MODEL ANSWER
Winter – 17 EXAMINATION

Subject Title: Automobile Engines Subject Code: 17408

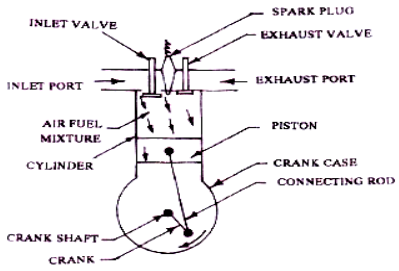
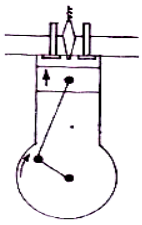
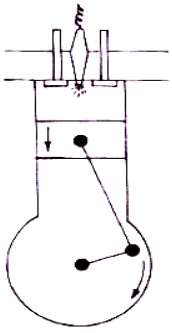
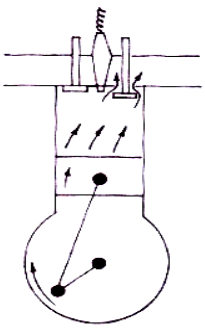
Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreimportance.(Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues 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.

Q. No.	Sub Que.	Answer	Marking Scheme
1		**Attempt any SIX of the following:**	12
a)	i)	**Define: i) Swept Volume ii) Piston Stroke**	2
		Answer: (*Definition 01 mark each)* **i) Swept Volume:** The volume swept by the piston in moving from T.D.C. to B.D.C. It is expressed in terms of cubic centimeter (cm^3) and given by $$Vs = A \times L = \frac{\pi}{4} d^2 \times L$$ **ii) Piston Stroke**: Distance travelled by the piston moving from T.D.C. to the B.D.C. is called piston stroke.	1 1
	ii)	**Write the name of the ports used in two stroke engine.**	2
		Answer:(*Correct Answer 02 marks*) 1) Inlet Port 2) Exhaust Port 3) Transfer Port	2
	(iii)	**Why the diesel engine is called CI engine?**	2
		Answer:(*Correct Answer 02 mark)* Since, diesel self-ignites due to the high pressure and temperature created during compression stroke, it is called as Compression Ignition (C.I*)* engines.	

	(iv)	**Define: i) Clearance Volume ii) Compression Ratio**	**2**
		Answer:(*Definition 01 mark each)* **i) Clearance Volume**: The volume of cylinder above the piston when it is in the T.D.C. position is called Clearance Volume. **ii) Compression Ratio:** It is the ratio of total cylinder volume to clearance volume. $$r = \frac{\text{Vs} + \text{Vc}}{Vc}$$ Where Total volume of cylinder = Vs + Vc	**1** **1**
	(v)	**State the need of cooling system.**	**2**
		Answer:*(Need 02 mark)* **Need of cooling system**: 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.	**2**
	(vi)	**Define: i) Brake Power ii) Indicated Power**	**2**
		Answer: (*Definition 01 mark each)* **i) 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 **ii) Indicated Power:** It is the power developed by the engine above the piston in the combustion chamber by burning of fuel.	**1** **1**
	(vii)	**Why the speed of camshaft is half of the crankshaft in 4 stroke engine.**	**2**
		Answer:*(Correct Answer 02 marks)* The cam shaft gear *(or sprocket)* has twice as many teeth as the gear *(or sprocket)* on the crankshaft, so it has 1:2 gear ratio. Thus, the speed of camshaft is half the speed of the crankshaft in 4 stroke engine.	**2**

MODEL ANSWER
Winter – 17 EXAMINATION

Subject Title: Automobile Engines | Subject Code: 17408

	(viii)	**State the air fuel ratio limits for SI and CI engine.**	**2**
		Answer:*(1 mark each)* The air fuel ratio limits for SI engine = 8:1 to 12:1 The air fuel ratio limits for CI engine = 14:1 to 22:1	**1** **1**
b)		**Attempt any TWO of the following:**	**8**
	i)	**With neat sketch explain the working of 4 stroke SI engine.**	**4**
		Answer:*(Any one diagram-2 marks, Description-2 marks)* **Working of four stroke petrol engine:** **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. **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 720^0.  **(A) Suction**  **(B) Compression**  **(C) Power**  **(D) Exhaust**	**2** **2**

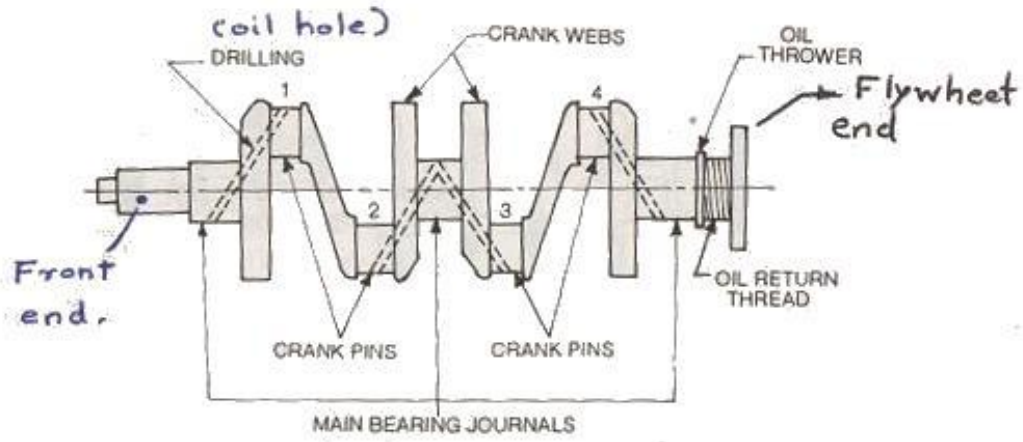
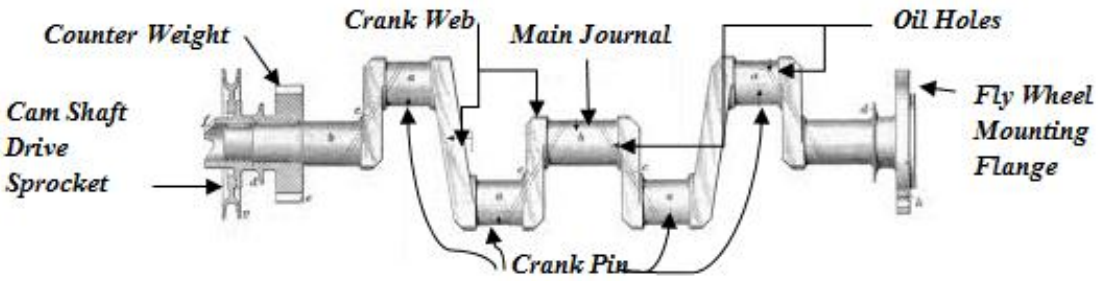
	ii)	**Write the engine specifications of any two wheelers. (minimum 8 parameters)**	**4**
		Answer:*(Any 8 parameters ½ mark each) Or (specification of any other 2 wheeler can be consider)* **(1) Honda CD 110 Dream DX Self Start:** Displacement : 109.19 cc No. of Cylinders : 1 No. of Gears : 4 Maximum Power : 8.25 BHp @7500rpm Maximum Torque : 8.63 N-m @ 5500rpm Engine Description : Air Cooled, 4 stroke, SI Engine Cooling : Air Cooling Compression Ratio : 9.9:1 Bore : 50 mm Stroke : 55.6 mm Air Filter Type : Viscous Paper Filter Fuel Type : Petrol Bharat Stage IV (BS4) : Yes Clutch : Multiple Wet Clutch **(2) Hero Super Splendor:** Displacement : 124.7 cc No. of Cylinders : 1 No. of Gears : 4 Maximum Power : 9 BHp @7000rpm Maximum Torque : 10.35 N-m @ 4000rpm Engine Description : Air Cooled, 4 stroke, Single Cylinder OHC Cooling : Air Cooling Compression Ratio : 9.1:1 Bore : 52.4 mm Stroke : 57.8 mm Fuel Type : Petrol Gearbox Type : Constant Mesh Fuel Type : Petrol Clutch : Multiple Wet Clutch	**4**
	iii)	**State two merits and two demerits of horizontal engine.**	**4**
		Answer:(*Any two merits 01 mark each & any two demerits 01mark each)* **Merits of Horizontal engine:** 1) The inertia forces of the reciprocating parts, i.e. primary and secondary forces combine together and give an impulse to the chassis frame of the vehicle. 2) The cylinder head is towards the front of the vehicle and hence driving impulse is obtained from the engine. 3) The bonnet height is reduced. 4) Engine is well balanced. **Demerits of Horizontal Engine:** 1) It required more space. 2) It will increase air drag. 3) It will cause more wear and tear, particularly on the lower side of piston and cylinder. 4) Improper mixing of fuel during expansion (or power) stroke.	**2** **2**

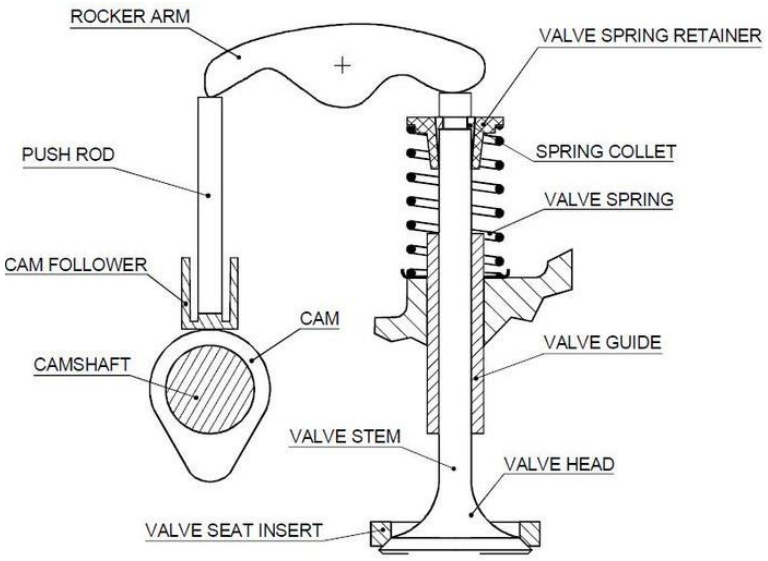
2		**Attempt any FOUR of the following:**	**16**
	a)	**Answer: Compare two stroke and four stroke engine on the basis of (i) Power Output (ii) Pollution (iii) Lubrication System (iv) Applications**	**4**
		Answer:*(01 Mark for each point)*	**4**

Parameters	**Two Stroke**	**Four Stroke**
Power Output	Power is produced once during 2 strokes of the piston. (More powerful)	Power is produced once every 4 strokes of the piston. (Comparatively less powerful)
Pollution	More pollution.	Less pollution.
Lubrication System	Addition of oil in the fuel is required. No Separate Dedicated Lubrication System (Petroil Lubrication System) is Provided hence more wear and tear of engine components	No need of adding oil or lubricant to fuel. Separate Dedicated Lubrication System (Splash, Pressure, Gravity, Lubrication System etc.)is Provided hence less wear and tear of engine components
Applications	Motor Cycles, Lawn Movers, Chain Saws, Outboards, Motor Boats etc	Motor Cycles, Cars, Trucks, Buses, Generators, Corn Grinders, Irrigation Pump, Marine, Earth Moving Machines, etc.

MODEL ANSWER
Winter – 17 EXAMINATION

Subject Title: Automobile Engines Subject Code: 17408

	b)	**Draw the neat sketch of crankshaft for 4 cylinder engine and label it.**	**4**
		Answer:*(Sketch 3 marks & labeling 01 mark)*  Three-bearing crankshaft for a four-cylinder engine. **OR**  	**4**
	c)	**Name the materials for the following engine components.** **(i) Cylinder Block (ii) Exhaust Manifold (iii) Camshaft (iv) Piston Pin**	**4**
		Answer:*(One Material of each 01 mark each)* **(i) Cylinder Block:** Cast iron, Cast aluminum, Welded Steel **(ii) Exhaust Manifold:** Cast Iron, Cast Aluminium. **(iii) Camshaft:** Forged Steel, Cast iron, Cast Steel, **(iv) Piston Pin:** Forged Steel, Case hardened Steel.	**1** **1** **1** **1**

	d)	**Draw the neat sketch of overhead valve operating mechanism and explain its working.**	**4**
		Answer: Overhead valve operating mechanism*(Neat sketch of overhead valve operating mechanism 02marks & it's working 02 marks)*	**2**
		 Figure: Overhead Valve Operating Mechanism	
		Working: As the camshaft rotates, each off-center (eccentric) cam lobe pushes against a lifter or tappet. The upward motion of the lifter transfers through the push rod to the rocker arm. This upward motion changes to downward motion as the rocker arm pivots. The downward motion opens the valve. As the camshaft continues to rotate, the lobe passes by the lifter and allows the valve to close. A spring (attached to the valve) returns the valve to its seated position.	**2**

e) Compare dry liners and wet liners (any four points) **4**

Answer:*(Any four points 01 mark each)*

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.

f) State the functions of piston rings. Why a minimum two compression rings are required? **4**

Answer:(*Function 01 mark each & Correct reason 02 marks)*

Function of Piston rings: **2**

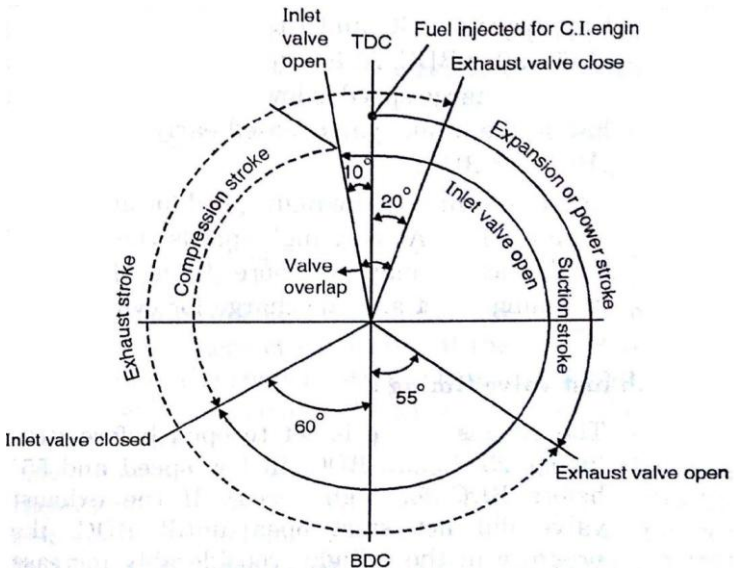
1. To provide a pressure seal to prevent blow-by of burnt gases.
2. To form the main path for conduction of heat from the piston crown to the cylinder walls.

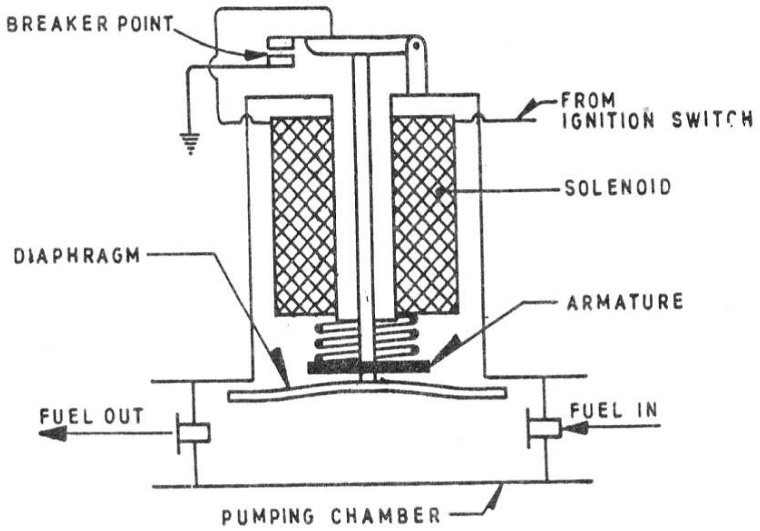
Why a minimum two compression rings are required? **2**

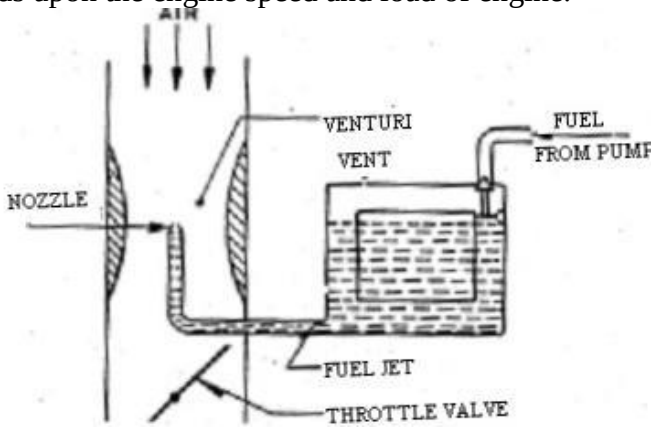
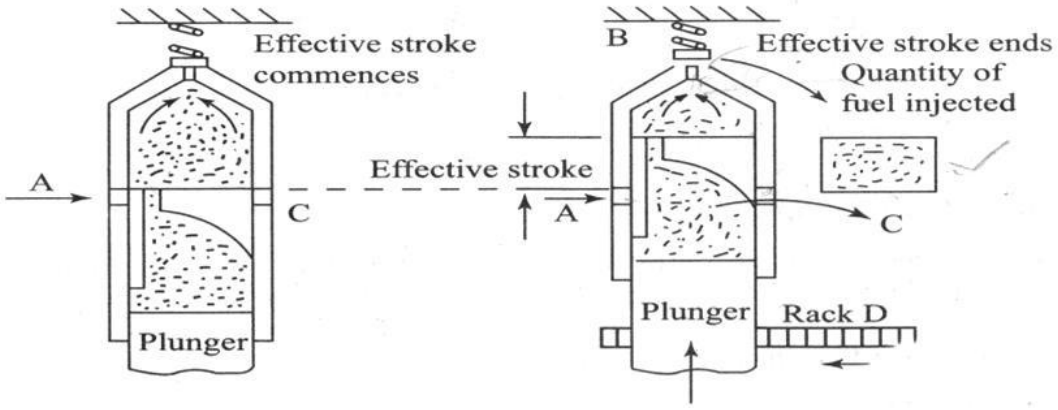
1. To Improve sealing between piston and cylinder bore
2. To prevent leakage of combustion gases.

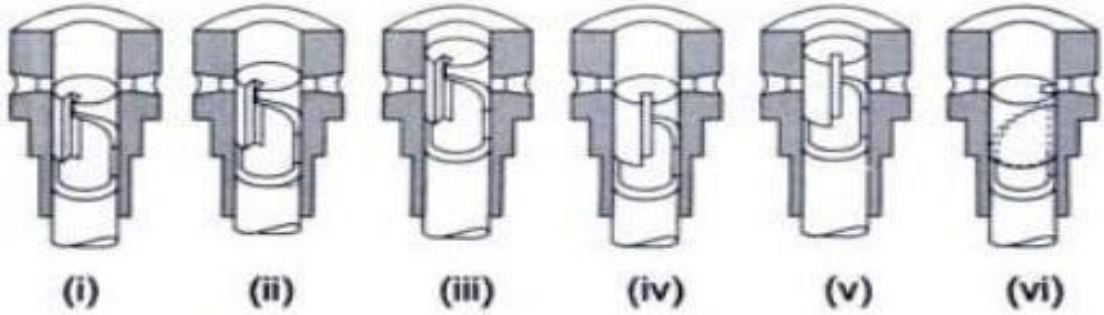
MODEL ANSWER
Winter – 17 EXAMINATION

Subject Title: Automobile Engines Subject Code: 17408

3		**Attempt any FOUR of the following:**	**16**
	a)	**Draw and explain Valve timing diagram for 4 stroke CI engine.**	**4**
		Answer:*(Diagram 2 marks, Explanation 2 Marks)*  **Figure : Valve Timing Diagram for 4- Stroke C. I. Engine** The opening and closing operation of the inlet and exhaust valves are described as follows: 1. The inlet valve opens 10^0-25^0 degrees before TDC and closes 25^0-60^0 after the BDC. 2. The Exhaust valve opens 30^0- 55^0 before BDC and closes 10^0-20^0 after TDC. 3.The fuel injection starts 5-10 degree before TDC in compression stroke and continues up to 15^0-25^0 degree after TDC in power stroke, depending on the speed of the engine.	**2** **2**
	b)	**List the various fuel supply system in petrol engine and explain any one.**	**4**
		Answer: *(Listing 2 Marks, Explanation of any one system 2 Marks)* Various fuel supply systems used in petrol engine are 1. Gravity feed system 2. Pressure feed system 3.Vacuum system 4.Pump system 5.Fuel injection system **Gravity system:** In this system fuel tank is mounted at the highest position from where fuel drops into the carburetor float chamber by gravity. The system is very simple and cheap. The disadvantage of the system is that fuel tank is necessarily required to be mounted over the carburetor.	**2** **2**

		Pressure system: In this system hermetically sealed fuel tank is used. The pressure is created in the tank by means of engine exhaust or a separate air pump. For starting, the pump is primed by hand. Thus fuel flows to the float chamber of the carburetor. There are chances of fuel leak but fuel tank can be placed at any suitable location **Vacuum system:** The system is based on the fact that the engine suction can be used for sucking fuel from the main tank o the auxiliary fuel tank from where it flows by gravity to the carburetor float chamber. **Pump system:** In this system a steel pipe carries petrol to the fuel pump which pumps it into the float chamber of the carburetor through a flexible pipe. If it is a mechanical fuel pump it is driven by engine camshaft and is placed on the engine. If it is electrical pump it can be placed anywhere. **Fuel injection system:** In this system carburetor is eliminated. The fuel is atomized by means of injector nozzle and then delivered into an airstream. Separate fuel injectors are used for each cylinder. The mixture under different load and speed conditions is controlled electronically.	
	c)	**Draw a neat sketch of SU electrical fuel pump and explain its working**	**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: SU Electric fuel pump	**2** **2**

	d)	**Describe working of Simple Carburetor with neat sketch.**	**4**
		Answer: *(Working 2Marks,Figure 2Marks)* **Working of simple carburettor:** During suction stroke air is drawn through the venturi (venture is a tube of decreasing cross section area). When air passing through the venturi increases velocity of air and decreases pressure of air. The pressure in float chamber is atmospheric pressure and the same is maintained with the help of vent. This pressure differential called carburetor depression. So the fuel from the float chamber is feed to a discharge jet. This 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.  Figure: Simple Carburettor	**2** **2**
	e)	**Explain fuel metering in inline fuel injection pump.**	**4**
		Answer:*(Figure 2Marks, Explanation 2 Marks)* **Fuel Metering in inline type fuel injection pump**:  	**2**

		OR  The position of the plunger in the fuel injection pump can be varied by means of a control rod having a rack and pinion arrangement. By operating this rod, the position of the plunger can be changed, and by changing the position of the plunger, the supply to the injection nozzle can either be increased or stopped. When the supply to the injection nozzle is stopped, the engine is also stopped. Various positions of the plunger are shown in Figure. In Fig., (i) is the position of the plunger when it is at the bottom stroke. The position of the plunger when it is closing both the ports is shown in (ii). The maximum amount of supply is shown in (iii). Only at this position is the plunger working at full load. The position of the plunger at (iv) shows a normal load. The position at (v) shows a part load. The position at (vi) shows that no fuel is being supplied to the injector; i. e. the engine has stopped.	**2**
	f)	**Draw neat sketch of fuel injector and explain its working**	**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**

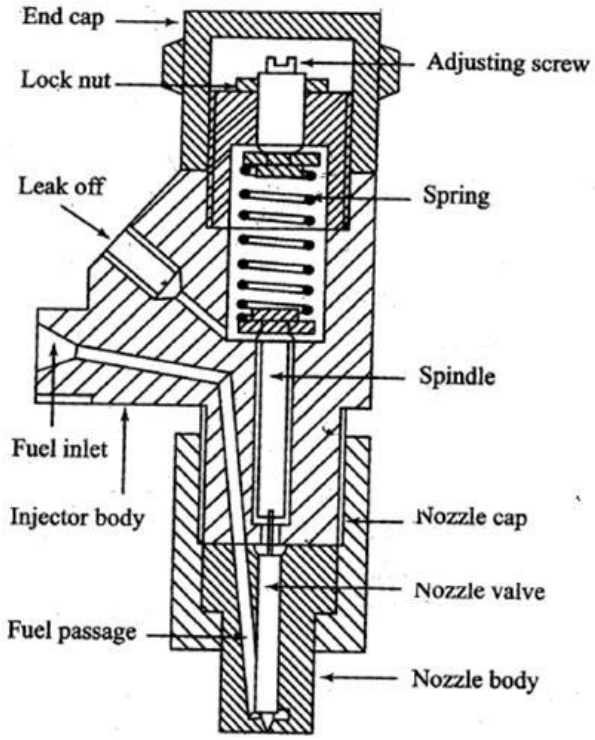


Figure: Diesel Fuel Injector

2

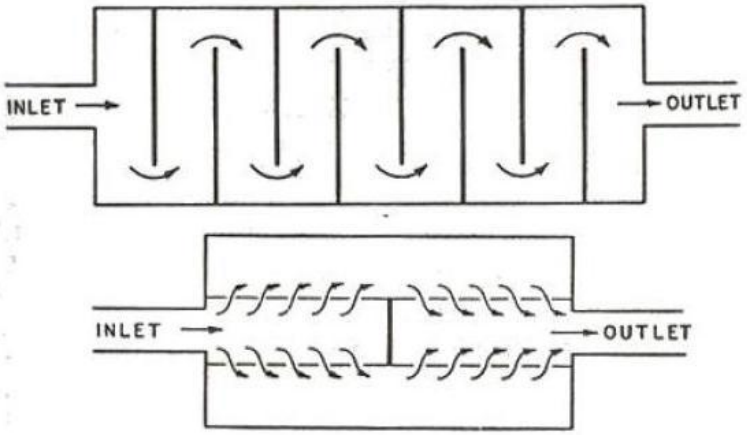
4. Attempt any FOUR of the following: **16**

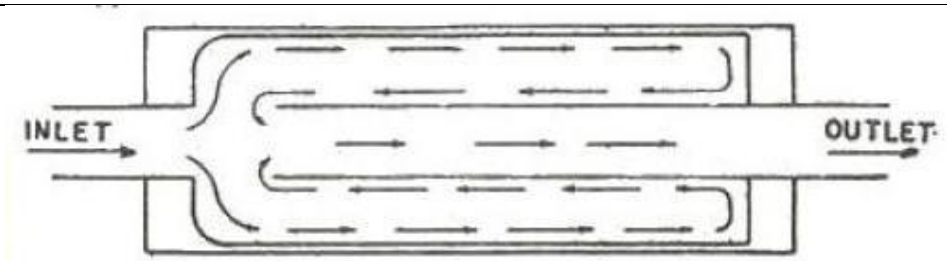
a) Compare battery and magneto ignition system on the basis of i) Source ii) Starting engine iii) Space required iv) Applications **4**

Answer:*(Comparison on each basis 1 Mark)*

Parameter	Battery Ignition system	Magneto Ignition system
Source	Current is obtained from the battery.	Current is generated by the magneto.
Starting engine	Starting of engine is easy.	Starting of engine is difficult.
Space required	Occupies more space.	Occupies less space.
Application	Used in Cars, Buses, Trucks.	Used in Motorcycles, Mopeds, racing cars.

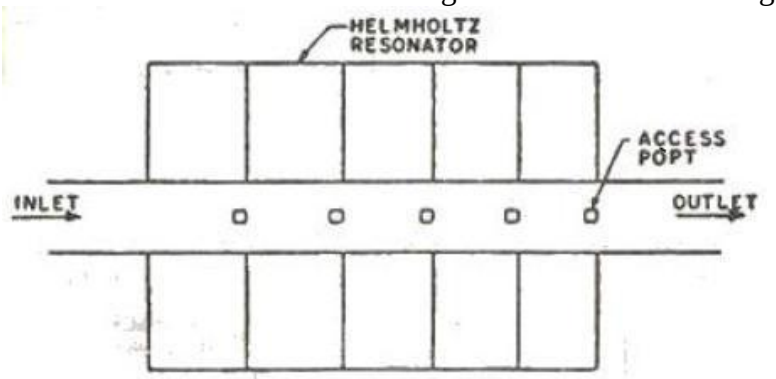
4

	b)	**State the importance of firing order in IC engine and write the firing order of 4 cylinder engine.**	**4**
		Answer:*(Importance 3 Marks, firing order 1 Mark)* **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	**3** **1**
	c)	**List the various types of Mufflers and explain any one with neat sketch**	**4**
		Answer: *(Types-1 mark, Diagram-2 marks, and explanation-1 mark)* **Types of mufflers:** 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.

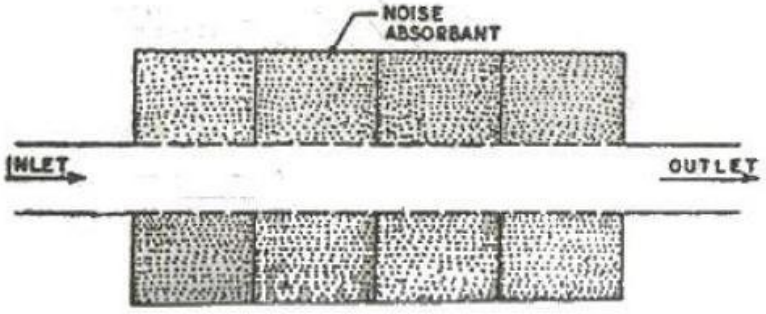
3. Resonance Type: It consists of a number of Helmholtz resonators in series through which a pipe having access port passes. Helmholtz is the name of a person who originated the idea of this type of muffler. The exhaust gases flow through this pipe. The resonators eliminate the fundamental and higher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



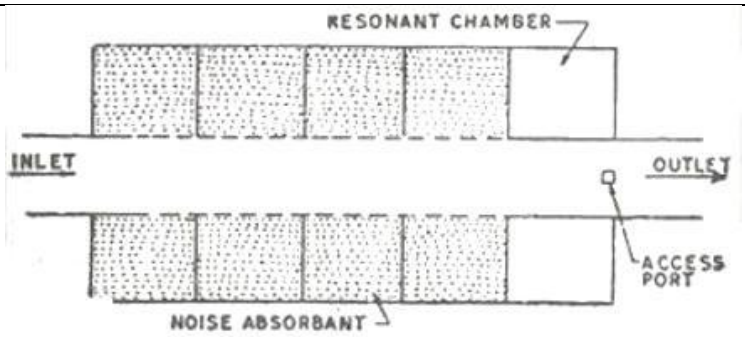
Resonance type muffler.

4.Absorber type :

It consists of a perforated tube, around which a sound absorbing material, like 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.



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) Differentiate between air cooling and water cooling system (minimum four points) **4**

Answer: Comparison of Air cooling and Water cooling system: *(Any four, 1mark each)* **4**

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**	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 worm up performance is better this results in **low cylinder wear**	The worm up performance is poor this results in **greater cylinder wear**
6	**Size of engine is small and weigh is less** as there is no water jacket, radiator and water pump	**Size and weight of engine is increased** to use of due radiator and water pump
7	Air cooled engine must be installed in front side. the vehicle	Water cooled 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, Buses, Trucks etc.

e) List four components of water cooling system and state function of each. **4**

Answer:*(Listing 1 Mark, functions, any three 1 Mark for each)* **1**

Components of water cooling system:
i) Radiator ii)Thermostat
iii) Water pump iv)Pressure cap
v)Expansion tank vi)Cooling fan

		Functions: **Radiator:** To ensure the close contact of the hot coolant coming out of the engine with the outside air, so as to ensure high rate of heat transfer from the coolant to air. **Thermostat:** To regulate the circulation of water in system to maintain the normal working temperature of the engine parts during the different operating conditions. **Pressure cap:** To form an air tight joint due to which the coolant is maintained at some pressure higher than the atmosphere. **Water pump:** To increase the velocity of the circulating water. **Expansion tank:** To recover the excess coolant as the engine temperature increases and when the cooling water cools down, to return the coolant to the reservoir. **Cooling fan:** To maintain an adequate air flow across the radiator matrix especially at low car speeds and under engine idling conditions.	**1** **1** **1**
	f)	**State the necessity of thermostat valve in engine cooling system. Describe the working of any one thermostat.**	**4**
		Answer: *(Necessity 1 Mark, Working of any one type 1 Marks, figure 2Marks)* Thermostat prevents the water in the engine jackets from circulating through the radiator for cooling until its temperature has reached to a value suitable for efficient engine operation. **Types of thermostat:1) Bellows type 2) Wax type** **Working: Bellows type Thermostat** It consists of metallic bellows filled with some volatile liquid like acetone, alcohol or ether which boils between 75-85^{0}C. When after start the engine is warming up it is desired that cooling system should not operate during this period thermostat valve remains closed as liquid inside has not changed its state. As the coolant temperature reaches a predetermined value (about 80^0) the liquid inside the thermostat is converted into vapour which exerts a pressure on the valve, which begins to open, so that the water circulation though the radiator starts. The valve then opens gradually further as the water temperature rises, until it is fully open bat about 95^0-99^{0}C	**1** **1**

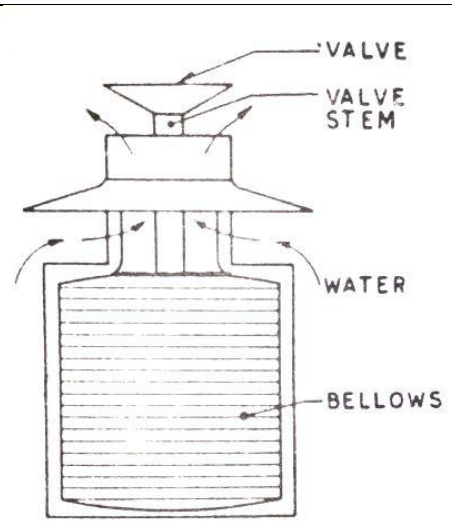


Figure: Bellows type Thermostat

2

OR

Working: Wax type Thermostat

As the coolant is heated it transmits its heat to the copper loaded wax having high coefficient of volumetric thermal expansion (0.280 per ^{0}C) which expands so that the rubber plug contracts against the plunger and exerts a force on it upwards so that it moves vertically. This movement of plunger opens a valve in the thermostat to allow coolant to flow through the radiator.

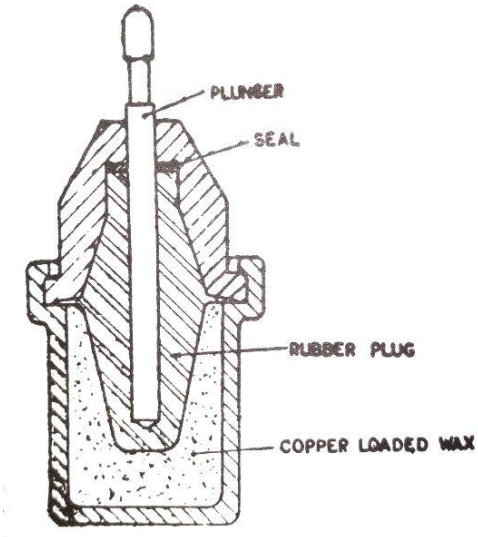
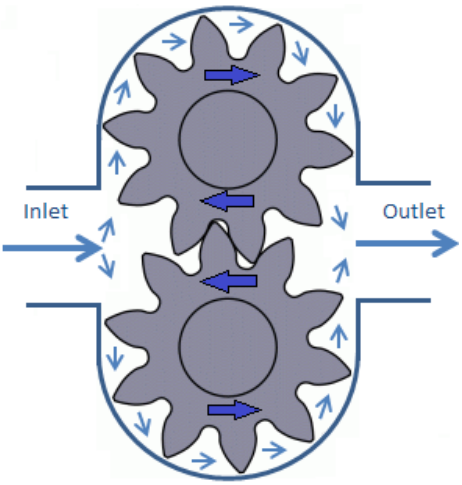
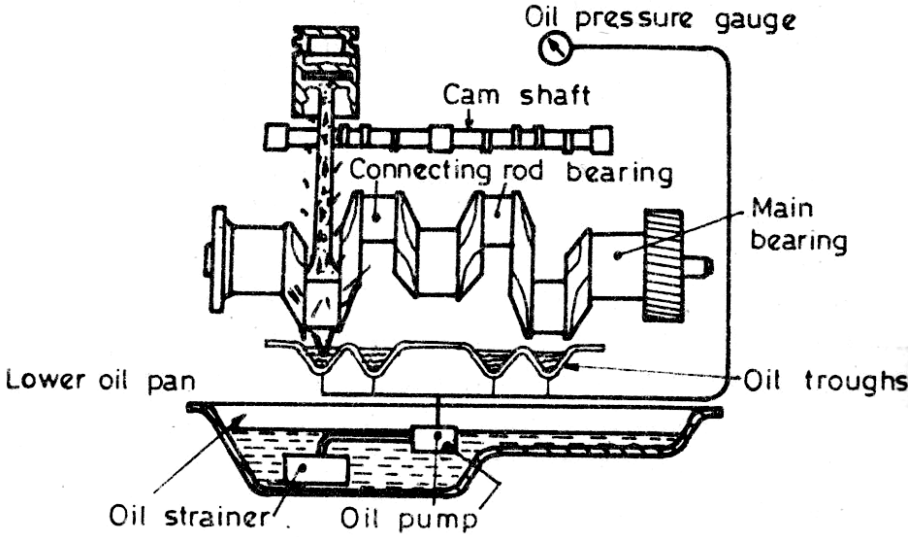


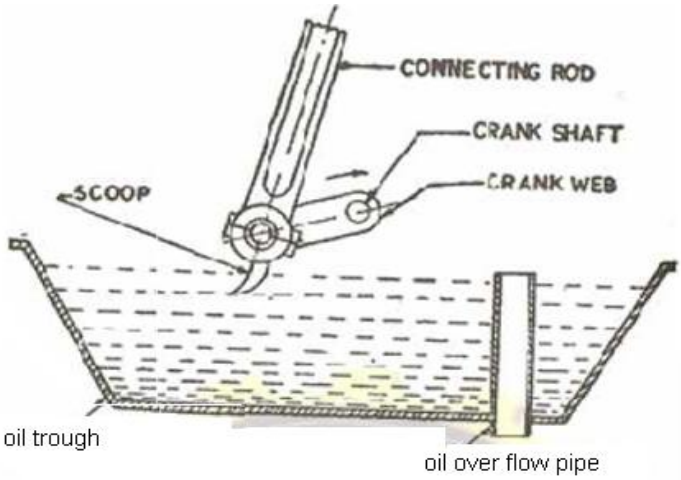
Figure: Wax type Thermostat

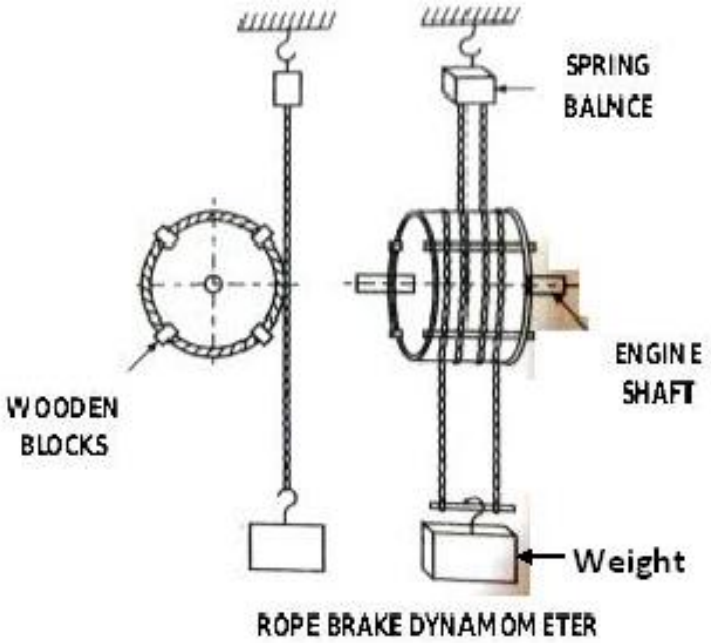
MODEL ANSWER
Winter – 17 EXAMINATION

Subject Title: Automobile Engines Subject Code: 17408

5		**Attempt any FOUR of the following**	**16**
	a)	**Explain any eight properties of lubricating oil.**	**4**
		Answer: Properties of lubricating oil *(Any Eight1/2 marks each)* 1) Viscosity:- Viscosity is a measures of the flow ability of an oil under a particular temperature and pressure 2) Flash Point or Fire Point: - The lowest temperatures at which the oil flashes and fires, known as flash and fire points. These two temperatures must be sufficiently high for any lubricating oil to avoid flash or burn during use. 3) Cloud: - The low temperature at which the lubricant changes from liquid state to a plastic or solid state is called cloud point. In some cases the oil appears to be cloudy at the start of solidification. 4) Carbon Residue**:-** Lubricating oils being the chemical compounds of carbon and hydrogen, when burnt deposit carbon on the engine parts. This should be as low as possible for lubricating oil. 5) Corrosion: - A lubricant should not corrode the working parts. 6) Pour Point: - The lowest temperature at which the oil pours is called its pour point. Below this temperature the oil becomes plastic, so it does not produce hydrodynamic lubrication and therefore cannot be used below this temperature. 7) Colour: - This test is not so important except for checking the uniformity of any given grade of oil. 8) Specific Gravity: - Specific gravity of lubricating oil varies considerably and hence should not be regarded as the main indication of its lubricating property. 9) Neutralisation Number: - Oil may contain impurities, if not removed during refining, which have deleterious effect on the properties of the oil.	**4**
	b)	**Explain any four additives used in oil.**	**4**
		Answer : - Four additives used in oil *(1 mark each)* 1) **Viscosity index improvers**:- long chain, high molecular weight polymers. Used to increase viscosity of oil more at high temperatures than at low temperatures. **2) Pour point depressants**:- Alkyl aromatic polymers. Used to reduces the lowest temperatures (pour point) at which oil will flow. **3) Antioxidant**:- Aromatic amine compounds. Used to minimize and delay the oxidation of lubricant & its degradation. **4) Extreme-pressure (E.P.) additives**:- Polysulfides, phosphate, dithiophosphates, and Dithiocarbamates. Used to prepare a thin layer of lubricant under boundary lubrication conditions i.e. under high load condition.	**4**
	c)	**Draw a neat sketch of externally mesh gear type oil pump and explain its working.**	**4**
		Answer: -*(Sketch-2 marks, Working-2 marks)* **Working of externally mesh gear type oil pump: -** As the gears rotate they separate on the intake side of the pump, creating a void and suction which is filled by fluid. The fluid is carried by the gears to the discharge side of the pump, where the meshing of the gears displaces the fluid. The mechanical	**2**

		clearances are small— in the order of 10 µm. The tight clearances, along with the speed of rotation, effectively prevent the fluid from leaking backwards. The rigid design of the gears and houses allow for very high pressures and the ability to pump highly viscous fluids.  Fig: - Externally mesh gear type oil pump.	2
	d)	**Explain splash lubrication system with neat sketch.**	4
		Answer: *(Explanation -2 marks, Sketch -2 marks)* **Splash lubrication system** 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. 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 2

		OR  Figure: Splash lubrication system.	
	e)	**Define:** **i) Mechanical efficiency** **ii) Volumetric efficiency** **iii) Brake thermal efficiency** **iv) Specific fuel consumption**	**4**
		Answer:-*(Defination-1 mark each)* **i) Mechanical efficiency: -**It is the ratio of brake power to indicated power. It is measured in percentage. $$\eta_M = \frac{\text{BrakePower}}{\text{IndicatedPower}} = \frac{\text{B.P}}{\text{I.P.}} \text{X}100\%$$ **ii) Volumetric efficiency: -**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. $$\eta_v = \frac{\text{Volume flow rate of air intake system}}{\text{Rate at which volume displaced by the piston}} = \frac{V_{actual}}{V_{swept}} \text{X}100\%$$ **iii) Brake thermal efficiency:-**It is the ratio of brake power to input fuel energy i.e total heat energy contain in the fuel $$\eta_{Bth} = \frac{\text{B.P.}}{m_f \times \text{c.v.}} \times 100\%$$	**1** **1** **1**

		iv) Specific fuel consumption: -It is defined as amount of fuel consumed per unit of power developed per hour. $SFC = \frac{\text{Fuel consumed in Kg/hr}}{\text{power developed}}$	**1**
	f)	**Explain rope brake type dynamometer with neat sketch.**	**4**
		Answer:- *(Explanation -2 marks, Sketch -2 marks)* **Rope Brake Dynamometer: -**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. 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. 4. 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** **2**

6		Attempt any TWO of the following:	16
a)	i)	Explain Morse test for finding out frictional power.	4

Answer: i) Morse test for finding out frictional 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

$$B = (I_1 +_{,} I_2 + I_3 + I_4) – (F1+F2+F3+F4) \text{----------} 1$$

When cylinder 1 is cut off, the BP developed by the remaining three cylinders,

$$B_{1=} (0 +_{,} I_2 + I_3 + I_4) – (F1+F2+F3+F4) \text{----------} 2$$

Subtracting (2) from (1) we get

$$B - B_1 = I_1$$

Therefore, IP of cylinder 1, $I_1 = B-B_1$

Similarly ,

IP of cylinder 2, $I_2 = B-B_2$

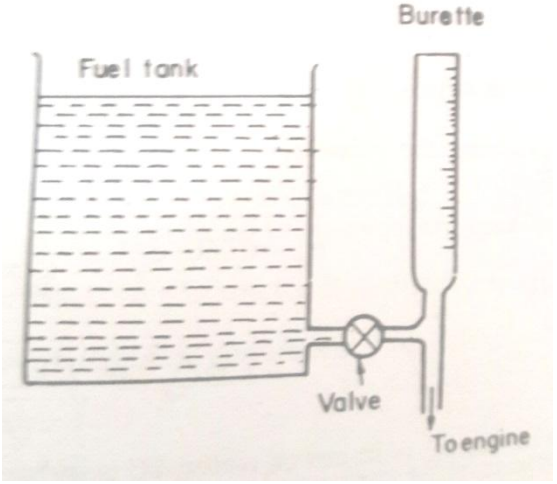
IP of cylinder 3, $I_3= B-B_3$

IP of cylinder 4, $I_4 = B-B_4$

Total IP of Engine = $I_1+I_2+I_{3+}I_4$

Friction Power F.P. = I.P – B.P

4

	ii)	Explain any one method for measurement of fuel consumption.	4
		Answer: Methods for measurement of fuel consumption 1. Burette Method 2. Automatic Burette Flowmeter. 3. Orifice Flowmeter 4. Gravimetric Fuel Flow measurement. **Burette Method:** As shown in the drawing a small glass tube is attached to the main fuel tank. When fuel rate is to be measured the valve is closed so that the fuel is consumed from the burette. The time from known value of fuel consumption (X_{CC}) can be measured & fuel consumption rate can be calculated by using following formula. Fuel consumption rate (Kg/sec) = $\frac{X_{cc} \text{ X Specific gravity of fuel}}{1000 \text{X time}}$  Fig:- Measurement of fuel consumption with the help of burette	**2** **2**

b)		**The following readings were taken on a single cylinder 4 stroke diesel engine running at full load. Area of indicator = 3 cm^2, length of diagram = 4 cm, spring constant = $10\frac{bar}{cm^2}$ .cm, speed of engine = 400 rpm, load on brake = 380 N, Spring reading = 50 N, Diameter of brake drum = 120 cm, fuel consumption = 2.8 Kg/hr, calorific value of fuel = 42000 KJ/kg, diameter of the cylinder = 16 cm, stroke = 20 cm. Find i) I.P ii) B.P iii) Mechanical efficiency iv) Brake thermal efficiency.**	**8**

Answer:

Given data :

No of cylinder n = 1

Area of indicator = 3 cm^2

Length of diagram = 4 cm

Spring constant = $10\frac{bar}{cm^2}$ .cm

$$\text{Indicated Mean Effective pressure } P_i = \frac{\text{Spring constant X Area of indicator}}{\text{Length of digram}} = \frac{10 \text{ X } 3}{4}$$

P i = 7.5 bar = 7.5 X 10 N/m^2

Speed = N = 400 rpm

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

$N' = \frac{400}{2} = 200$ rpm

Load on brake W = 380 N

Spring reading S = 50 N

Diameter of brake drum = 120 cm

Radius of brake drum = $\frac{120}{2}$ = 60 cm = 0.6 m

$$\text{Fuel cunsumption} = m_f = 2.8 kg/hr = \frac{2.8}{60 \times 60} = 7.7 \times 10^{-4}\ kg/\sec$$

Calorific value of fuel = 42000 KJ/kg

Diameter of the cylinder = 16 cm = 0.16 m

Area = A = $\frac{\pi}{4} D^2 = \frac{\pi}{4} 0.16^2 = 2.009 \times 10^{-2} m^2$

Stroke = L = 20 cm = 0.2 m

(i) I.P. of the engine

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

$$= \frac{1\times7.5\text{X}10^5\text{X}0.2\text{X}2.009\text{X}10^{-2}\text{X}200}{60\times1000} = 10.045kW$$

I.P. of the engine = 10.045 kW **2**

(ii) B.P. of the engine

Torque on the engine T = (W –S) X Radius of brake drum

T = (380 –30) X 0.6

T = 198 Nm

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

$$\text{B.P.} = \frac{2\times3.14\times400\times198}{60\times1000} = 8.289\text{kW}$$

B.P. of the engine = 8.289 kW **2**

(iii) Mechanical efficiency

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

$$\eta_{mech} = \frac{8.289}{10.045}\times100\%$$

$$\eta_{mech} = 82.51\%$$

Mechanical efficiency = 82.51 % **2**

		iii) Brake thermal efficiency $\eta_{Bth} = \frac{B.P.}{m_f \times c.v.} \times 100\%$ $= \frac{8.289}{7.7 \times 10^{-4} \times 42000} \times 100$ $\eta_{Bth} = 25.63\%$ **Brake thermal efficiency = 25.63 %**	**2**
c)		**The following observations are made during a trial on an oil engine.** **1) RPM = 1750 2) Brake torque = 327.5 Nm 3) Fuel used = 15 Kg/hr.** **4) Air supplied = 4.75 Kg/min. 5) CV of fuel = 42 MJ/kg 6) Room temp. = 20.8^{o}c** **7) Quantity of cooling water = 16 Kg/min.** **8) Outlet temp. of cooling water = 65.8^{o}c** **9) Exhaust gas temp. = 400^{o}c** **Take C_{pw} = 4.2 KJ/Kg^{0}K and** **C_{pg} = 1.25 KJ/Kg^{0}K** **Draw heat balance sheet on KW basis and percentage basis.**	**8**
		Answer: Given Data:- 1) RPM = 1750 2) Brake torque = 327.5 Nm 3) Fuel used = 15 Kg/hr. 4) Air supplied = 4.75 Kg/min 5) CV of fuel = 42 MJ/kg 6) Room temp. = 20.8^{o}c 7) Quantity of cooling water = 16 Kg/min 8) Outlet temp. of cooling water = 65.8^{o}c 9) Exhaust gas temp. = 400^{o}c Take , C_{pw} = 4.2 KJ/Kg^{0}K C_{pg} = 1.25 KJ/Kg^{0}K **Solution:** Total heat (Energy) input Fuel used = 15 kg/hr = 15/(60X 60) = 4.16 X 10^{-3}kg/ Sec. CV of fuel = 42 MJ/kg = 42 x 10^3KJ/kg Input heat = m_f X C.V. = 4.16 X 10^{-3} X 42 X 10^3 = 174.72 Kw Total heat (Energy) input = 174.72 Kw	**1**

1) Heat energy Converted in to B.P.

$$B.P.=\frac{2\pi NT}{60\times1000}$$

$$B.P.=\frac{2X3.14X1750X327.5}{60\times1000}$$

$$B.P.=59.98kw$$

Heat energy Converted in to B.P. = 59.98 Kw **1**

3) Heat energy lost in to cooling water

Cooling water heat = m_{w} X Cpw X ΔTw

= (16/60) X4.2 X(65.8-20.8)

= 50.4 KJ/sec

= 50.4 Kw

Heat energy lost in to cooling water = 50.4 Kw **1**

4) Heat lost in to Exhaust Gas

Air supplied

m_a = 4.75 kg/min = 15/60= 79.16 X 10^{-3}kg/ Sec.

Mass of exhaust gas m_{eg} = mass of fuel + mass of air

= 4.16 X 10^{-3}kg/ Sec. + 79.16 X 10^{-3}kg/ Sec.

= 83.32 X 10^{-3}kg/ Sec

Heat lost in to Exhaust Gas = m_{eg} X CPegXΔTeg

= 83.32 X 10^{-3}x 1.25 x (400-20.8)

= 37.91 KJ/ sec.

= 37.91 Kw

Heat lost in to Exhaust Gas = 37.91 Kw **1**

5) Heat unaccounted= heat input – (heat to BP+ heat to cooling +heat to exhaust)

= 174.72- (59.98 + 50.4 + 37.91) = 26.43 KJ/sec

= 26.43 Kw

Heat balance sheet **1**

Parameter	KW Basis	Percentage (%) Basis
Input Heat	174.72	100
Heat converted in to B.P.	59.98	34.32
Heat lost in to cooling water	50.4	28.84
Heat lost in to Exhaust Gas	37.91	21.69
Unaccounted Heat loss	26.43	15.12

3