Subject Name: Automobile Engine **Subject Code:** 22308

WINTER– 18 EXAMINATION

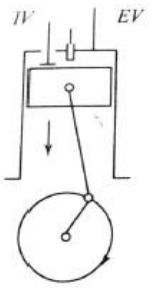
Model Answer

Important Instructions to examiners:

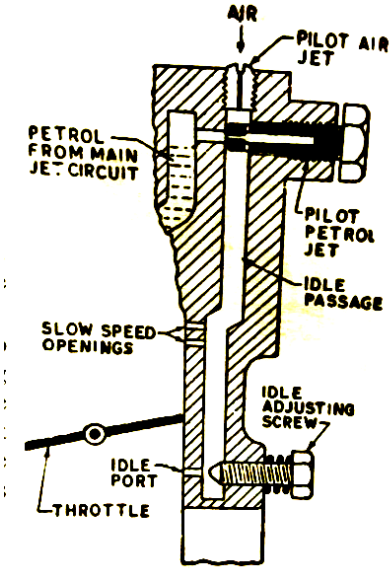
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 judgement 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.

Q. No	Sub Q.N.	Answer	Marking Scheme
1	A)	**Attempt any FIVE:**	**10**
	(a)	**Define internal combustion engine**	**02**
	Ans	**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).	**02**
	(b)	**Classify I. C. Engine on the basis of** **-Cycle of operation** **-Method of cooling**	**02**
	Ans	Classification of I. C. Engine on the basis of (one mark each) -Cycle of operation: a) Otto cycle engine b) Diesel cycle engine c) Duel combustion engine or semi-diesel cycle engine -Method of cooling: a) air cooled engine b) water cooled engine	**02**
	(c)	**State the function of exhaust manifold.**	**02**
	Ans	**Function of exhaust manifold:** The exhaust manifold collects the products of combustion (exhaust gases) from two or more cylinders and conducts these to a single exhaust pipe. The exhaust manifold is designed to minimise restriction to the flow of exhaust gases. The exhaust manifold helps to increase the speed at which exhaust leaves the system.	**02**

	(d)	**List the function of air filter**	**02**
	Ans	**function of air filter: (Any two)** **1.** Filters are used to remove foreign particles like dirt, dust and grit or filters are used to remove dust and particles out of the air. **2.** It may also remove odors and gaseous pollutants. **3.** It acts as a silencer for the carburation system. **4.** In case the engine backfires, the air filter also acts as a flame arrester. As hundreds of cubic meters of air per hour is used by the engine of an automobile, it is very important that this air should be very clean. Impurities like dust in the air cause a very rapid wear if the engine, particularly of the cylinders, pistons, rings, valves and guides. Further if the dirty air enters the crankcase, it will contaminate the lubricant oil and ultimately damage the bearings and journals and decrease the service period of the lubrication system. It is therefore customary to install air filter on the intake system of automobile engines.	**02**
	(e)	**State the common firing orders used in 4 cylinder engine.**	**02**
	Ans	**Firing order:** The sequence in which the power impulses occur in an engine is called the firing order. Firing order for 4 cylinder engine.(Any one) 1-3-4-2 **OR** 1-2-4-3 **OR** 1-4-3-2	**02**
	(f)	**List any two advantages of water cooling over Air Cooling.**	**02**
	Ans	**Answer:** *(Any two)* **Advantages of water cooling system** 1. Engine can be installed anywhere on the vehicle 2. Volumetric Efficiency of water cooled engine is more than air cooled engine 3. Uniform cooling of cylinder, cylinder head and valves. 4. Specific fuel consumption of engine improves by using water cooling system. 5. Engine is less noisy as compared with air cooled engines, as it has water for damping noise.	**02**
	(g)	**Define brake power and frictional power.**	**02**
	Ans	**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 OR The actual power available or delivered at the crankshaft. **Frictional power:** The difference between the Indicated power and Brake power is called as frictional power. It is the power lost in overcoming the friction between the moving parts.	**01** **01**
2		**Attempt ant THREE:**	**12**
	(a)	**Describe the working of four stroke C. I. engine with neat sketch.**	**04**
		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	**02** **02**
	(b)	**Compare Dry Liner and Wet Linker.**	**04**
	Ans	**Answer:** *(Any four)* S. N. | DRY LINERS | WET LINERS 1 | Dry liners are **not in direct contact** with cooling water hence it is known as dry liners. | Wet liners are **in direct contact** with cooling water on the outside hence it is known as dry liners. 2 | It is **difficult to replace** | It is **easy to replace** 3 | **No leak proof joint** is provided in case of dry liners. | **A leak proof joint** are provided in case of wet liners. 4 | In dry liners the casting of cylinder block is **complicated** | In wet liners the casting of cylinder block is **very simple.** 5 | A cylinder block with dry liners is generally **more robust** | A cylinder block with wet liners is generally **less robust compare to dry liner** 6 | For perfect contact between liner and the block casting, **very accurate machining** of block and outer liner surface is required | No such necessity in case of wet liners. 7 | A dry liner **cannot be finished correctly**, before fitting, because of the **shrinkage** stress produced. | A wet liner **can be finished accurately**, before fitting.	**01 mark each**

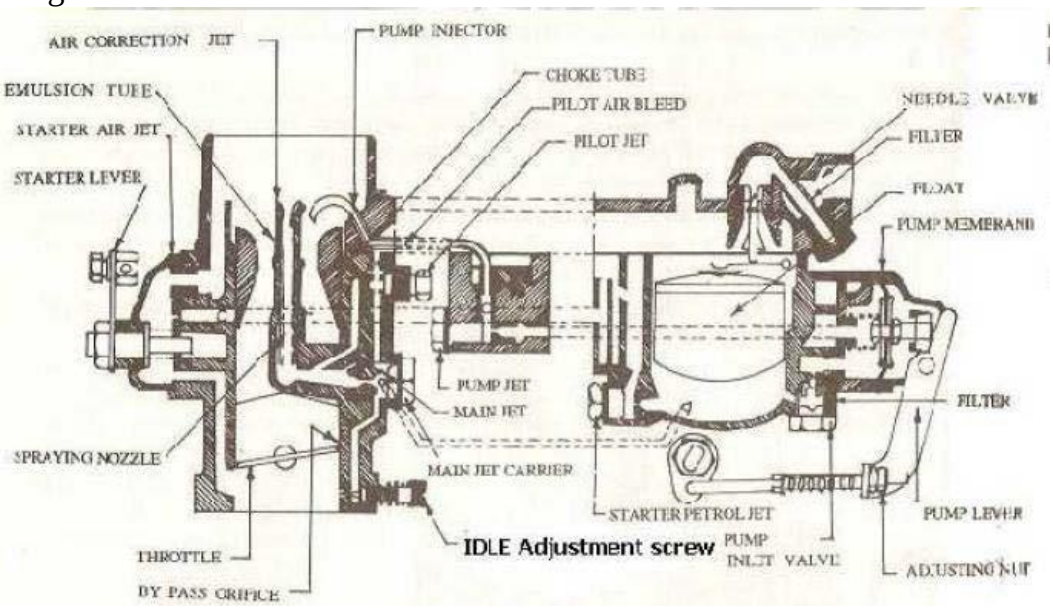
	(c)	**Describe the working of Idling circuit used in carburettor**	**04**
	Ans	**Idling or Low speed operation:** The throttle valve is almost closed. Engine suction is applied at pilot petrol jet. The jet draws petrol from main jet circuit. The air is drawn from pilot air jet. The air and petrol mix in the idle passage. When the throttle valve is opened wide suction decreases at idle port and applied at slow speed openings.	**02**



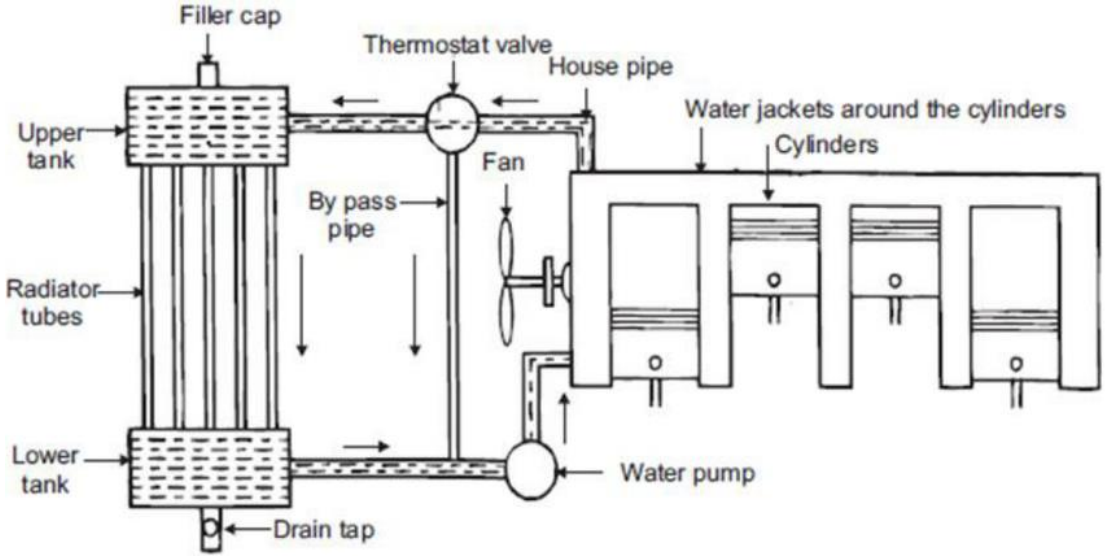
02

OR **OR**

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 **02**

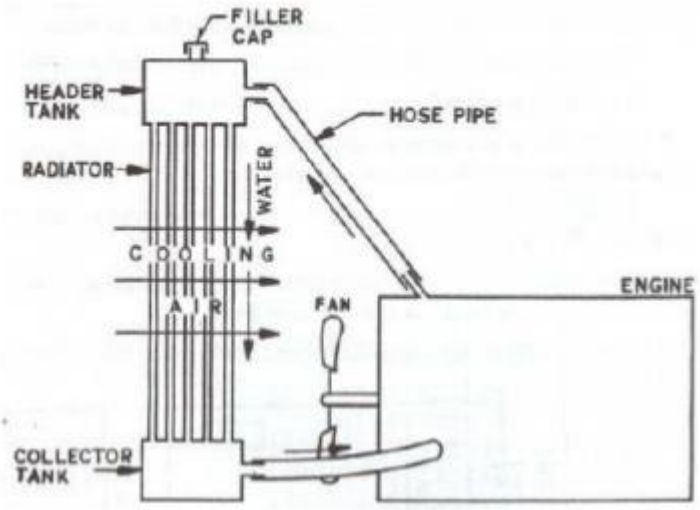


02

	(d)	**Describe the working of water/liquid cooling system with neat sketch.**	**04**
		A water-cooled engine block and cylinder head have interconnected coolant channels running through them. At the top of the cylinder head all the channels converge to a single outlet. A pump, driven by a pulley and belt from the crankshaft, drives hot coolant out of the engine to the radiator, which is a form of heat exchanger. Unwanted heat is passed from the radiator into the air stream, and the cooled liquid then returns to an inlet at the bottom of the block and flows back into the channels again. Usually the pump sends coolant up through the engine and down through the radiator, taking advantage of the fact that hot water expands, becomes lighter and rises above cool water when heated. Its natural tendency is to flow upwards, and the pump assists circulation. The radiator is linked to the engine by rubber hoses, and has a top and bottom tank connected by a core a bank of many fine tubes. The tubes pass through holes in a stack of thin sheet-metal fins, so that the core has a very large surface area and can lose heat rapidly to the cooler air passing through it. On older cars the tubes run vertically, but modern, low-fronted cars have cross flow radiators with tubes that run from side to side. In an engine at its ordinary working temperature, the coolant is only just below normal boiling point. The risk of boiling is avoided by increasing the pressure in the system, which raises the boiling point. The extra pressure is limited by the radiator cap, which has a pressure valve in it. Excessive pressure opens the valve, and coolant flows out through an overflow pipe. In a cooling system of this type there is a continual slight loss of coolant if the engine runs very hot. The system needs topping up from time to time. Later cars have a sealed system in which any overflow goes into an expansion tank, from which it is sucked back into the engine when the remaining liquid cools.  **OR**	**02** **02**

There are two systems of water cooling (Any one)

1. **Thermosiphon system:** In this system of water cooling, the circulation of water is obtained due to the difference in densities of hot and cold regions of the water. There is no pump to circulate the water. The hot water from the engine jacket being lighter rises up in the horse pipe and goes in the radiator from the top side. It is cooled there and hence goes down at the bottom side of the engine jackets. The system is quite simple and cheaper, but the cooling is rather slow. To maintain continuity of the water flow, the water must be maintained up to a certain minimum level. If the water level falls down, the circulation will discontinue and the cooling system will fail. **2**

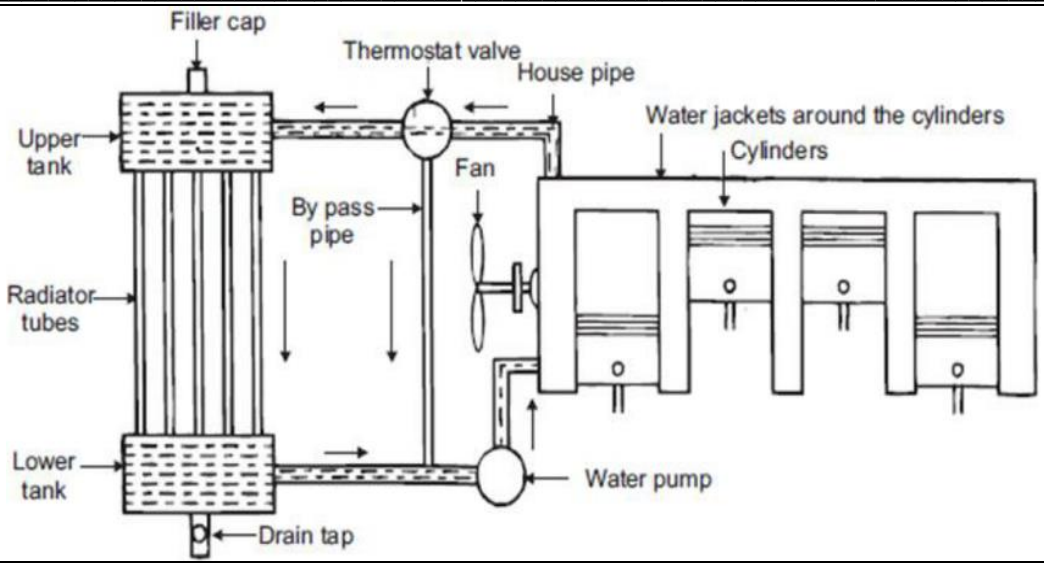
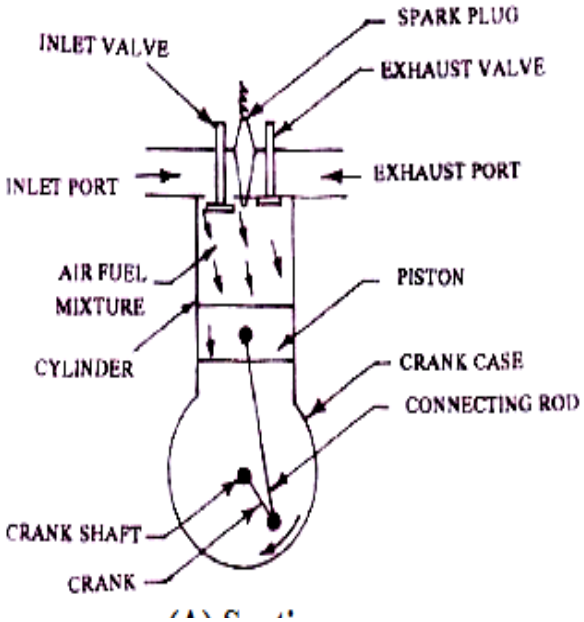


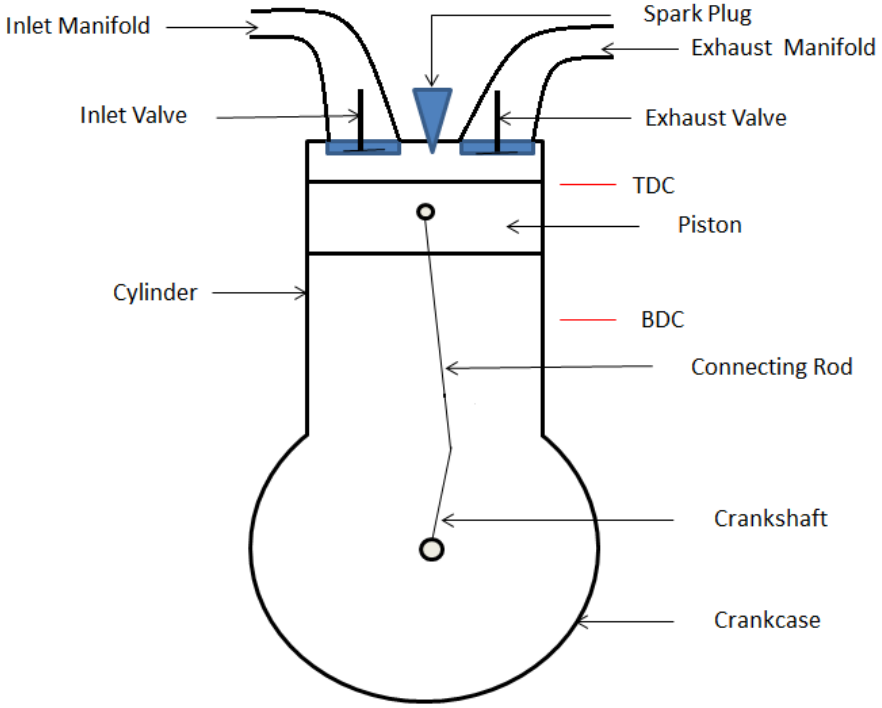
2

OR

2. **Pump circulation system**: in this system of water cooling, the circulation of water is obtained by a pump. The pump is driven by means of a V-belt from a pulley on the engine crankshaft. The system is more effective. The circulation of water becomes faster as the engine crankshaft. The system is more effective. The circulation of water becomes faster as the engine speed increases. There is no necessity of maintaining the water up to a correct level**.** **2**

2

			
03		**Attempt any THREE**	**12**
	(a)	**Show the following components in an engine with neat sketch: piston, connecting rod, valves, spark plug**	**04**
		 OR	**04**



04

(b) **Distinguish between overhead cam and overhead valve arrangement** **04**

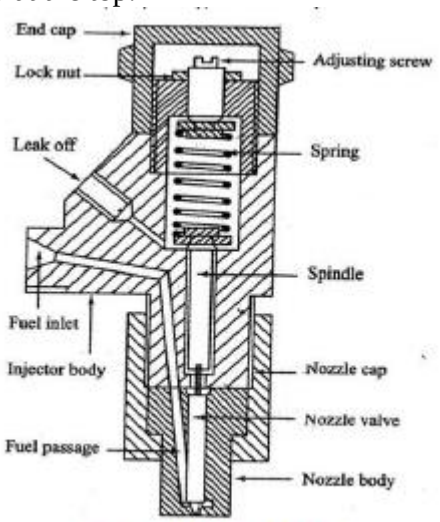
(Any 4)

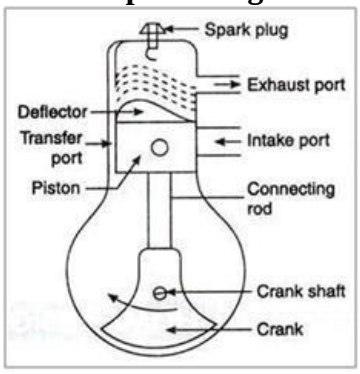
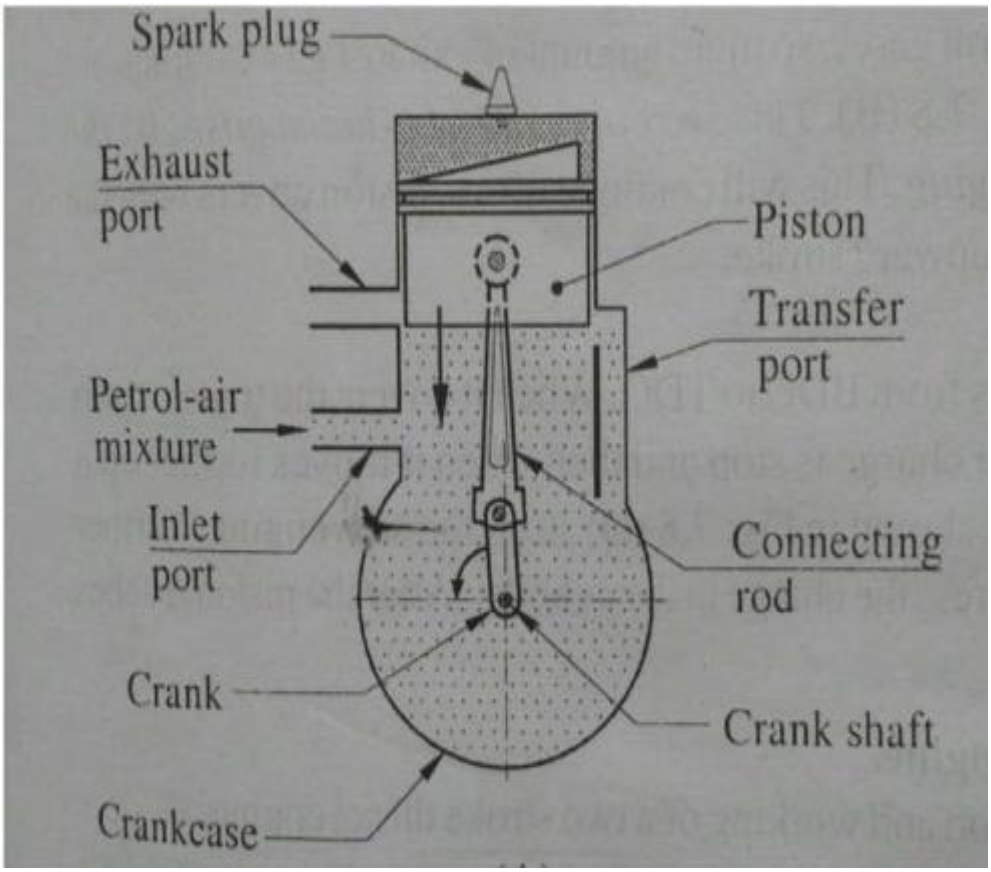
SR. NO.	Overhead cam	Overhead valve arrangement
01	This mechanism complicated in construction due to space contraint.	This mechanism simpler than overhead camshaft type.
02	The valves operating mechanism with overhead camshaft are highly efficient and less expensive.	This type arrangement engines are less efficient and also more expensive.
03	In this arrangement the distance between the cam and valves is much shorter.	In this arrangement the distance between the cam and valves is much more.
04	Valve response is quicker and valve adjustment can be more accurate.	Valve response is slower and valve adjustment cannot be more accurate.

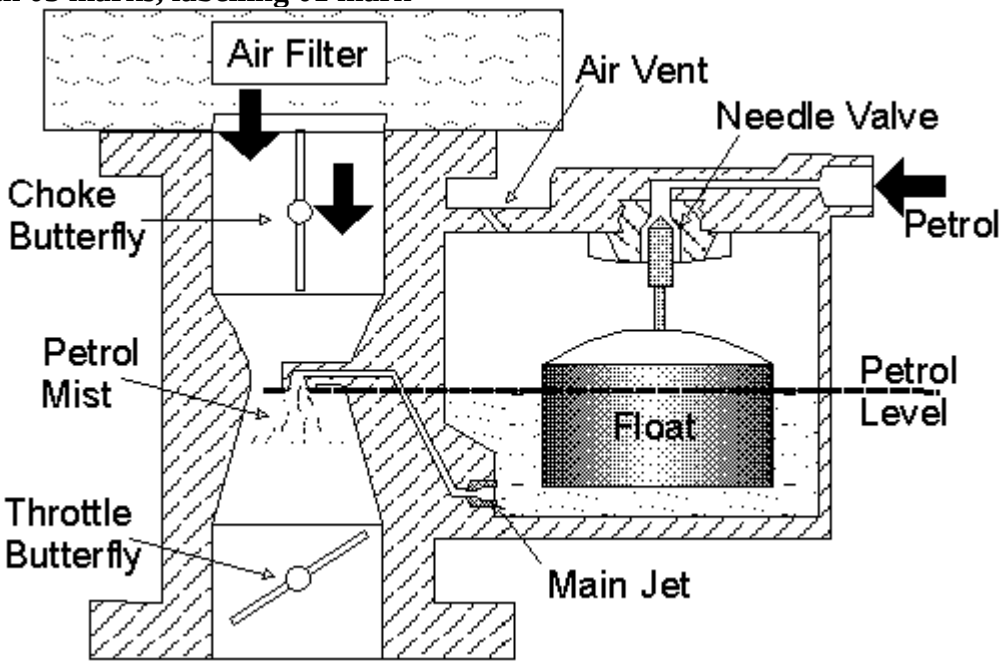
04

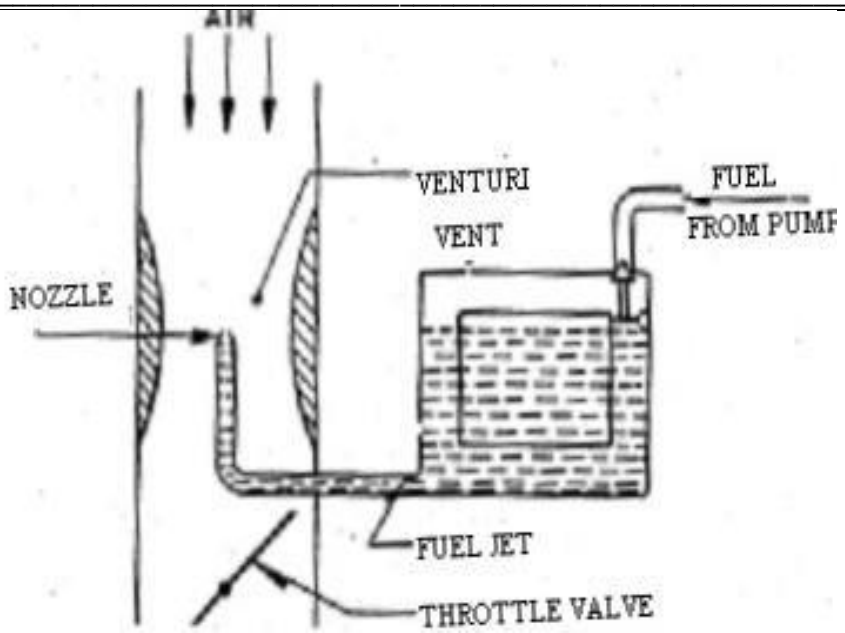
c) **Illustrate with neat sketch the construction of fuel injector** **04**

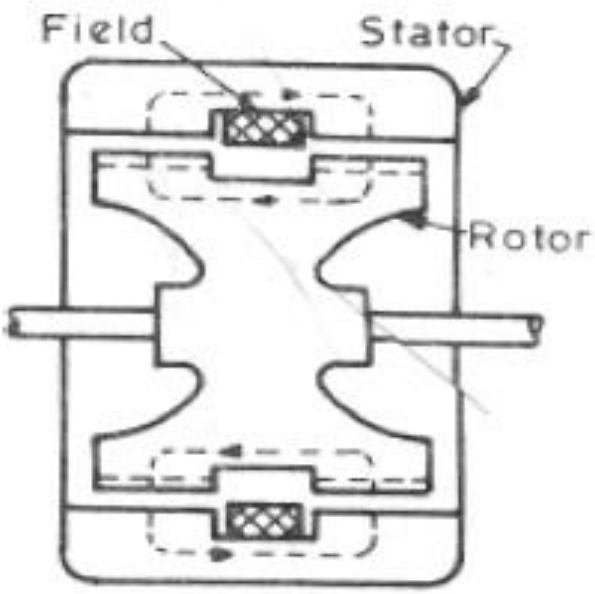
Answer: *(Diagram-2 marks, explanation-2 marks)*
Diesel Fuel Injector: The injector assembly consists of - i) a needle valve ii) a compression spring iii) a nozzle iv) an injector body. When the fuel is supplied to lift the injection pump it exerts sufficient force against the spring to lift the nozzle 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.  Figure: Diesel Fuel Injector	**02** **02**
	(d)	**State the use of oil additives used in lubricating oil**	**04**
		These are the chemical substances which are added to the lubricating oil either to reinforce some of its natural properties or to provide it with certain new properties which it does not possess originally. **Additives of lubrication oil and their function:** 1) **Viscosity index improvers**:- long chain, high molecular weight polymers **2) Pour point depressants**:- Alkyl aromatic polymers **3) Antioxidant**:- Aromatic amine compounds **4) Extreme-pressure (E.P.) additives**:- polysulfides, phosphate, dithiophosphates, and dithiocarbamates. **5) Oxidation inhibitors:-**Organic compounds such as amines, sulphides or phenols with metals like tin, zinc **6) Anti-foaming additives**: - polyorganosiloxanes.	**04**
04		**Attempt any THREE:**	**12**
	(a)	**(i) state any two applications of I. C. Engine** **(ii) Draw a neat sketch of Two stroke petrol engine.**	**04**
	Ans	Answer: *(Any two)* **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	Any four – ½ marks each

		(ii) Draw a neat sketch of Two stroke petrol engine.  Fig. Two Stroke Petrol Engine **OR**  Fig. Two Stroke Petrol Engine	02
	(b)	**State any four requirements of gasket**	**12**
	Ans	**Requirement of Gasket:** *(Any 4)* Gaskets are used to provide a tight fitting joint between two surfaces.	

		For example, the joint between cylinder head and block. 1. **Conformity: -** The gaskets must be able to conform to the mating surfaces which may have roughness or warpage. 2. **Impermeability: -** The gaskets must be impermeable to the fluid it is expected to seal. 3. **Resistance to chemical attack: -** the gaskets should be resistant to the chemicals with which it may come in to contact. 4. **Resistance to operating conditions: -** The cylinder head gasket should be resistant to widely fluctuating and pulsating internal pressures and temperatures and exposure to flame. 5. **Provision of apertures: -** The gasket must have apertures for any studs, bolts, opening etc.	**04**
	(c)	**Sketch and label simple carburettor**	**04**
	Ans	**Sketch 03 marks, labelling 01 mark**  Fig. Simple Carburettor **OR**	**04**

		 Fig. Simple Carburettor	
	(d)	**Describe the working of electrical dynamometer**	**04**
		Electric Dynamometer:- These may be either the i) Swinging field type ii) Eddy current type. **Working principle of eddy current dynamometer**: *(Sketch - 2mark, Description-2 marks)*	**02**

		 Figure: Working principle of Eddy current dynamometer *(Note: Credit should be given to suitable diagram)* The details of eddy current dynamometer are shown in figure. It consists of a stator on which are fitted a number of electromagnets and a rotor disc made of copper or steel and coupled to the output shaft of the engine. When the rotor rotates eddy currents are produced in the stator due to magnetic flux set up by the passage of field current in the electromagnets. These eddy current oppose the motion, thus loading the engine. These current are dissipated in producing heat so that this type of dynamometer also requires some cooling arrangement. The torque is measured exactly as in other types of absorption dynamometer i.e. with the help of a movement arm. The load is controlled by regulating the current in the electromagnets.	**02**
	(e)	**Draw neat sketch of valve timing diagram for 4-stroke petrol engine & label it.**	**04**
		Sketch 03 marks, labelling 01 mark	**04**

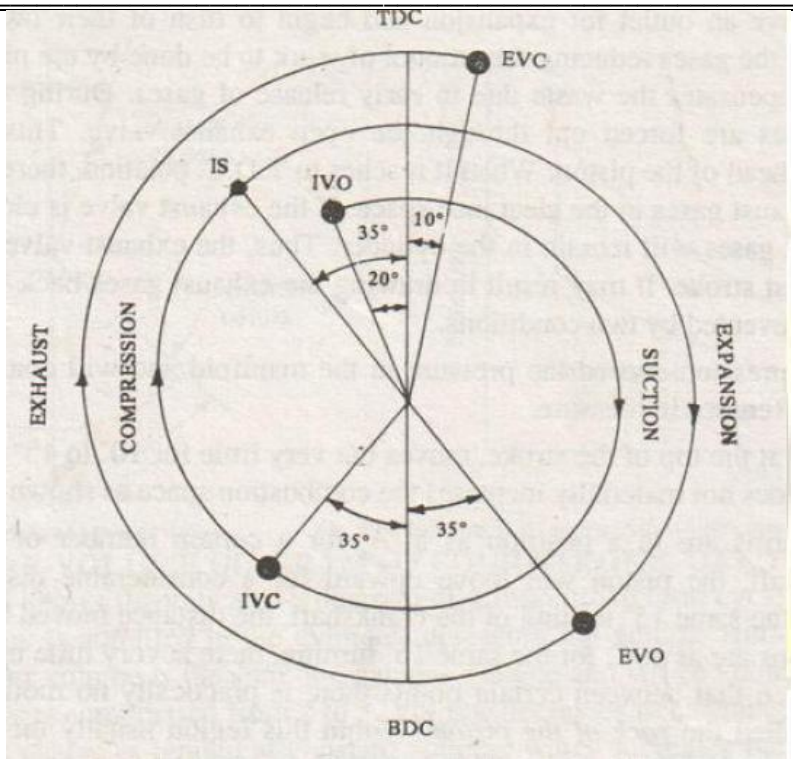
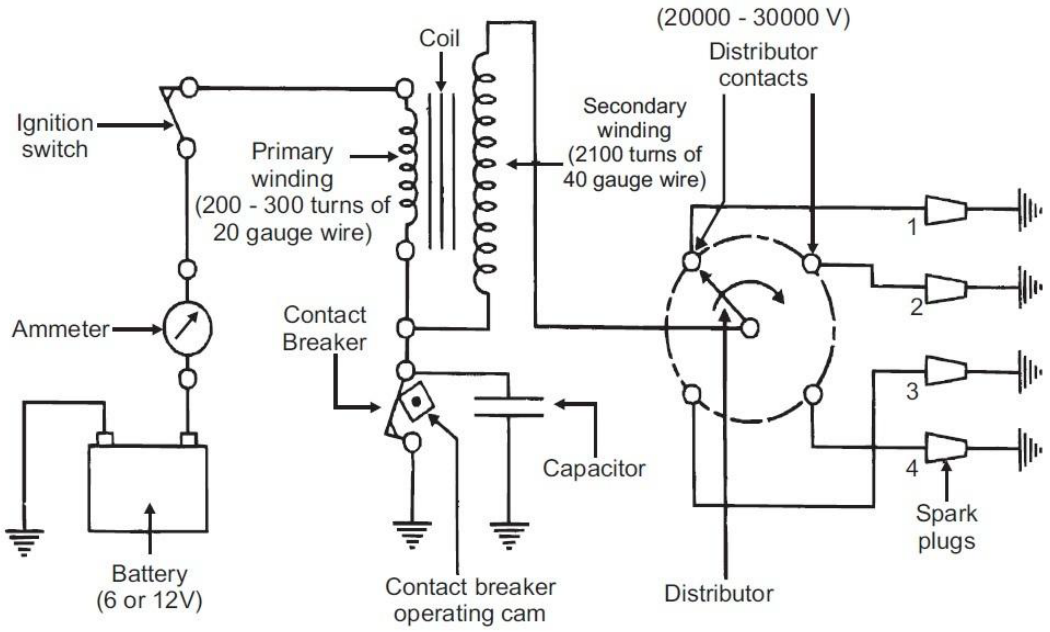


Figure: Valve timing diagram of 4 stroke SI engine

5		**Attempt any TWO:**	**12**
	(a)	**While performing Morse test on a four cylinder petrol engine, the following result were obtained at particular throttle setting and speed.** **B.P. with all cylinders working =32.2 kW** **B.P. with Cylinder no. 01 Cutout = 22 kW** **B.P. with Cylinder no. 02 Cutout = 21.8 kW** **B.P. with Cylinder no.03 Cutout = 22.2 kW** **B.P. with Cylinder no. 04 Cutout = 22.8 kW** **Determine I.P. of the engine and its mechanical efficiency.**	**06**
		Given Data: **B.P. with all cylinders working $(BP)_{engine}$ =32.2 kW** **B.P. with Cylinder no. 01 Cutout, $(BP)_{2,3,4}$ = 22 kW** **B.P. with Cylinder no. 02 Cutout $(BP)_{1,3,4}$= 21.8 kW** **B.P. with Cylinder no.03 Cutout $(BP)_{1,2,4}$= 22.2 kW** **B.P. with Cylinder no. 04 Cutout$(BP)_{1,2,3}$ = 22.8 kW** Let IP of cylinder 1 2 3 and 4 be IP_1, IP_2 ,IP_3 And IP_4 Respectively. The total IP of engine is given by, $(IP)_{engine} = IP_1 + IP_2 + IP_3 + IP_4$ We Know That When cylinder 1 is cut off, the IP developed by cylinders 1 is given by	

		$IP_1 = (BP)_{engine} - \mathbf{(BP)_{2,3,4}}$ $IP_1 = 32.2 - 22$ **$IP_1 = 10.2$ kW** Similarly , IP developed by cylinder 2 is given by $IP_2 = (BP)_{engine} - \mathbf{(BP)_{1,3,4}}$ $IP_2 = 32.2 - 21.8$ **$IP_2 = 10.4$ kW** Similarly , IP developed by cylinder 3 is given by $IP_3 = (BP)_{engine} - \mathbf{(BP)_{1,2,4}}$ $IP_3 = 32.2 - 22.2$ **$IP_3 = 10$ kW** Similarly , IP developed by cylinder 2 is given by $IP_4 = (BP)_{engine} - \mathbf{(BP)_{1,2,3}}$ $IP_4 = 32.2 - 22.8$ **$IP_4 = 9.4$ kW** Total IP of the engine is given by Total IP of Engine = $IP_1 + IP_2 + IP_3 + IP_4$ $= 10.2 + 10.4 + 10 + 9.4$ **$(IP)_{engine} = 40$ kW** Mechanical Efficiency = $\frac{BP}{IP}$ **X 100** $= \frac{32.2}{40} \times 100$ **= 80.5 %**	**01** **01** **01** **01** **01**
	(b)	**Illustrate with neat sketch the working of battery ignition system.**	**06**
		Answer: 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	**03**

		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.  **Figure : Schematic Diagram of Coil/Battery Ignition System** **OR**	**03**

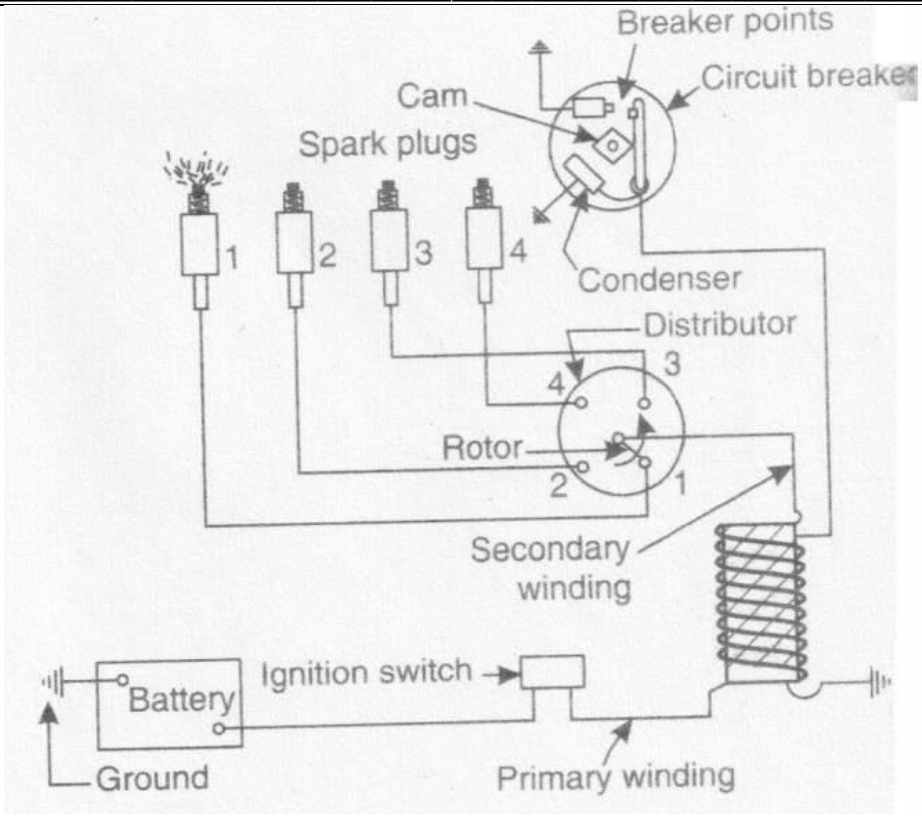
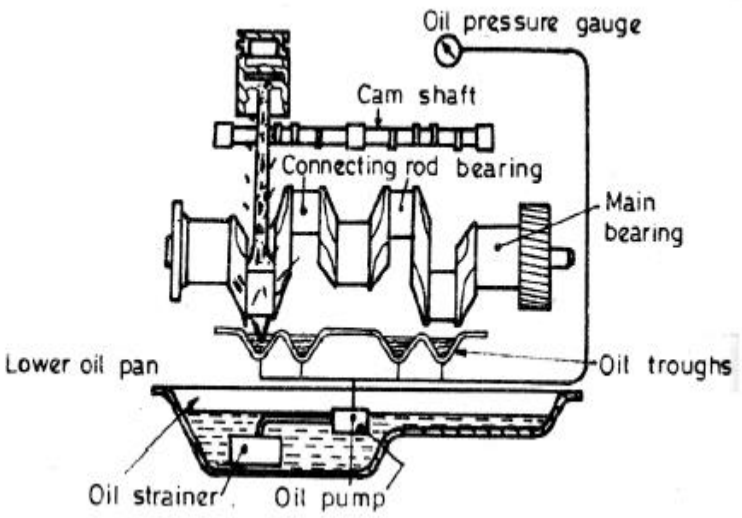


Fig. Battery Ignition System

	(c)	**(i) Illustrate the working of splash lubrication system.** **(ii) state any two functions of lubrication system**	**06**
		(Sketch 2M, Working 2M, functions 02 marks) **(i)** **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. 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.	**02**



02

OR

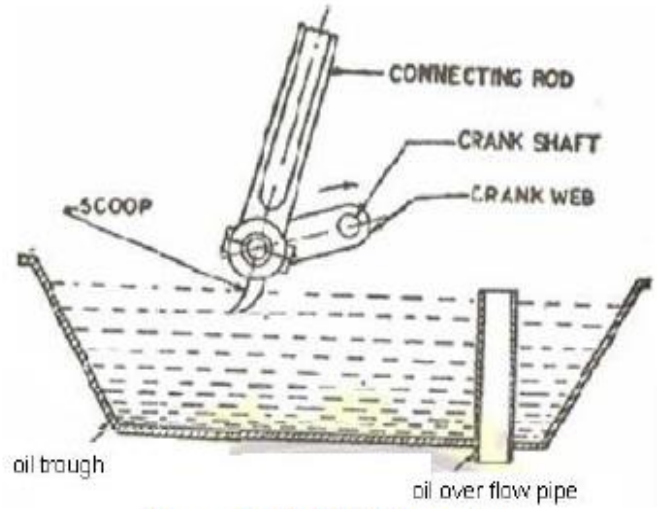
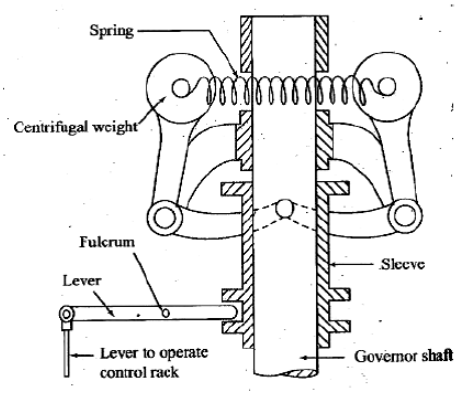


Figure: Splash lubrication system

(ii) State any two functions of lubrication system: *(Any two)*

1. To provide a barrier between moving parts to reduce friction, heat build-up, and wear.
2. To disperse heat - Friction from moving parts and combustion of fuel produce heat that must be carried away.
3. Absorb and suspend dirt and other particles. Dirt and carbon particles need to be carried by the oil to the oil filter where they can be trapped. -
4. Neutralize acids that can build up and destroy polished metal surfaces.
5. Coat all engine parts. Oil should have the ability to leave a protective coating on all parts when the engine is turned off to prevent rust and corrosion.
6. Resist sludge and varnish build-up.

02

06		**Attempt any TWO:**	**12**
	a)	**(i) Describe the principle of mechanical governor in fuel injection pump.** **(ii) State four types of injector nozzles**	**06**
	Ans	(i) **Working Principal of mechanical governor of FIP:** *(Diagram-2marks, explanation-2 marks, types of injector nozzles 02 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 (ii) **Types of Nozzles:** *(Any Four)* 1) Single hole nozzle 2) Multi-hole nozzle 3) Long stem nozzle 4) Pintle nozzles 5) Pintuax nozzles	**02** **02** **02**
	b)	**(i) Illustrate with neat sketch the working of absorber type of muffler** **(ii) sketch bellow type of thermostat**	**06**
	Ans	**(i) Working of absorber type of muffler:** 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.	**02**

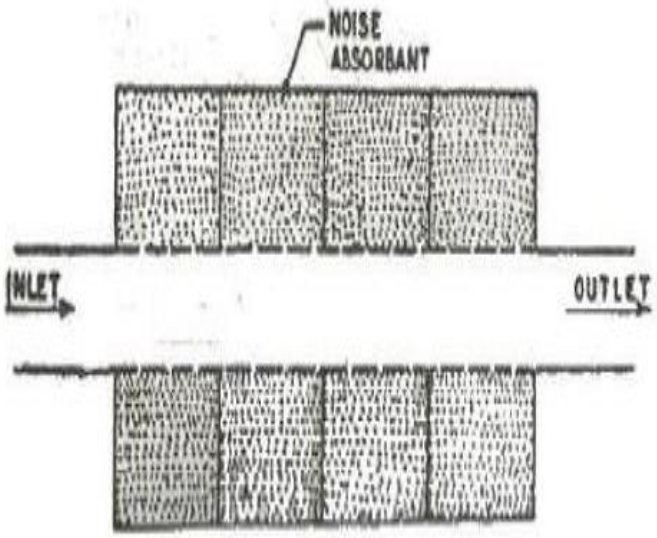


Fig. Absorber Type of Muffler

02

(ii) Bellow type of thermostat:

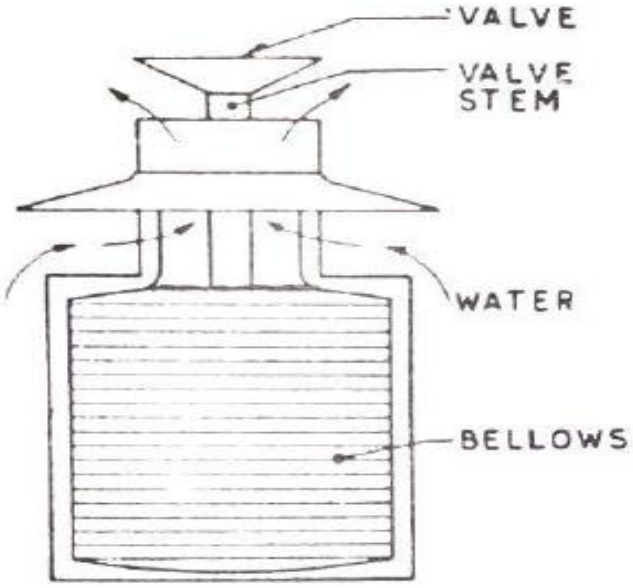


Figure: Bellows type Thermostat

02

	c)	**In a trail on four cylinder engine 150 mm bore, 260 mm stroke and working on a four stroke cycle. The following observations were made: speed= 2500 rpm, net dynamometer load at 500 mm radius = 200N, power required to rotor with ignition off= 4.5 KW, petrol consumption = 200 g/m minute, cooling water circulated= 7.5 kg/minute, Temp. rise of cooling water = 50 C, if the calorific value of petrol = 46,000KJ/Kg** **(i) Calculate mechanical efficiency and indicated mean effective pressure.** **(ii) draw heat balance sheet for the test in KJ/Kg**	**06**
	Ans	**Bore D= 150 mm=0.15m, Length of stroke L= 200mm =0.2m,** **Speed N = 2500 rpm,** **Net dynamometer load at 500 mm radius = 200N,** **Power required to rotor with ignition off(FP) = 4.5 KW,** **Petrol consumption = 200 g/m minute,** **Cooling water circulated= 7.5 kg/minute,** **Temp. rise of cooling water = 50 C,** **Calorific value of petrol = 46,000KJ/Kg** **1. Mechanical Efficiency = ?** **BP is given by,** $BP = \frac{2\pi N T}{60000}$ $= \frac{2\pi 2500 X (200X0.5)}{60000}$ **01** **BP= 26.18 kW** **IP is given by** **IP = BP + FP** **= 26.18+4.5** **IP = 30.68 kW** **We know that** **Mechanical Efficiency =** $\eta = \frac{BP}{IP}$ **X 100 =** $\frac{26.18}{30.68}$ **X 100** η_{mech} **= 85.33 %** **01** **2. Indicated mean effective pressure** **IMEP =** $\frac{IP \text{ X } 60000}{4 \text{ L A } \frac{N}{2}}$ **…….(N=N/2 for 4stroke engine)** $= \frac{30.68 \text{ X } 60000}{4 \text{ X } 0.2 \text{ X} \left(\frac{\pi}{4} X \, 0.15^2 \right) 1250}$ **IMEP= 104167 N/ m^2** **IMEP= 104.167 kPa** **01**

3. Heat Balance Sheet

Note: Heat balance sheet is prepared on kJ/ Minute Basis

(a) Heat Supplied by fuel per minute = mf X CV
= 0.2 X 46000
= 9200 kJ/ min

(b) Heat equivalent of IP = 30.68 x 60
= 1841 kJ/min

(c) Heat lost to cooling water = m_w X C_{pw} X ΔT_w
= 7.5 X 4.187 X 50
= 1570 kJ/min

(d) Heat Unaccounted = 9200 –(1841+1570)
= 5789 kJ/ min

Heat input per minute		Heat utilized/lost per minute	
Source	**Amount (kJ)**	**Factor**	**Amount (kJ)**
Fuel	**9200**	**(i) Heat equivalent of IP** **(j) Heat lost to cooling water** **(k) Heat Unaccounted**	**1842** **1575** **5783**
Total	**9200**	**Total**	**9200**

03