke the piston displacement Vs is	4

given by $V_s = \frac{\prod}{4} d^2 S$

7. **Engine capacity**: this is piston displacement or the swept volume of all the cylinders if 'n' is the numbers of cylinders V_s and is the piston displacement then engine displacement or engine capacity V_d is given by $V_d = n \times V_s$

8. **Compression Ratio**: This indicates the extent to which the charge in the engine is compressed this is calculated as the ratio of the volume above the piston at B.D.C. to the volume above the piston at T.D.C. if r is the compression ratio then

$$r = \frac{V_s + V_c}{V_c}$$

OR

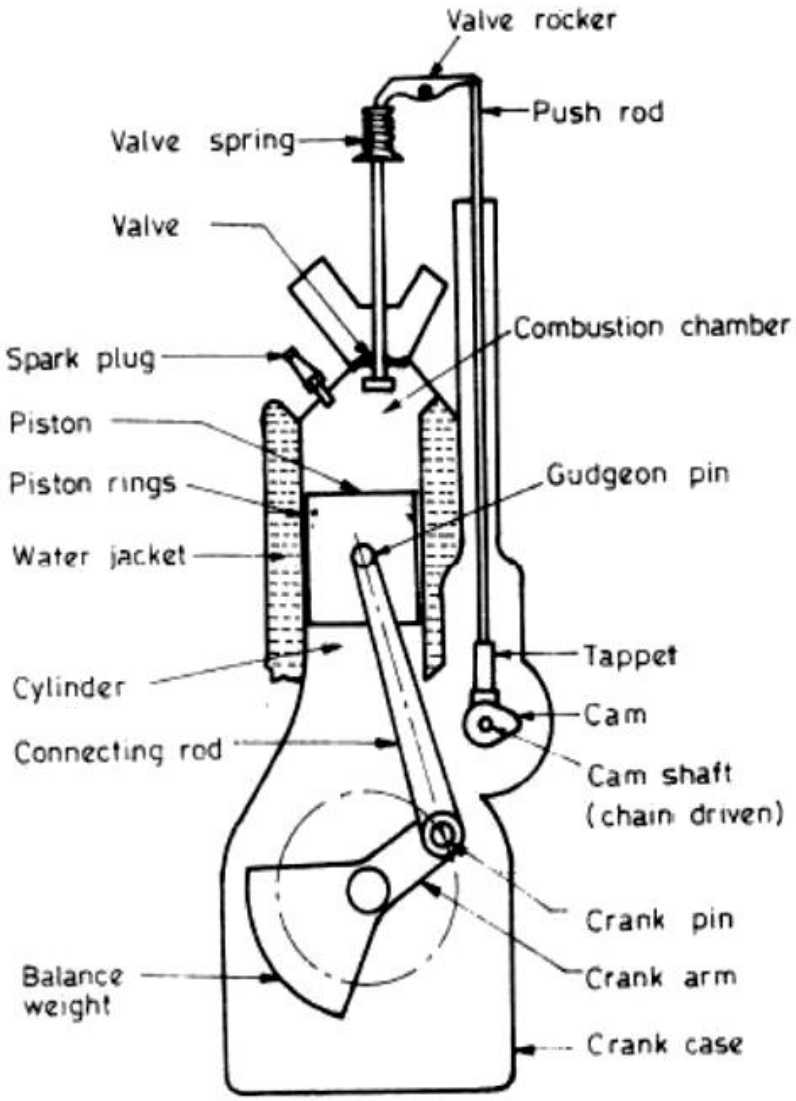


Figure: Engine Nomenclature

4

b) State the necessity of valve cooling with neat sketch. 4

Answer**: Necessity of Valve Cooling:**

Exhaust valve temperature in modern engine is as high as 750˚C. Valve burn (overheating) is a major problem. It causes excessive valve wear and defective sealing, as well as engine knocking. It can be solved by valve cooling systems that use water or oil as a coolant. Thus cooling of exhaust gas becomes very important. Cooling water jackets are arranged near the valves for valve cooling. In many cases nozzles are directed towards hot spot caused by the exhaust valve. In heavy duty engine, sodium cooled valves are used. 2

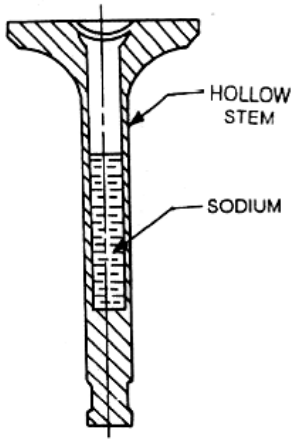


Figure: Sodium cooled valve 2

c) Mention the function and manufacturing methods for following engine components: 4
i) Camshaft
ii) Crank shaft
iii) Flywheel
iv) Gasket

Answer: **Function and manufacturing methods for engine components:**
(Note:1 mark for function and manufacturing method of each component)

Sr	Engine components	Function	Manufacturing Method	
i)	Camshaft	1. Camshaft is responsible for opening of the valves. Cam shaft has number of cams along the length, two cams for each cylinder, one operates inlet valve and another operates exhaust valve. 2. The camshaft has a eccentric lobe which operates fuel feed pump. 3. A gear is present on the camshaft which drives ignition distributor and oil pump.	Casting, Forging	1
ii)	Crankshaft	1. It converts the reciprocating motion to the rotating motion. 2. It transmits Power to the Flywheel. 3. It receives Power from flywheel.	Forging	1

iii)	Flywheel	1. Flywheel absorbs energy during power stroke and supplies it during remaining strokes. 2. Flywheel keeps the crankshaft rotating at the uniform speed throughout in spite of Uneven power impulses of engine cylinders. 4. Flywheel carries the drive from the starting motors to crankshaft while the starting the Engine.	Casting	1
iv)	Gasket	1. Gasket is placed between cylinder head and cylinder block to retain compression in the cylinder. 2. Gasket prevents leakage of the gases from combustion chamber and ensures tight fit joint. 3. Gasket also withstands high pressure and high temperature.	Moulding	1

d) Explain working of overhead valve mechanism with neat sketch. 4

Answer: **Working of Overhead valve mechanism:**

Valves in the head are operated either by tappet rods extending up the side of the cylinders, or by means of an overhead camshaft.

As the cam rotates 180^0, it lifts the valve- tappet or the lifter which actuates the push rod. The push rod rotates the rocker arm about a shaft or a ball joint in some designs. This causes one end of the arm to push down the valve to open it. The valve is opened and the valve port is connected with the combustion chamber. As the cam rotates further 180^0 the valve spring closes the valve and the push rod is pushed back to its original position. 2

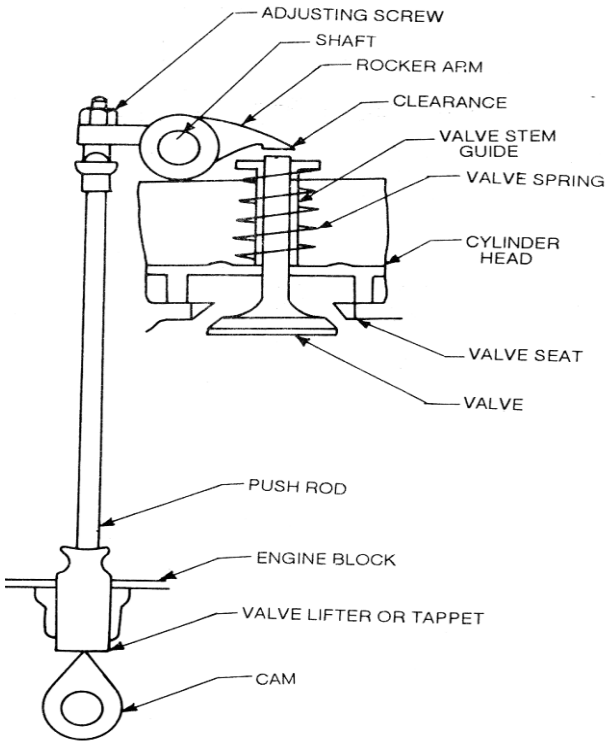


Figure: Overhead valve operating mechanism 2

e) Compare camshaft and crankshaft. 4

Answer**: Comparison of camshaft and crankshaft:** *(Any four points)* 4

Sr	Crank Shaft	Cam Shaft
1	It is the part of an engine where the brake power is available.	This shaft used to operate inlet and outlet valves
2	Two revolution per power stroke in Four stroke engine	One revolution per power stroke in Four stroke engine
3	Available in both two stroke as well as in four stroke engine	Available only in four stroke engine
4	More weight	Less weight
5	Crank shaft is located in the crankcase	Cam shaft is located either in the crankcase or on the cylinder head
6	It consists crank pin, main journal bearing, crank web, oil hole	It consists integrated cams and gear

f) State the difference between dry liner and wet liner (minimum four points). 4

Answer: **Difference between dry liner and wet liner**: *(Any four)* 4

Sr	**Dry liners**	**Wet Liners**
1.	Dry Liner is not in direct contact of cooling water hence it is known as a "dry liners"	Wet Liner is in direct contact with cooling water on the outside &hence it is known as a "wet liners"
2.	It is difficult to replace.	It is easy to replace.
3.	No leak proof joint is provided in the case of dry liners.	A leak proof joint between the cylinder casting & liner has to be provided.
4.	In dry liners casting of cylinder block is complicated.	In wet liners casting of cylinder block is simplified.
5.	A cylinder block with dry liners is generally more robust.	A cylinder block with wet liners is less robust as compare to dry liners.
6.	For perfect contact between liner & the block casting in case of dry liner, very accurate machining of block & outer liner surface is required.	Whereas there is no necessity in case of wet liner.
7.	A dry liner cannot be finished accurately before fitting. Because of the shrinkage stresses is produced.	A wet liner can be finished accurately before fitting.
8	Thickness ranges from 1,5 mm to 3 mm	Thickness ranges from 3 mm to 6mm

3.Attempt any FOUR: 16

a) Explain importance of intake manifold with neat sketch. 4

Answer: Importance of intake manifold:

The intake manifold carries the air-fuel mixture from the carburetor to the cylinders in case of S.I. engine and carries only air from air filter in case of CI engine. With the help of intake manifold we can distribute the accurate & equal amount of charge or air to the cylinders. Shape and size of the intake manifold prohibits the formation of fuel droplets without restricting the air flow in case of S.I. engine and smooth flow of air is maintained to the cylinders in case of CI engine. 2

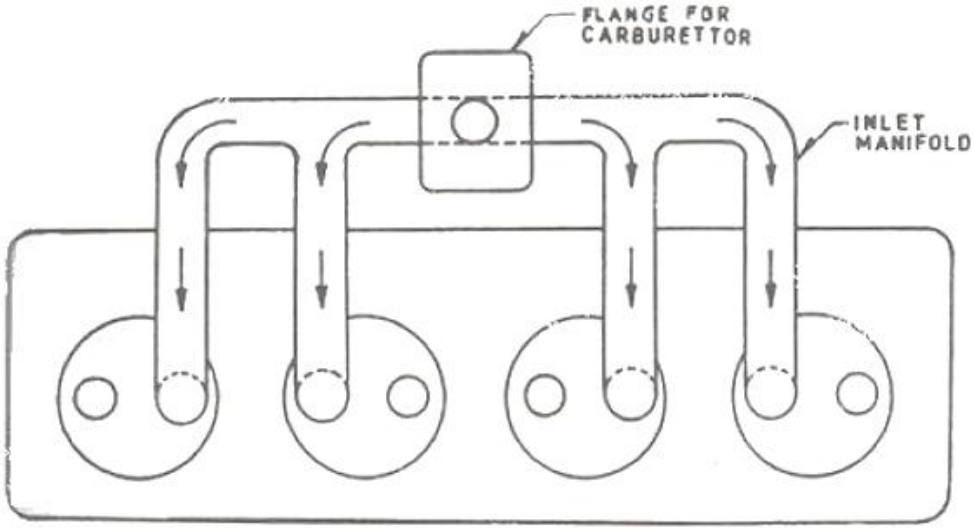


Figure: Intake manifold — 2

b) Explain working principle of solex carburetor. — 4

Answer: Working principle of Solex carburetor:

1. Starting circuit:

The starter valve is in the form of a flat disc with holes of different sizes. The holes connect petrol jet and starter jet sides to the passage; this passage opens into the air horn just below the throttle valve. The starter lever is operated by the driver from the dashboard, which adjust the position of the starter valve so that either bigger or smaller holes come opposite to the passage. With special provision for a progressive starter which supplies richer mixture for starting and then gradually weakens it till the engine has reached its normal operating temperature. When the engine reaches to normal working speed and temperature, the starter is brought to "off" position. — 1

2) Idling or low speed circuit:

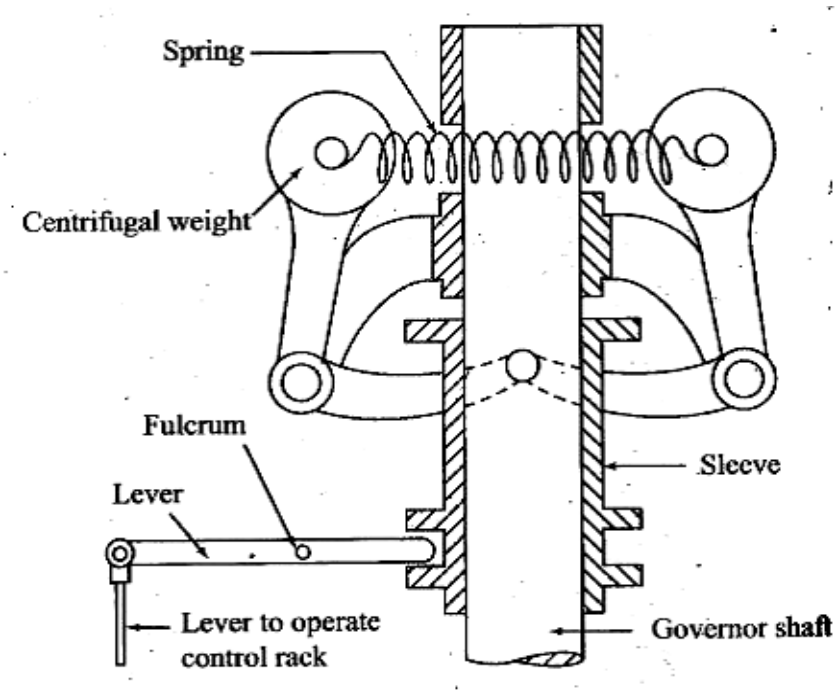
The idle port is controlled by idle screw. It is provided near throttle valve. As the throttle is almost closed the engine suction is applied at the pilot petrol jet to supplies the petrol. The air is drawn from the pilot air jet and mixes with the petrol and supply to the engine. When the throttle valve is opened the suction decreased at the ideal port and is applied at slow speed opening. — 1

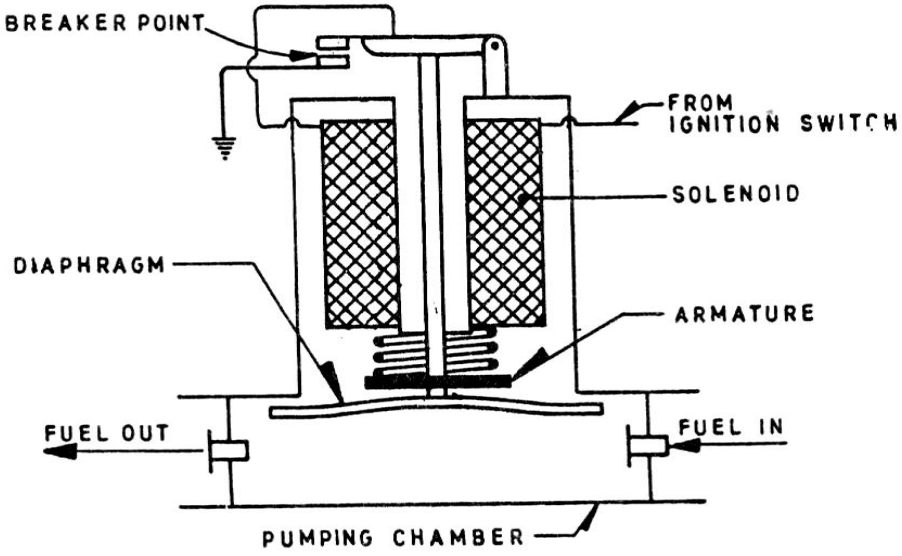
3) Normal running circuit:

During normal running, the throttle valve is opened and engine suction is applied at the main jet, which supplies the fuel. The air enters directly through venturi and mixes with the fuel. The air- fuel mixture is governed by the throttle valve. — 1

4) Acceleration circuit:

For acceleration, extra fuel is required by the engine, which is supplied by the membrane pump. The pump lever is connected to the accelerator. When the accelerator pedal is depressed, the pump lever presses the membrane (diaphragm) forcing the fuel into main jet. When the pedal is returned the membrane moves back sucking the fuel from the float chamber through the ball valve. — 1

c) State the function of nozzle and state their types.	4
Answer: **Functions of nozzle:** *(Any Two)* 1) To atomize fuel by converting it in to fine droplets. 2) To convert pressure energy in to kinetic energy. 3) To inject the fuel at right quantity at right time with respect to load & speed of the engine. **Types of Nozzles:** *(Any Four)* 1) Single hole nozzle 2) Multi-hole nozzle 3) Long stem nozzle 4) Pintle nozzles 5) Pintuax nozzles	2 2
d) Explain working of mechanical governor in 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.  Fig **:** Mechanical Governor	2 2

e) Explain working of S.U. Electrical fuel pump.	4
Answer: Working of electric fuel pump: *(Diagram-2 marks, explanation-2 marks)* 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: S.U. Electric fuel pump	2 2
f) Compare petrol and diesel fuel supply system (minimum four points)	4
Answer: **Comparison of petrol and diesel fuel supply system:**	4

Parameter	**Petrol fuel supply system**	**Diesel fuel supply system**
Injection pressure	Low	High
System used	Carburetor , and fuel injection (MPFI)	CRDI, Pressurized fuel injection
No. of components	Less	More
Cost	Low	High
weight	Low	High

(Note: credit should be given to any other relative differences)

4. Attempt any FOUR:	16
a) Explain working of magneto ignition system.	4
Answer: **Working of Magneto ignition system:** A schematic diagram of a high tension magneto ignition system is shown Figure. The high tension magneto incorporates the windings to generate the primary voltage as well as to step up the voltage and thus does not require a separate coil to boost up the voltage required to operate the spark plug. Magneto	2

can be either rotating armature type or rotating magnet type. In this type, the armature consisting of the primary and secondary windings all rotate between the poles of a stationary magnet. With the help of a cam, the primary circuit flux is changed and a high voltage is produced in the secondary circuit. At start the cranking speed is low the current generated by the magneto is quite small. As the engine speed increases the flow of current also increases.

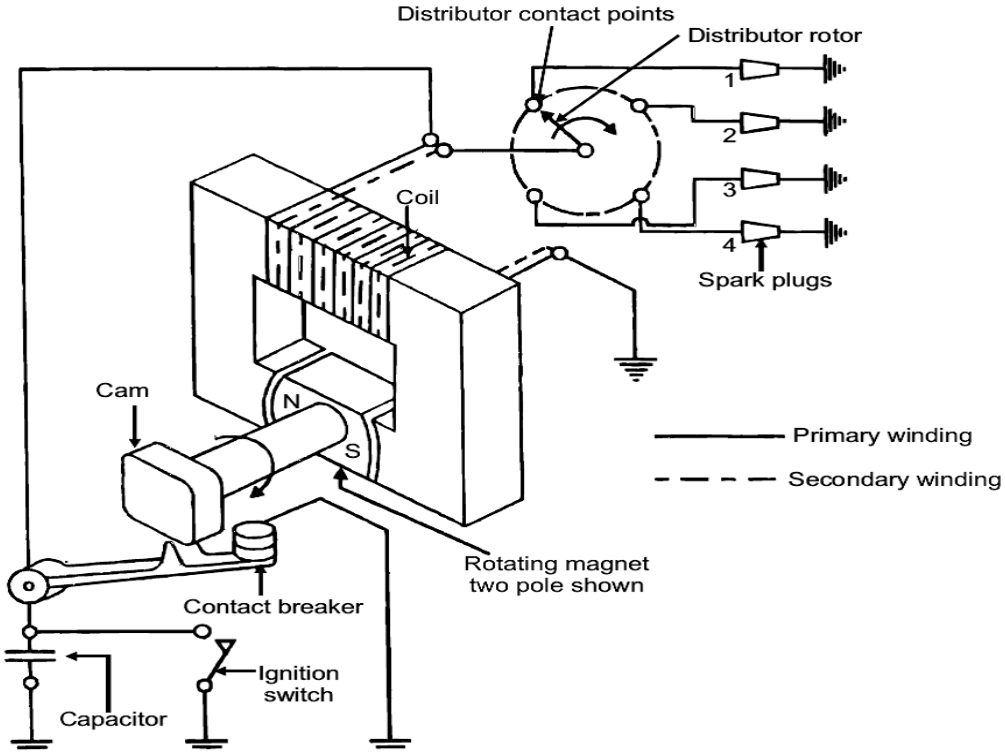


Figure : Schematic Diagram of Magneto Ignition System

(Note: Credit shall be given to any other suitable sketch)

2

b) State different types of Silencer. Explain any one type of silencer. 4

Answer: *(Note: Silencer types-1 mark, Diagram -2 marks and explanation-1 mark of any one type)*

Types of silencer:

The silencers are usually of the following types: 1. Baffle type 2. Wave cancellation type 3. Resonance type 4. Absorber type

1

1. Baffle type silencers:

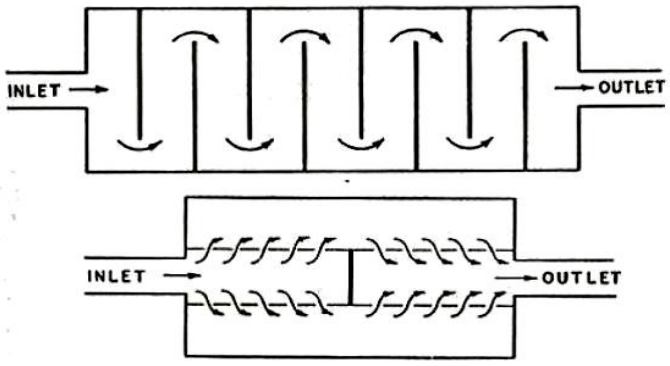


Figure: Baffle type silencers

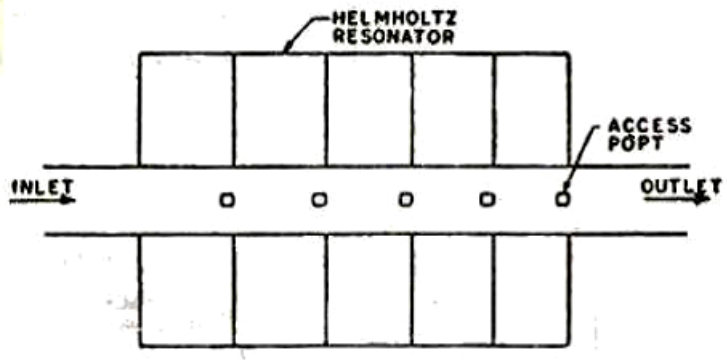
2

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. 1

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.

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 fiber 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.

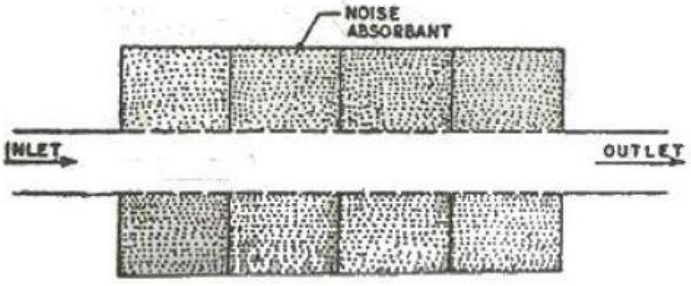
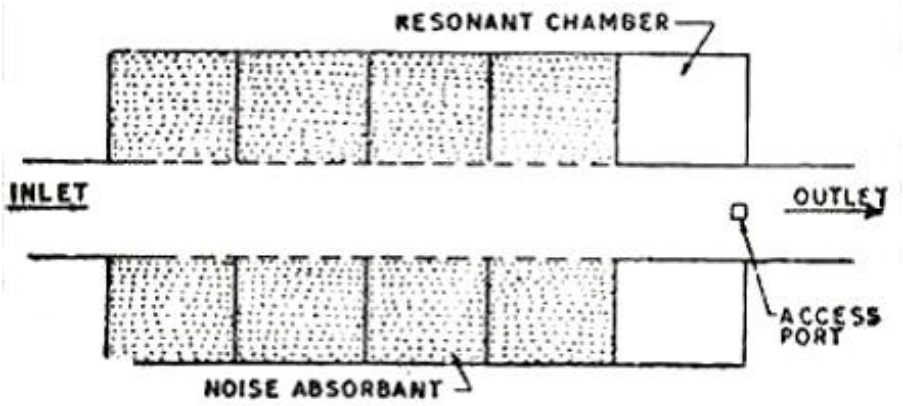


Figure: Absorber type Silencer

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.

c) Discuss need of firing order for multicylinder engine. 4

Answer: **Need of firing order in multicylinder 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. 4

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.

d) State any four coolant additives with their function. 4

Answer: **Coolant Additives and their funtion**

1. **Wood alcohol (Methyl alcohol)**
   Function: It is used as antifreeze additive for coolant.

2. **Glycerin**:
   Function: By using this additive coolant will not get freeze under lower temperature. 4

3. **Ethylene glycol:**
   Function: It will keep coolant in liquid state at higher temperature.

4. **Silicates and Chromates:**
   Function: It will prevent scaling and corrosion of metallic parts of cooling system.

e) Compare water and air cooling system. 4

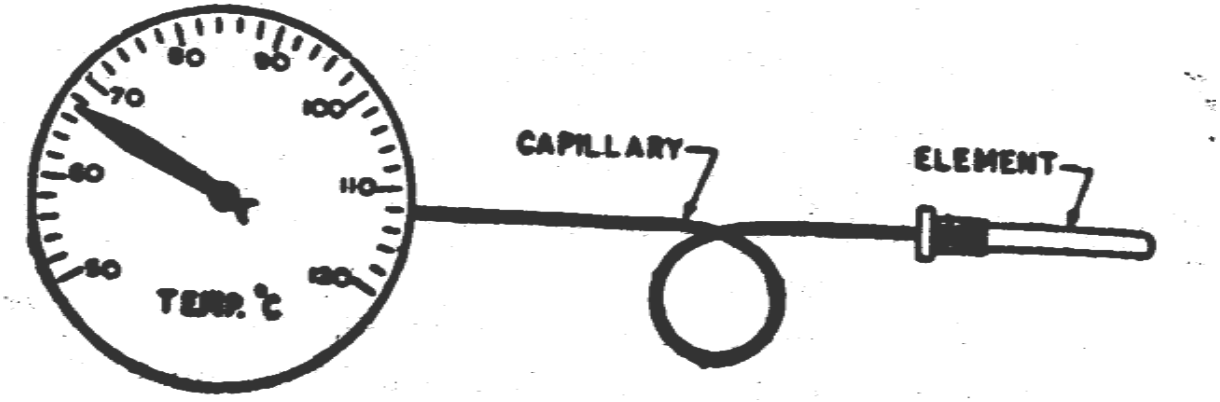
Answer**: Comparison of air and water cooling system**:*(Any Four)* 4

Sr.	Water Cooling	Air Cooling
1	In this system cooling medium used is water	In this system cooling medium used is Air.
2	As compared to air cooling its efficiency is more.	As compared to water cooling its efficiency is low
3	It is heavier in weight.	It is light in weight.
4	Regular maintenance is required.	No maintenance is required.
5	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.
6	The engine design is complex	The engine design is simple
7	The warm up performance is poor ,this results in greater cylinder wear.	The warm up performance is better, this results in low cylinder wear
8	It is used in four wheelers, HMV,LMV, cars, buses, trucks etc.	It is used in two/ three wheelers like motorcycles, scooters, auto rickshaw etc.

f) Explain working of bourdon tube type temperature indicator with neat sketch. 4

Answer: **Bourdon tube type temperature indicator:**

This has a Bourdon tube inside, which is connected by a capillary tube to the element, containing some volatile liquid at suitable temperature and which is inserted in the cooling water circuit at an appropriate point, generally on the engine side of the thermostat. As the temperature of cooling water increases, the liquid in the element evaporates and exerts its pressure in the capillary, which is further transmitted to the Bourdon tube. Due to this pressure, the Bourdon tube tries to straighten out and thus moves a pointer attached to it, to show higher temperature on it. 2



2

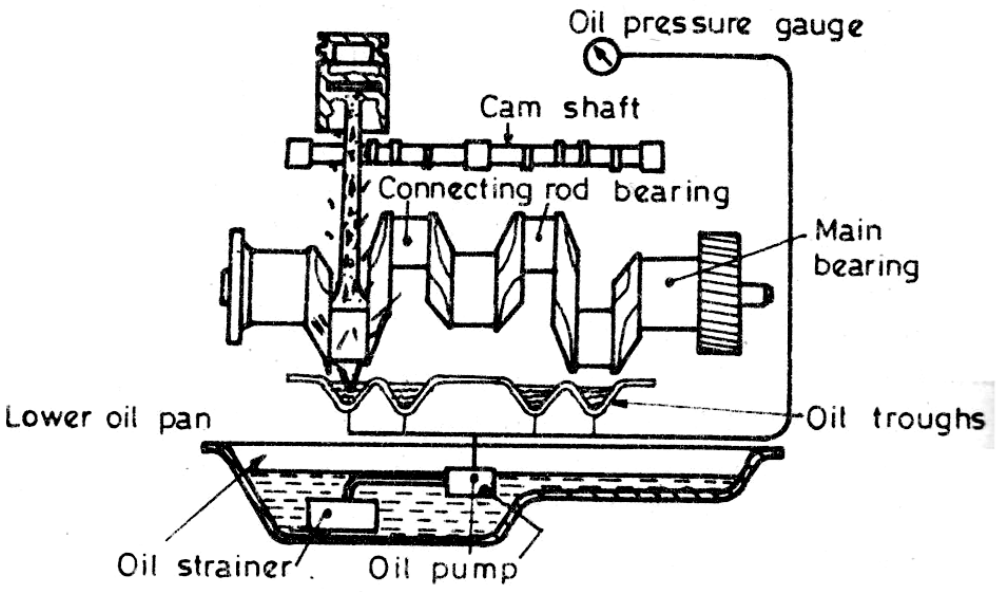
Fig: Bourdon tube type temperature indicator

5. Attempt any FOUR of the following:	16
a) Explain construction and working of splash lubrication system.	4

Answer: **Construction and working of splash lubrication system**:

This was employed for the engine of early vehicles. It is one of the cheapest methods of engine lubrication. A scoop is made in the lowest part of the connecting rod and the oil is stored in the oil trough. 2

Oil is being pumped there from the crankcase oil sump to the oil$ trough. When the engine runs the scoop causes the oil to splash on the cylinder walls each time it passes through in B.D.C. position .This affects the lubrication of the engine walls, gudgeon pin, main crankshaft bearings, big end bearing etc. 2



OR

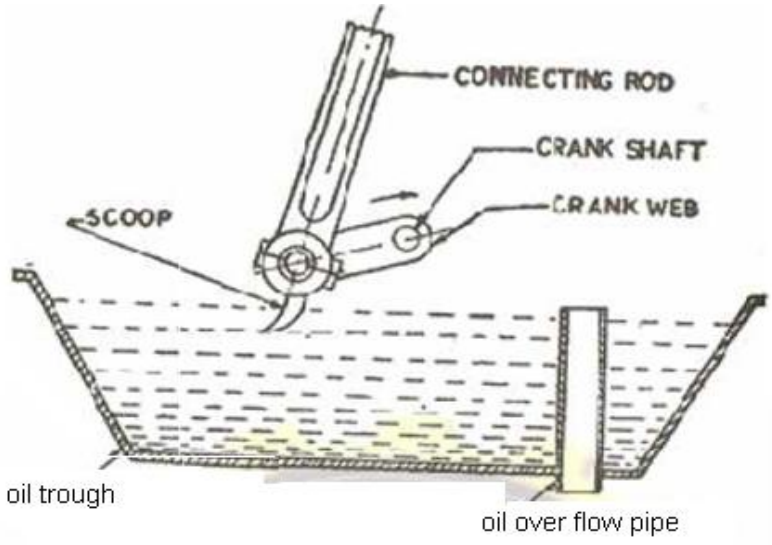
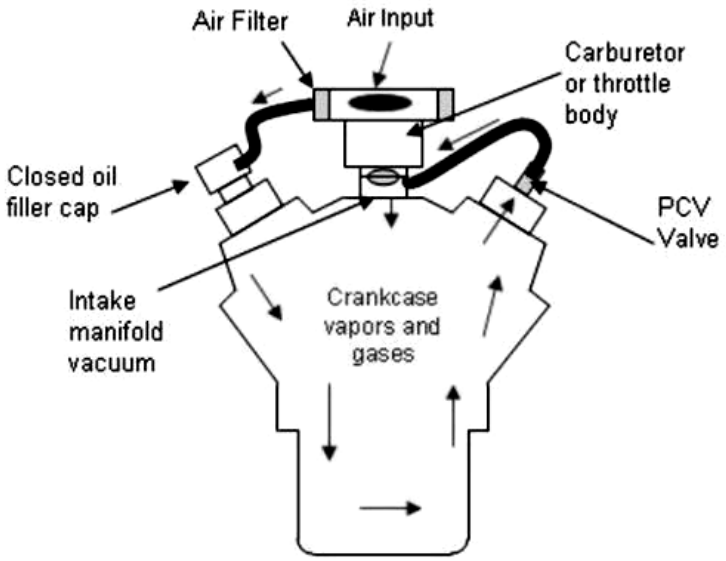
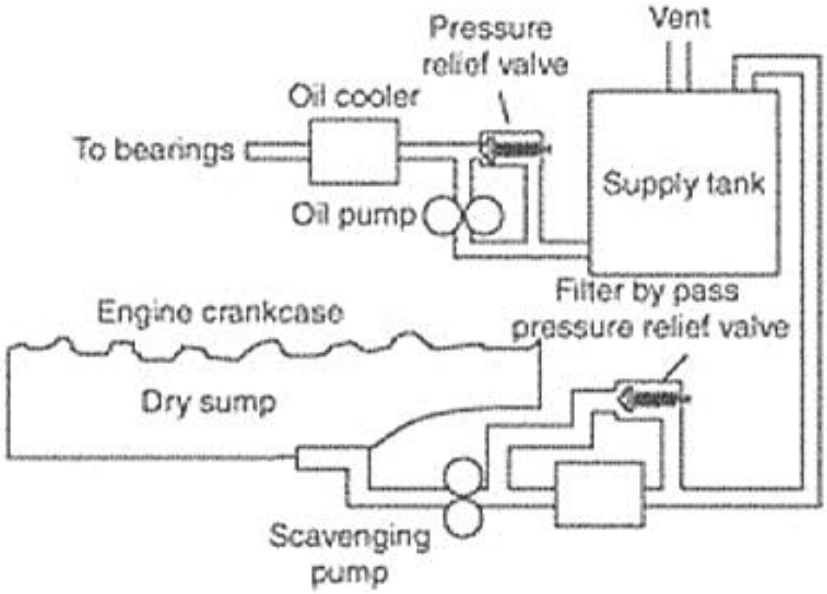
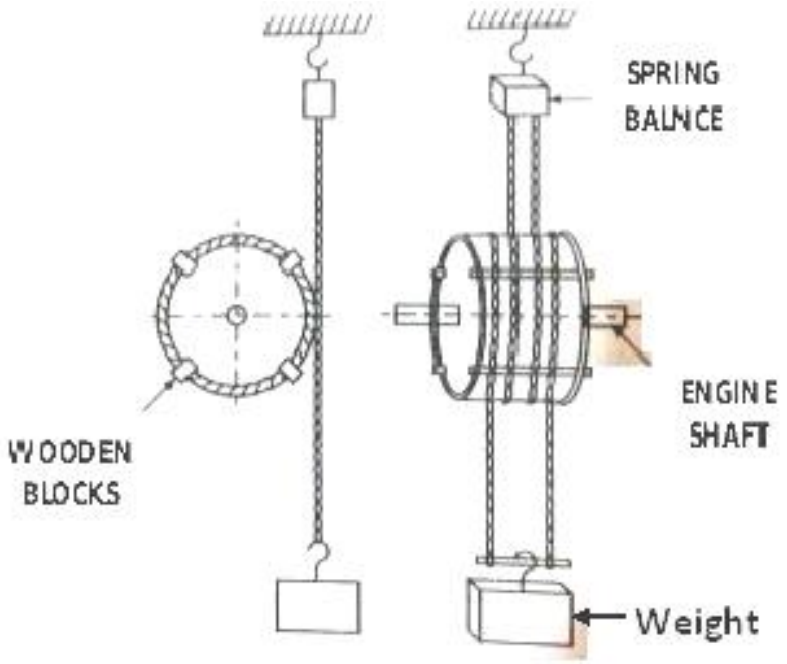


Figure: Splash lubrication system

b) Describe working of positive crank case ventilation with suitable diagram.	4
Answer: **Working of Positive Crankcase Ventilation System**: PCV system is used to reduce the HC emission and improve the fuel economy as well as to relieve any pressure build-up in the crankcase which may cause crankshaft seal leakage. 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  Figure: PCV system.	2 2
c) Give a layout of dry sump lubrication system and explain its working.	4
Answer: **Layout of dry sump lubrication system and explain its working:**  Figure: dry sump lubrication system	2

Working of dry sump lubrication system: In this system, the lubricating oil is not stored in oil sump .The oil from the sump is carried to a separate storage tank outside the engine cylinder block. The oil from sump is pumped by means of a scavenging pump through filter to the storage tank. Oil from storage tank. Oil from storage tank is pumped to the engine cylinder through oil cooler. Oil pressure may vary from 3 to 8 bar. Dry sump lubrication system is generally adopted for high capacity engines. The pressure relief valves are used to maintain the predefined pressure value inside the lubricating system.	2
d) State additives of lubrication oil with their function. (minimum 4 points)	4
Answer: **Additives of lubrication oil and their function:** 1) **Viscosity index improvers**:- long chain, high molecular weight polymers Function: - To increase viscosity of oil more at high temperatures than at low temperatures. **2) Pour point depressants**:- Alkyl aromatic polymers Function: - To reduces the lowest temperatures (pour point) at which oil will flow. **3) Antioxidant**:- Aromatic amine compounds Function: - To minimize and delay the oxidation of lubricant & its degradation. **4) Extreme-pressure (E.P.) additives**:- polysulfides, phosphate, dithiophosphates, and dithiocarbamates. Function: - To prepare a thin layer of lubricant under boundary lubrication conditions i.e. under high load condition	1 1 1 1
e) Define the following: i) Brake power ii) Indicated power iii) Mechanical efficiency iv) Relative efficiency	4
Answer: Definition: **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) Relative Efficiency:** It is the ratio of thermal efficiency to the air standard efficiency**.**	1 1 1 1
f) State working principle of rope brake dynamometer with neat sketch.	4
Answer: **Working principle of rope brake dynamometer:** *(Diagram-1 mark, Description - 2marks)* Dynamometer is a device for measuring force and torque and hence power. It works on the principal of absorption Transmission, in which case it is known as Transmission Dynamometers. It measure and absorb the power output of the engine to which it is coupled. The power absorbed is usually dissipated as heat. 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.	2

At constant engine speed, the power developed by an engine is equal to the power absorbed by the rope brake dynamometer. The brake power can be calculated as follows: $BP = \pi DN (W-S)/60$ (watt) Where , D = Brake drum diameter (m) W = Weight (N) S = spring scale reading.(N) N= RPM of engine.  ROPE BRAKE DYNAMOMETER	2
6 . Attempt any TWO :	16
a) State the necessities of heat balance sheet and give procedure in details to prepare heat a balance sheet.	8
Answer: **Necessities:** 1. To know an account of heat supplied and heat distributed in various ways in the system. 2. To analyses the performance of the engine. **Procedure to prepare Heat balance sheet supplied:** **Heat supplied by fuel:** Heat supplied to engine $Qs = m_f \times C_v$, where m_f and C_v are mass used per minute (kg) and lower calorific value (kJ or kcal) of the fuel respectively.	1 1

Heat distribute in various ways in the system:-

1) Heat absorbed in B.P.: 1

Heat equivalent of B.P. (per minute) $Q_{.B.P}$ = B.P. X 60 kJ/min

2) Heat taken away by cooling water:

If, m_w= Mass of cooling water used per minute

t_1= Initial temperature of cooling water, and

t_2= Final temperature of cooling water, 1

Then heat taken away by water $Q_w = m_e \times c_w \times (t_2 - t_1)$

Where c_w = specific heat of water

3) Heat taken away by exhaust gases

If, m_e = Mass of exhaust gases (kg/min)

c_{pg} = Mean specific heat at constant pressure, 1

t_e = Temperature of exhaust gases, and

t_r = Room (or boiler house) temperature.

Then heat carried away by exhaust gases $Q_g = m_e \times c_{pg} \times (t_e - t_r)$

4) Unaccounted heat losses Q_{un}:

$Q_{un} = Q_s - (Q_{.B.P} + Q_w + Q_g)$ in KJ / min 1

Heat balance sheet

Item	kJ/min	Percent
Heat supplied by fuel	-----	-----
1) Heat absorbed in I.P.	-----	-----
2) Heat taken away by cooling water.	-----	-----
3) Heat carried away by exhaust gases	-----	-----
4) Heat unaccounted for (by difference)	-----	-----
Total		

2

b) A four stroke engine with four cylinders, bore 80mm and stroke 100 mm was tested at 3500 rpm and following data were recorded: 8

Fuel Consumption = 300 gm/minute

Indicated mean effective pressure = 1MPa

Engine torque developed =140N-m

If the calorific value of fuel used in 42000 kJ/kg. Calculate

i) I.P.of the engine

ii) Mechanical efficiency

iii) Brake thermal efficiency

Answer:

Given data :

No of stroke = n = 4

Speed = N = 3500 rpm

$N' = \frac{N}{2}$ …….For Four Stroke Engine

$N' = \frac{3500}{2} = 1750$ rpm 1

Bore = D = 80mm = 0.08m

Area = A = $\frac{\pi}{4}D^2 = \frac{\pi}{4}0.08^2 = 5.026\times10^{-3} m^2$

Stroke = L = 100mm = 0.1m

$$\text{Fuel cunsumption} = m_f = 300\text{gm/minu te} = \frac{300}{1000\times60} = 5\times10^{-3}\ kg/\text{sec}$$

Indicated mean effective pressure = P_i = 1 Mpa = 1×10^6 N/m^2 1

C.V. = 42000 kJ/kg

(i) I.P. of the engine

$$\text{I.P.} = \frac{nP_i LAN'}{60\times1000}\text{kW}$$ 1

$$= \frac{4\times1\times10^6\times0.1\times5.026\times10^{-3}\times1750}{60\times1000} = 58.64kW$$

I.P. of the engine = 58.64 kW 1

(ii) Mechanical efficiency

$$\text{B.P.} = \frac{2\pi N T}{60\times1000}$$ 1

$$\text{B.P.} = \frac{2\times3.14\times3500\times140}{60\times1000} = 51.31\text{ kW}$$

$$\eta_{mech} = \frac{\text{B.P.}}{\text{I.P.}}\times100\%$$

$$= \frac{51.31}{58.64}\text{ X }100$$

$$\eta_{mech} = 87.5\%$$

Mechanical efficiency = 87.5 % 1

iii) Brake thermal efficiency

$$\eta_{Bth} = \frac{\text{B.P.}}{m_f\times\text{c.v.}}\times100\%$$ 1

$$= \frac{51.31}{5\times10^{-3}\times42000}\times100$$

$$\eta_{Bth} = 24.44\%$$

Brake thermal efficiency = 24.44 % 1

c) In a test of a four – cylinder four stroke petrol engine with 80 mm bore and 100 mm stroke the following results were obtained at particular speed: B.P. with all cylinder working = 21.0 kW B.P. with cylinder no.1cut out = 14.5 kW B.P. with cylinder no.2 cut out = 14.3 kW B.P. with cylinder no.3 cut out = 13.9 kW B.P. with cylinder no.4 cut out = 14.7 kW Calculate : i) I.P. of the engine ii) Indicated thermal efficiency of the engine, if the calorific value of fuel is 42000kJ/kg. iii) Relative efficiency, if the clearance volume of each cylinder is 96 X 10^3 mm^3.	8
Answer: Given Data:- No of stroke = n = 4 Bore = D = 80mm = 0.08m Area = A = $\frac{\pi}{4}D^2 = \frac{\pi}{4}0.08^2 =$ 5.027 X 10^{-3} m^2 Stroke = L = 100mm = 0.1m Fuel cunsumption $= m_f = 120$ gm/minute $= \frac{120}{1000\times 60} = 2\times 10^{-3}\ kg/\sec$ C.V. = 42000 kJ/kg (i) I.P. of the engine I.P. = I.P.$_{(1)}$+ I.P.$_{(2)}$+ I.P.$_{(3)}$+ I.P.$_{(4)}$ I.P.$_{(1)}$ = B.P. with all cylinder working – B.P. with cylinder no 1 cut out = 21- 14.5 = 6.5 kW I.P.$_{(2)}$ = B.P. with all cylinder working – B.P. with cylinder no 2 cut out = 21- 14.3 = 6.7 kW I.P.$_{(3)}$ = B.P. with all cylinder working – B.P. with cylinder no 3 cut out = 21- 13.9 = 7.1 kW I.P.$_{(4)}$ = B.P. with all cylinder working – B.P. with cylinder no 4 cut out = 21- 14.7 = 6.3 kW I.P. = I.P.$_{(1)}$+ I.P.$_{(2)}$+ I.P.$_{(3)}$+ I.P.$_{(4)}$ I.P. = 6.5+ 6.7+ 7.1+ 7.1 = 26.6 kW	1 2

I.P. of the engine = 26.6kW

(i) Indicated thermal efficiency

Indicated thermal efficiency = $\eta_{ith} = \frac{\text{I.P.}}{m_f \times \text{c.v.}} \times 100\%$ 1

$$= \frac{26.6}{2 \times 10^{-3} \times 42000} \times 100$$

$$\eta_{ith} = 31.66\%$$

Indicated thermal efficiency = 31.66 % 1

(ii) Relative efficiency

Relative efficiency = $\eta_{rel} = \frac{\eta_{ith}}{\eta_{air\,stand}} \times 100\%$ 1

Clearance volume = $V_c = 96 \times 10^3 mm^3 = 96 \times 10^{-6} m^3$

Swept Volume = $V_s = \frac{\pi}{4} D^2 \times L = \frac{\pi}{4} 0.08^2 \times 0.1 = 5.026 \times 10^{-4} m^3$

Compression ratio = $R_c = \frac{V_s + V_c}{V_c} = \frac{(5.026 \times 10^{-4}) + (96 \times 10^{-6})}{(96 \times 10^{-6})} = 6.22$

Assume ratio of specific heat $\gamma = 1.4$

Air standard efficiency = $\eta_{air\,stand} = 1 - \frac{1}{R_c^{\gamma-1}} \times 100\,\%$

$$= 1 - \frac{1}{6.22^{(1.4-1)}} \times 100\,\%$$

$$= 51.89\,\%$$

Relative efficiency = $\eta_{rel} = \frac{\eta_{ith}}{\eta_{air\,stand}} \times 100\%$ 1

$$= \frac{31.66}{51.89} \times 100\%$$

$$= 61\%$$

Relative thermal efficiency = 61 % 1