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. N.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any SIX of the following:**	12
		i) i) List any four applications of IC Engine	2
		Answer : Applications of IC Engine: *(Any Two)* 1) In Automotive – i) Two stroke engine – Mopeds, Scooters. ii) Four stroke engine – Light vehicles, Heavy vehicles. 2) Marine Application – Ships, Boat 3) Locomotives – Railway *4) Stationery* engines – For lifting water, Generator, Material handling system	
		ii) (ii) Define Brake Power and Indicated Power.	2
		(1)Brake Power: The brake power (B.P.) is the power obtained at the engine flywheel is measured with the help of dynamometer , it is measured in kW $B.P. = \frac{2\pi NT}{60000}$ KW Where, N=Engine speed in R.P.M. T=Torque in Newton meters (obtained from dynamometers test) **(2) Indicated Power:** It is the power developed by the engine above the piston in the combustion chamber by burning of fuel.	1 1

		$I.P. = \frac{mf \times CV}{60000}$ KW Where, mf=mass of fuel in kg CV=Calorific value of fuel in J/Kg-K	
		iii) State the function of cylinder head and cylinder block	**2**
		Answer: *(One Mark Each))* **Function of Cylinder Head:** It provides the housing for exhaust and intake valves, the fuel injector and necessary linkages, and passages for the fuel and air mixture. **Function of Cylinder Block:** It is an integrated structure consists of the ***cylinder***s of a reciprocating ***engine***, coolant passages, intake and exhaust passages and ports, and crankcase, etc.	**1** **1**
		iv) State function of fuel feed pump.	**2**
		Answer : *(Correct Answer = 02 Marks)* **Function of Fuel Feed Pump:** The **fuel feed pump** compress the fuel to high pressure when the cam lifts the plunger, and is then sent to the injector.	
		v) Define I.C. engine.	**2**
		Answer : *(Correct Answer = 02 Marks)* **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).	
		(vi) State any two disadvantages of water cooling System	**2**
		vii) State any three Specifications of light motor vehicle engine	**2**
		Answer: (*Any Three=02 Marks)* **Manufacturer:** **Hyundai India Ltd.** **Type :** 1.1 Ltr, 4 Valve, 3 Cylinder, Air cooled, Diesel engine **Cubic capacity:** 1120 cc **Brake Power:** 70 bhp at 6000rpm **Torque**: 160 N-m	
		viii) State any two merits of vertical engine	**2**
		Answer: Merits of vertical I.C. Engine: *(Any Two-02 mark)* 1. The piston doesn't wear the cylinder lining during motion	

2. As the crankcase is at the bottom lubricating oil can be stored in it.

3. Splash lubrication system can be used as the oil is stored in the sump.

4. The lubricating oil of the bearing and other engine parts can be collected in the crankcase.

5. Weight of the piston is carried by the crank.

6. Piston and cylinder liner have more life as compared to the horizontal engine.

7. The consumption of lubricating oil is less.

(Note: Any other merits may be considered).

b) Attempt any <u>TWO</u> of the following **8**

i) Classify I.C. engines on the basis f following **4**

Answer : *(Any Four)*

Classification the IC Engine on the basis of

1. Fuel Used: a) Petrol (b) Diesel (c) Gasoline

2. Cycle of operation: a) Otto cycle engine

b) Diesel cycle engine

c) Duel combustion cycle engine or semi- diesel cycle engine.

3.Method of charging: a) Naturally aspirated engines

b) Supercharged aspirated engines

4.Ignition: a) Spark ignition (S.I.) engine

b) Compression ignition (C.I.) engine

ii) Compare 4-stroke and 2- Stroke Engine **4**

Answer : *(Any four points= 04 Marks)*

Comparison of Four Stroke and Two Stroke Engine:

S. N.	4-stroke Engine	2-stroke Engine
1	**One Working Stroke** for **every two**	**One Working Stroke** for **each revolution** of the crank shaft

		revolutions of the crank shaft		
	2	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.	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	
	3	Less mechanical efficiency due to more friction on many parts.	More mechanical efficiency due to less friction on few parts.	
	4	More output due to full fresh charge intake and full burnt gases exhaust.	Less output due to mixing of fresh charge With burnt gases.	
	5	Engine Requires more Space	Engine Requires less Space.	
	6	Engine is heavy	Engine is light	
	7	Engine design is complicated	Engine design is simple	
	8	More cost	Less cost	
	9	Engine is water / air cooled	Engine is air cooled.	
	10	Engine runs cooler.	Engine runs hotter.	

iii) Define the Scavenging, what is the need of Scavenging; Describe any one method of scavenging **4**

Answer: *(Definition =1 Mark, Need= 01 Mark and Description or figure of any one Method two mark each)*

Definition: Scavenging is process of removing the exhaust gases (combustible products) from the cylinder with help of incoming fresh charge in two stroke engine. **1**

Need: To wipe out the burnt or un-burnt combustion gases or any residue particles at the end of exhaust stroke to avoid its mixing with fresh charge during suction stroke. **1**

Methods: **(1) Cross Flow Scavenging:-** **1**

In this method, the inlet port and exhaust port are situated on the opposite sides of engine cylinder.

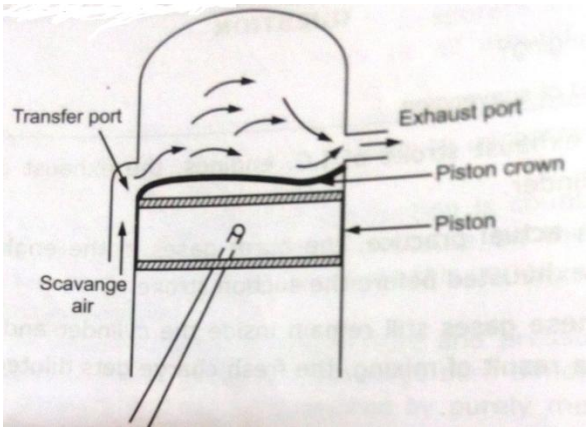


Figure: **Cross Flow Scavenging**

(2) Back Flow or Loop Scavenging :-

In this method, the inlet and outlet ports are situated on the same side of the engine cylinder

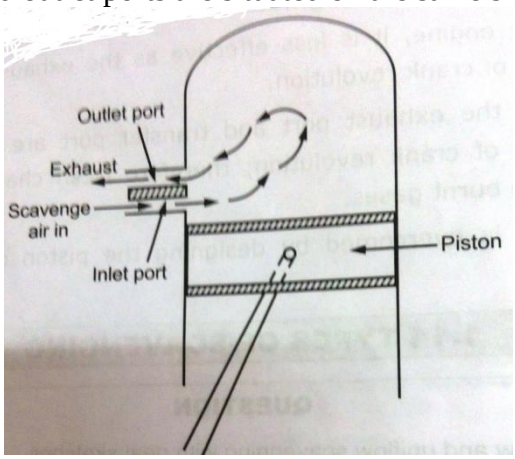


Figure: **Back Flow or Loop Scavenging**

(3) Uni- flow Scavenging:-

In this method, the fresh charge, while entering from one side (or sometimes two sides) of the engine cylinder pushes out the gases through exhaust valve situated on the top of the cylinder

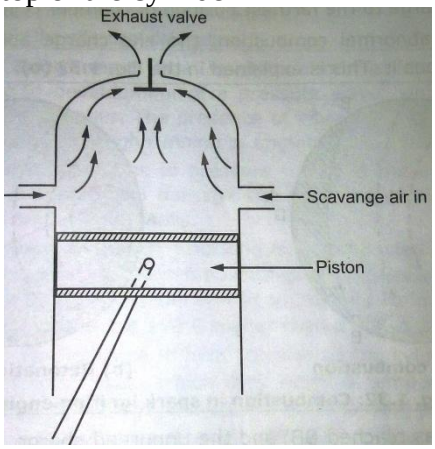


Figure : **Uni- flow Scavenging**

1

2 **Attempt any FOUR of the following:** **16**

a) Differentiate between dry liners and wet Liners **4**

Answer :

Answer: *(Any Four Points= 04 Marks)*

S. N.	Dry Liners	Wet Liners
1	Dry liner is **not in direct contact** of cooling water hence it is known as dry liner	Wet liners is in **direct contact** with cooling water on the outside and hence is known as wet liner.
2	It is **difficult to replaced**	It is **easy to replaced**
3	**No leak proof joint** is provided in the case of dry liner	A leak proof joint between the cylinder casting and the liner has to be provided
4	In dry liners the **casting of cylinder block is complicated**	In wet liners the **casting of cylinder block is very 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 liner
6	For perfect contact between the liner and the block casting in case of dry liner, very **accurate machining of block and outer liner surface** is required	Whereas there is **no such necessity** in case of wet liner
7	A dry liner **cannot be finished accurately** before fitting because of the shrinkage stresses produced	A wet liner **can be finished accurately** before fitting

b) Give I. C. Engine Nomenclature **4**

Answer: I.C. **Engine nomenclature.** *(any four=04 Marks or sketch 2 marks & labeling 2 marks)*

4

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 given by

$$Vs = \frac{\pi}{4}\ d^2.S$$

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

$$V_d = n.V_s$$

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

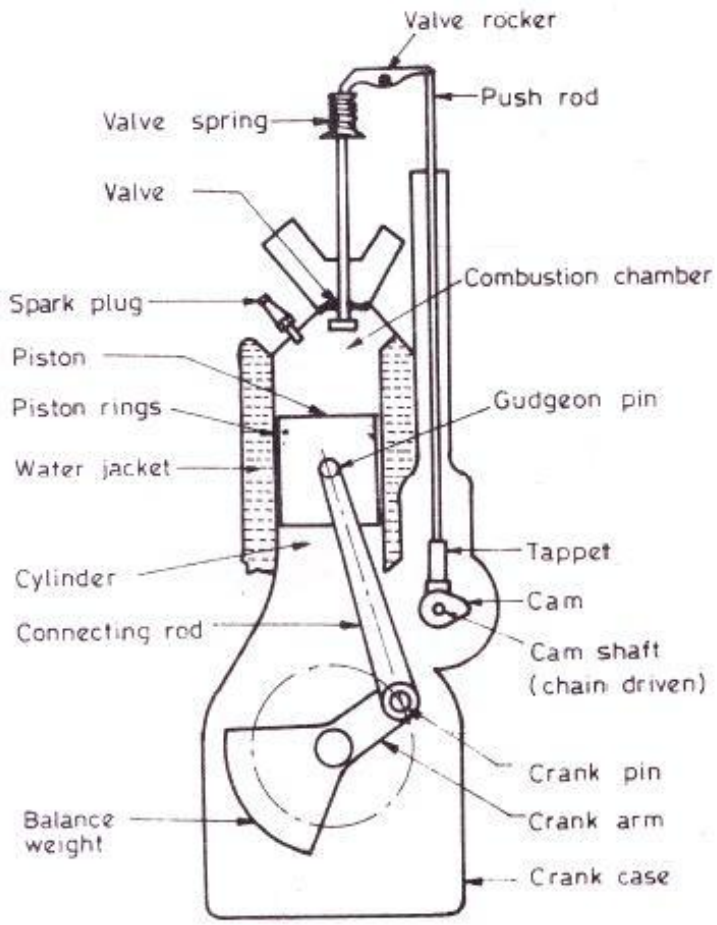
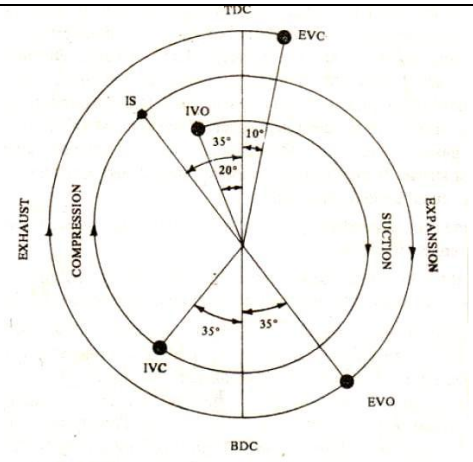
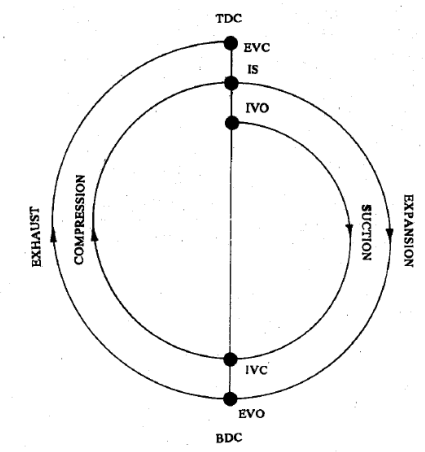


Figure: Engine Nomenclature

4

c) Compare actual and theoretical valve timing diagrams for 4- Stroke C. I. Engine. **4**

Answer: *(Any four points=04 Marks)*

S. N.	Actual Valve Diagram	Theoretical Valve Timing
1	The inlet valve starts opening 100 to 300 before beginning of suction stroke (TDC) and closes after 300 to 400 at the end of the stroke (BDC)	The inlet valve opens exactly at the beginning of suction stroke (TDC) and closes at the end of the stroke (BDC)
2	The exhaust valve starts opening 300 to 600 before beginning of exhaust stroke (BDC) and closes after 80 to 100 at the end of the stroke (TDC)	The exhaust valve opens exactly at the beginning of exhaust stroke (BDC) and closes at the end of the stroke (TDC)
3	Inertia of the valve operating mechanism is considered	Inertia of the valve operating mechanism is not considered
4	Time for the charge to fill completely into the cylinder is considered	Time for the charge to fill completely into the cylinder is not considered
5	Time for the exhaust gases to escape out of the cylinder is considered	Time for the exhaust gases to escape out of the cylinder is not considered
6	The inlet valve is closed when the piston reaches a point in its next stroke at which the pressure in the cylinder equals the pressure outside	The inlet valve is closed when the piston reaches TDC
7	The valves are opened or closed slowly.	The valves are closed or opened instantaneously
8	There is valve overlap	There is no valve overlap
9	 Figure: Actual Valve timing diagram of 4 stroke SI engine	 Figure: Theoretical Valve timing diagram of 4 stroke SI engine

4

d) Distinguish between crank shaft and cam-shaft — **4**

Answer : *(Any four points=04 Marks)* — **4**

S. N.	Crank Shaft	Cam Shaft
1	Manufactured by forging Process.	Manufactured by Casting or Forging Proc
2	To convert the reciprocating motion into rotary motion.	It converts rotary motion of cam into reciprocating motion of follower according to circumference of ca
3	It transmits power to the flywheel	To operate Inlet and Exhaust valve
4	It receives power from flywheel	A gear is present on the camshaft which drives ignition distributor and oil pump.
5	Space required is more	Less Space required.
6	Independent of time	Depend on time.

e) Name the method of manufacturing for following components — **4**

Answer: *(One mark each= 04 Marks)* — **2**

(i) Connecting Rod- Forging

(ii) Cam Shaft- Forging or Casting.

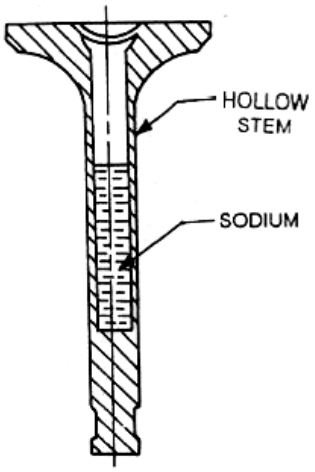
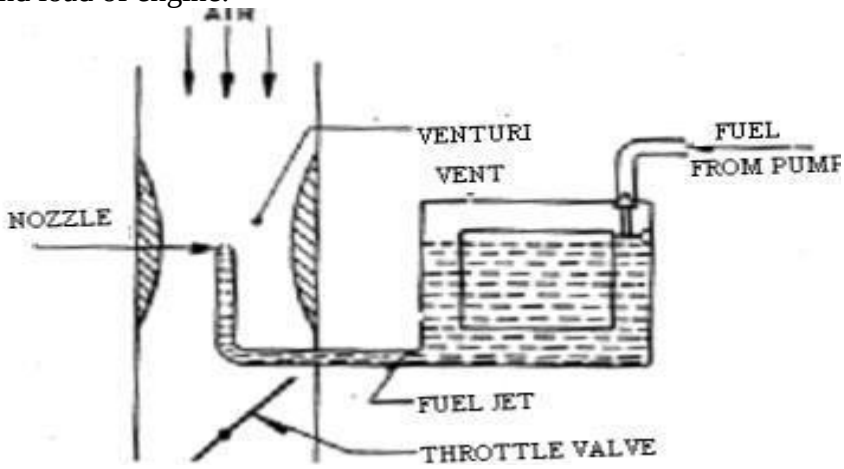
(iii) Piston- Casting

(iv) Gasket- Moulding

f) Describe the method, used to cool the valves of IC engine. — **4**

Answer : ***Answer:*** *(Description= 02 Marks and figure=02 Mark)* — **2**

Exhaust valve temperature in modern engine is as high as 750˚C. 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, the working of this valve is stated below –
A sodium cooled valve has a hollow stem, which is partly filled by metallic sodium. Sodium melts at 97.5˚C. Thus at operating temperature sodium is in liquid state. When engine runs, valve moves up and down, thus sodium is thrown upward in hotter part of valve. There it absorbs heat, which is later given to cooler stem as it falls back to stem again. This keeps the valve head cool.

		 Figure: Sodium cooled valve	2
3		**Attempt any FOUR of the following.**	16
		a) Explain the construction working of simple carburetor	4
		Answer : *(Diagram-2 marks, explanation-2 marks)* During suction stroke air is drawn through the venturi. When air passes through the venturi, velocity of air increases and pressure decreases. The pressure in float chamber is atmospheric pressure and the same is maintained with the help of vent. This pressure differential is called as carburetor depression. So the fuel from the float chamber is feed to a discharge jet. The jet or nozzle delivers a spray of gasoline into the airstream which is passing through venturi same time it mixes with the air. This air fuel mixture enters into the cylinder through the intake manifold. The rate of fuel flow into the venturi tube depends upon the engine speed and load of engine.  Fig. Simple carburetor	2 2
		b) Explain with a neat sketch any one type of camshaft and valve arrangement	
		Answer:- Answer (Explanation 2 marks & sketch 2 marks) **i) Straight poppet 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 1800, 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 1800 the valve spring closes the valve and the push rod is pushed back to its original position.

2

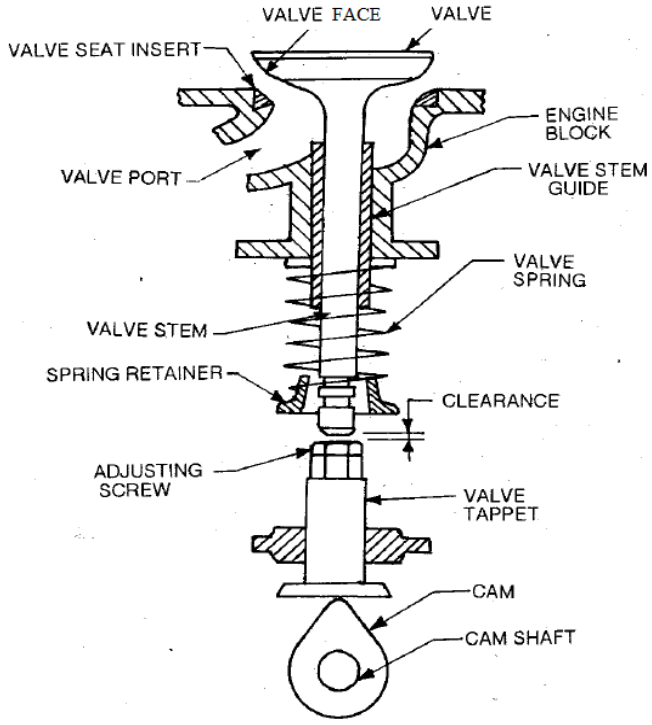
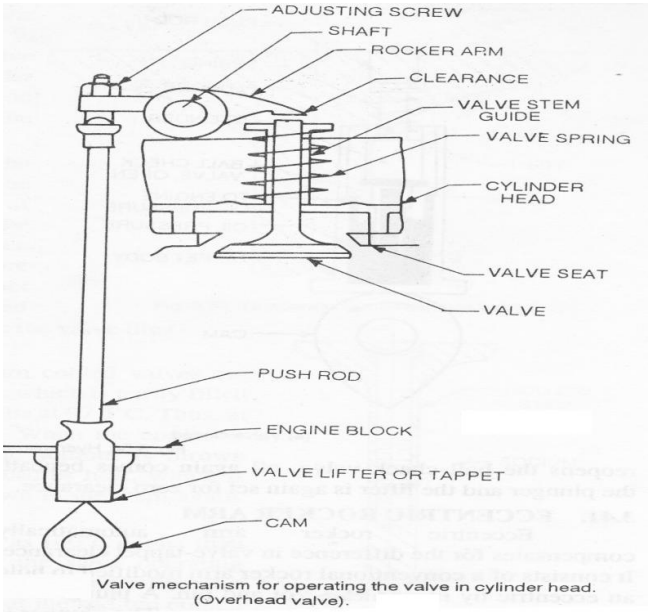


Figure: Straight poppet Overhead valve operating mechanism

OR

Overhead Valve Arrangement:

Figure shows the valve mechanism to operate the valve when it is in the cylinder head (in I and F head design). This type of mechanism requires two additional moving parts – the push rod and rocker arm. As the cam rotates, it lifts the valve- tappet or the lifter which actuates the push rod. The push rod rotates the rocker arm about a shaft- the rocker –arm shaft, or a ball joint in some designs to cause one end to push down on the valve stem to open the valve, thus connecting the valve port with the combustion chamber.



Valve mechanism for operating the valve in cylinder head. (Overhead valve).

OR

iii) Overhead camshaft - operated inverted bucket type

Figure shows single row valves operated by a single overhead camshaft and an inverted bucket type follower. With this type of follower, the camshaft is arranged directly over the valve stems. This type of mechanism is direct and very rigid so that valve movement follows precisely the designed cam-profile lift. Moreover, valve stems are not subjected to side-thrust which means less wear. Tappet clearances are also quite small and do not require adjustment very often

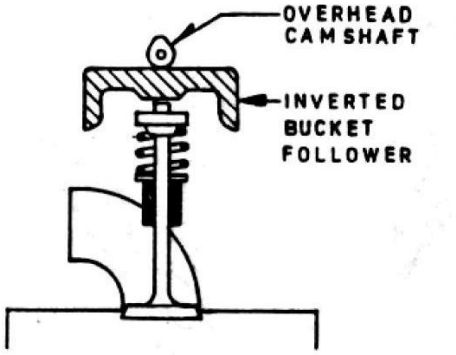


Fig. Overhead camshaft-operated mechanism with inverted bucket type follower (Single row valves)

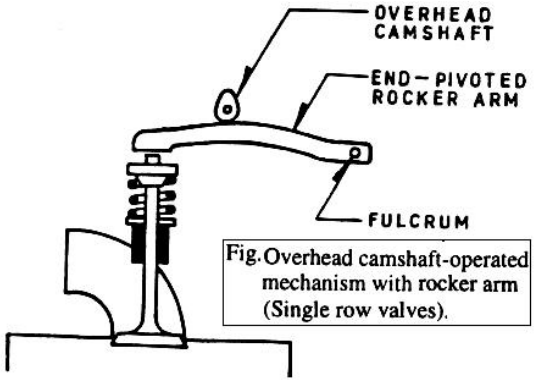
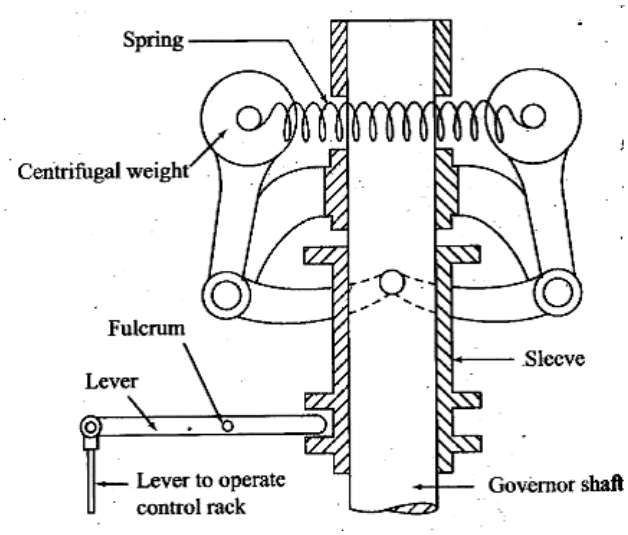


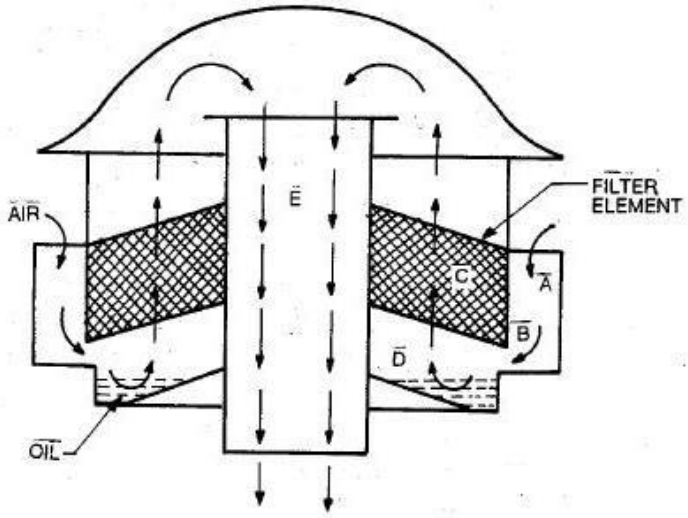
Fig. Overhead camshaft-operated mechanism with rocker arm (Single row valves).

		c) Explain working principle of mechanical governor in Fuel injection pump	**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**
		d) Compare petrol and diesel fuel supply system	**4**
		Answer: (*Each point 1 mark*) **Paramete r** / **Petrol supply system** / **Diesel supply system** Injection pressure / Low / High System used / Carburetor, and fuel injection (MPFI) / CRDI, Pressurized injection No. of components / Less / More Cost / Low / high Weight / Low / High ***(Note: credit should be given to any other relative differences)***	**4**
		e) State different types of air cleaners and explain any one in detail.	**4**
		Answer: Types of air cleaner: *(Type-1 mark, Diagram-2 marks, explanation-1 marks)* The air cleaners generally used are of following types- 1. Oil bath type air cleaner. 2. Dry type air cleaner	**1**

3. Oil wetted type air cleaner
4. Paper pleated type air cleaner
5. Centrifugal type air cleaner

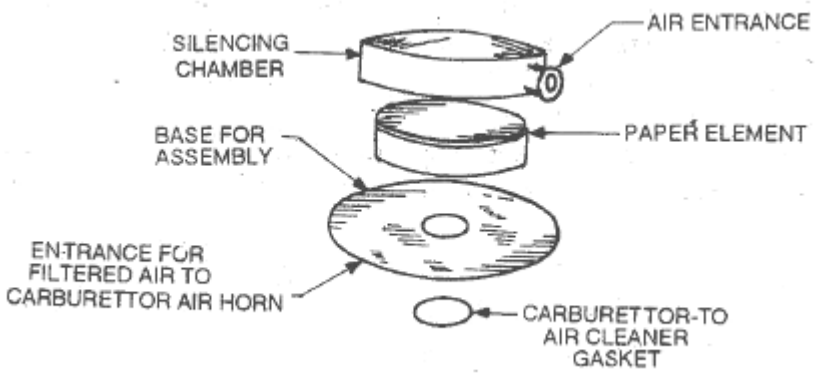
1. Oil bath type air cleaner:

It is a heavy duty air cleaner. It is designed to be placed on the top of the carburetor and to be clamped to the air horn. It consists of a filter element saturated with oil. At the bottom there is a separate oil pan. The operation of air cleaning is carried out in two stages. In the first stage, the air strikes on the oil surface and then reverse upward into the filter element. The dust particles impinge on the oil surface and absorbed by it. In the second stage, the partly cleaned air passes through the filter element in which the remaining dust particles are retained. Finally, the cleaned air passes to the carburetor through the passage way **2**

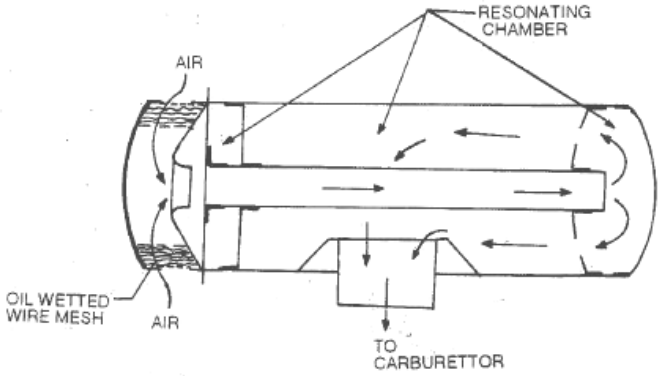


1

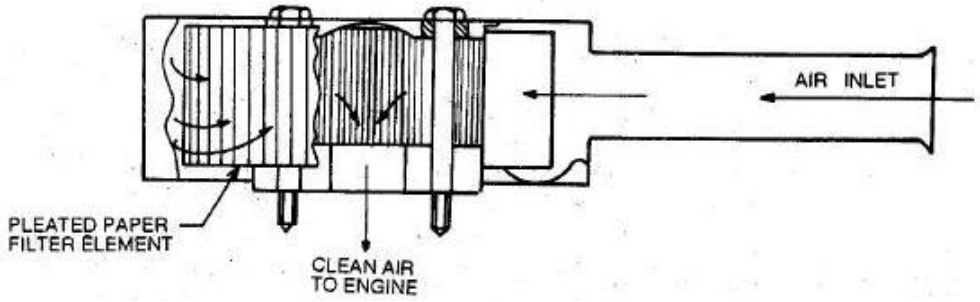
2. Dry type air cleaner: It is light duty air cleaner. It does not contain oil path. It consists of cleaning element only and not the oil bath. The cleaning element is a specially pleated paper element, over which is put a fire mesh screen to provide strength. This cleaning element is enclosed in silencing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



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



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



f) State different types of fuel injection systems and explain any one in detail. **4**

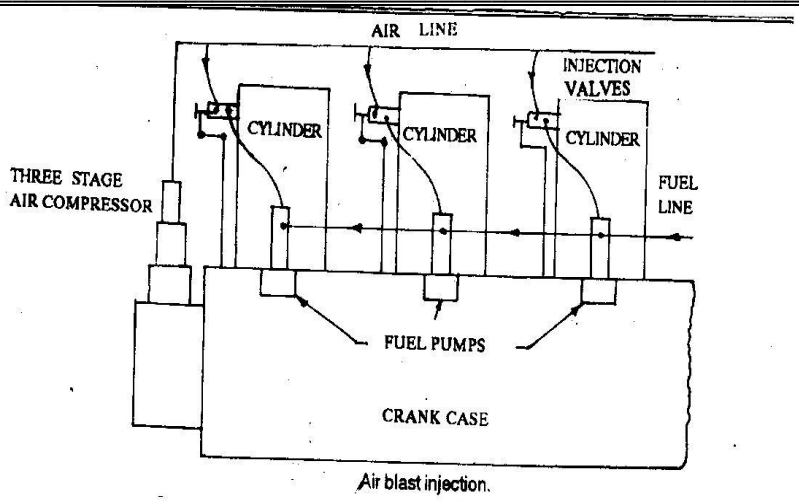
Answer: (*Types-2 marks, explanation-2 marks*) **2**

Types of fuel injection systems are

i) Air blast injection
ii) Airless or solid injection
   a)Individual pump fuel injection system
   b)Common rail fuel injection system

Air blast injection: In this method air is compressed to a very high pressure. A blast of this air is then injected carrying fuel along with it into the cylinder. This method was used in large stationary engines and it is now obsolete.

2

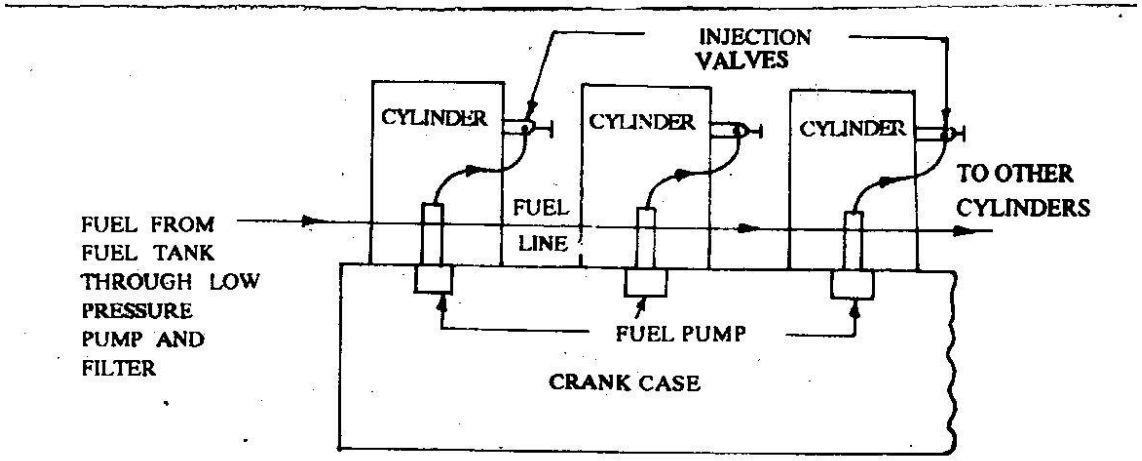


Air blast injection.

Airless or solid injection: In this method the fuel under high pressure is directly injected into the combustion chamber. It burns due to the compression of air. This method requires a fuel pump to deliver the fuel at high pressure(300Kg/sq. cm).Types of airless or solid injection systems are

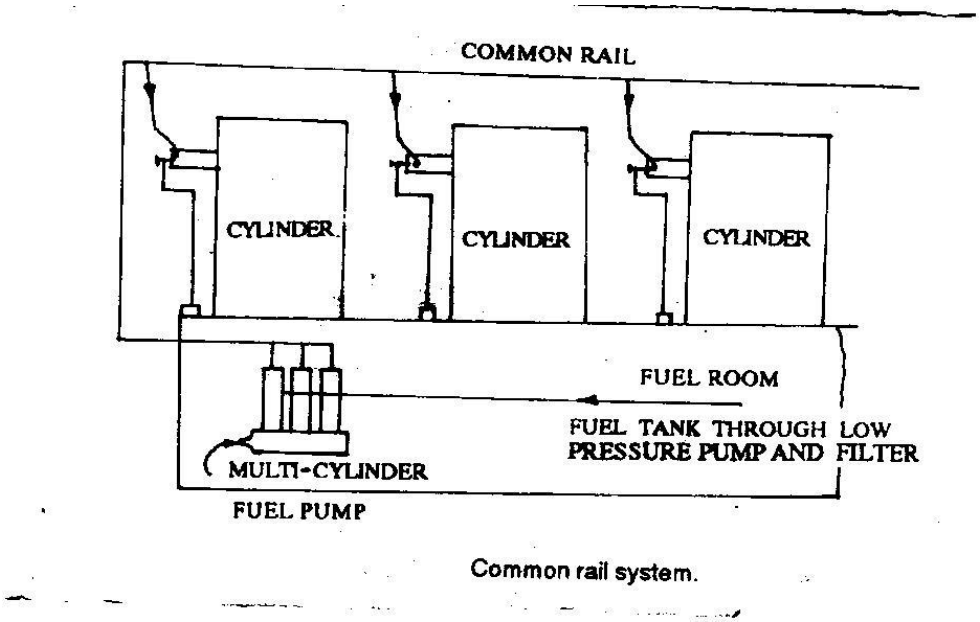
a) Individual pump fuel injection system: In this system each cylinder has its own individual

high pressure pump and a metering unit. It is a compact method and involves higher cost.



Individual pump injection.

b) Common rail fuel injection system: In this system a fuel is pumped by a multi cylinder pump into a common rail, pressure in rail is controlled by a relief valve. A metered quantity of fuel is supplied to each cylinder from the common rail



Common rail system.

4		**Attempt any FOUR of the following:**	**16**
		a) Explain working of magneto ignition system	**4**
		Answer Explanation two marks & sketch two marks) *(Note: Credit shall be given to any other suitable sketch)* **Answer: Magneto ignition system:** Magneto is mounted on the engine and replaces all the components of the coil ignition system except the spark plug. A magneto when rotated by the engine is capable of producing a very High voltage and does not need a battery as a source of external energy. A schematic diagram of a high tension magneto ignition system is shown Figure. The high tension magneto incorporates the windings to gen-rate 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 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.	**2**

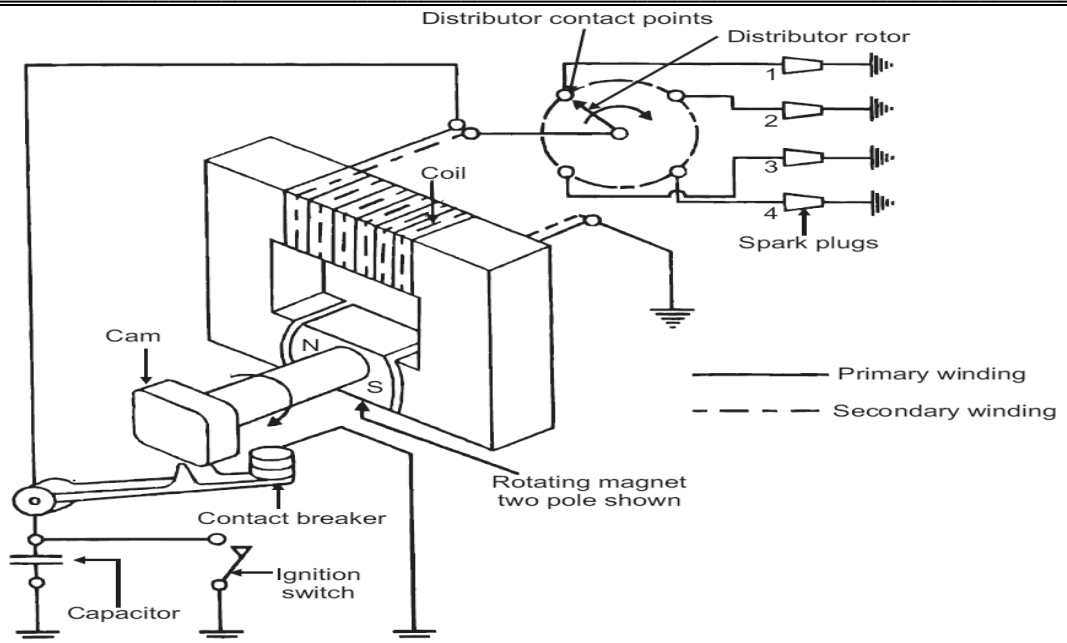


Figure : Schematic Diagram of Magneto Ignition System

2

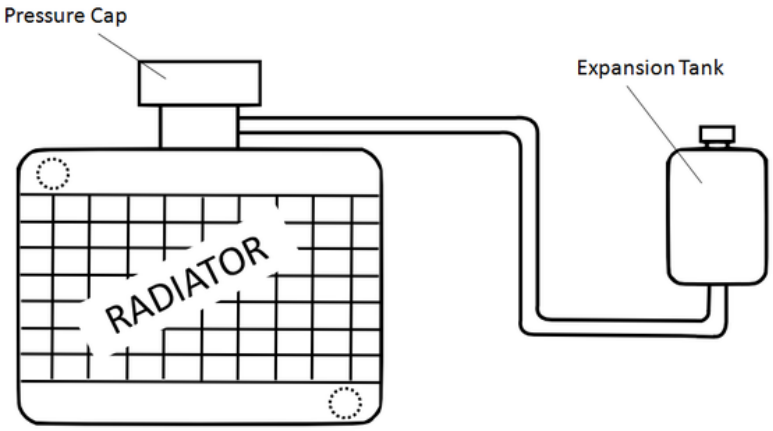
b) State the need of cooling system, compare air cooling system and water cooling system **4**

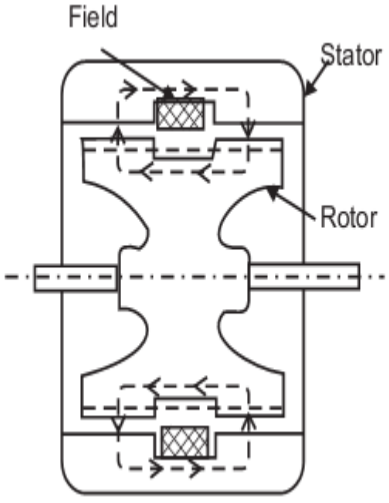
Answer:(*Need-2 mark, difference -2 mark each*)

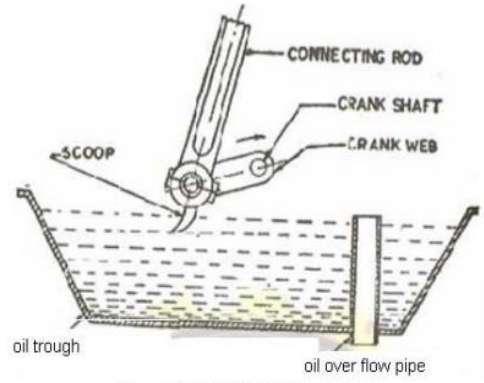
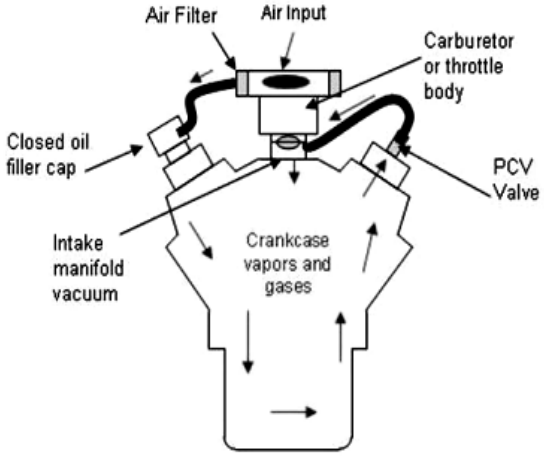
Need of cooling system: The cooling system is needed to keep the engine from not getting so hot as to cause problems and yet to permit it to run hot enough to ensure maximum efficiency of the engine. During the process of converting the thermal energy to mechanical energy, high temperatures are produced 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**

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

2

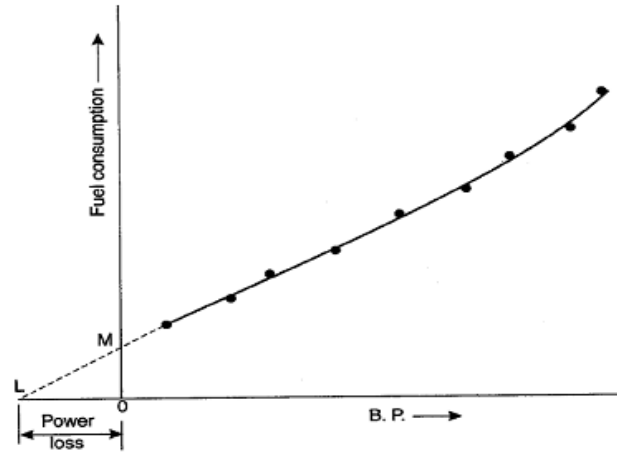
		etc.	
		c) List different properties of coolant	**4**
		Answer: .(*Each property-1 mark*) **Properties of coolant:** 1. Low freezing temperature 2. High boiling point 3. Large latent heat of vaporization 4. Non corrosive 5. Easily and cheaply available 6. Chemically inert 7. Should not deposit foreign matter on the water jackets and radiator	**4**
		d) State the function of water expansion tank; explain with a neat sketch the working principle.	**4**
		Answer: (*function – 2 marks, sketch 2 marks*) **Function of water expansion tank** : In modern engines, instead of overflow pipe an expansion reservoir is provided. This so connected with the radiator that it receives the excess coolant as the engine temperature increases. When the cooling water cools down, its volume decreases and the coolant in the reservoir returns to the radiator keeping the system full of coolant.  	**2** **2**
		e) List components used in exhaust system and explain the function of any two components.	**4**
		Answer: (*List components – 2 marks, function - 2 marks*) **Components of exhaust system:** i) Exhaust manifold. ii) Exhaust pipe. iii) Muffler. iv) Tail or outlet pipe. **Function** (*Any two*) i) **Exhaust manifold:** To carrying the exhaust gases away from the engine cylinder. It collects the gases from the exhaust ports of the various cylinders and conducts them to central exhaust passage. ii) **Exhaust pipe**: It collects the gases from the exhaust ports of the various cylinders and conducts them to central exhaust passage is connected between the exhaust	**2** **2**

		manifold and tail outlet. iii) **Muffler**: to reduce the pressure of the exhaust gases sufficiently to permit them to be discharged to the atmosphere silently. **iv) Tail or outlet pipe**: helps to direct the gases to escape to the atmosphere at the rear of the vehicle	
		f) List the requirements of ignition system used in S.I. engine.	**4**
		Answer: Requirements of ignition system: (*Any four)* 1. The spark should be sufficiently strong to start ignition of the charge 2. The spark duration should be sufficient to establish burning of the air-fuel mixture in all conditions 3. It should have service life almost equal to the engine 4. It should provide a good spark between the electrodes of the plugs at the correct timing 5. It should function efficiently over the entire range of engine speed. 6. It should be light, effective and reliable in service. 7. It should be compact and easy to maintain. 8. It should be cheap and convenient to handle. 9. It should not drain the battery at the time of operation	**4**
Q. 5		**Attempt any <u>FOUR</u> of the following**	**16**
		a) Explain with a neat sketch eddy current dynamometer	
		Answer:(fig -02M explain -02) 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.  	**2** **2**

		b) Explain splash lubrication system with a neat sketch.	**4**
		Answer: (fig -2 Marks explain -2 Marks) 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.  Figure: Splash lubrication system	**2** **2**
		c) What is the need of P.C.V. (Positive crankcase ventilation) describe the working of the same.	**4**
		Answer: (fig -01M,need-01M, explain -02) **Need –** To remove the blow-by gas from engine crankcase, which is present due to leakage past the piston and rings**.** **Working:** 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. 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.  	**1** **2** **1**

		d) State various engine performance parameters and describe any two of them.	**4**
		Answer : **Engine Performance parameters:** 1. Power and mechanical efficiency 2. Mean effective pressure and Torque 3. Specific output 4. Fuel-air ratio 5. Volumetric efficiency 6. Specific fuel consumption 7. Thermal efficiency and heat balance. 8. Exhaust smoke and other emissions 9. Specific weight. 1. **Brake Power**: It is measured at the crankshaft with help of dynamometer. $$B.P. = \frac{2\Pi NT}{60} = \frac{2\Pi N(W \times R)}{60} \text{ Watt}$$ Where , W = Net brake load on dynamometer N = Engine rpm R = Brake drum radius . 2. **Indicated Power**: It is measure on the top of piston. $$\text{I.P.} = \frac{nPLAN'}{60 \times 1000} kw$$ Where, n = Number of cylinders P = Indicated mean effective pressure in N/m^2 L= Stroke in m, D = Diameter in m. A = Area of combustion chamber = $\frac{\Pi}{4} D^2$ in m^2 N = Engine rpm N' = $\frac{N}{2}$ for four stroke and N' = N for two stroke engine. 3. **Mechanical Efficiency**: It is the ratio of brake power to the indicated power	**2** **1** **1**

		e) State various components of lubricating system, also state their functions.	**4**
		Answer: The main components of lubrication system are-(Any Four 1 marks each) i) Oil pump ii) Oil filter iii) Pressure regulator iv) Oil pressure gauge **Functions:** **i) Oil pump:** To supply oil under pressure to the various engines parts **ii) Oil filter:** To remove the impurities from oil & consequently to avoid permanent damage to any or more running part of engine. **iii) Pressure regulator**: - Maintain the predefined pressure value inside the lubricating system. **iv) Oil pressure gauge**: - To indicate the oil pressure in the lubricating system and bring it to notice that whether pressure falls below the predefined value	
		f) Classify lubricating oils and name the oils used in modern engines.	**4**
		Answer The classification of lubricating oil is based on their origin; there are 3 types of lubricating oil. a) Liquid-mineral oil, vegetable oil animal oil etc b) Semi solid- greases. c) Synthetic Lubricants. **Name of engine oils used in modern engines:** a) SAE 5W b) SAE 10W c) SAE 20 W d) SAE 30 e) SAE 40 f) SAE 50 **OR** **1. On the basis of Viscosity :** Lubricating Oils Classify in terms of Viscosity at -18 ^{0}C or in cold climates. a) SAE 5W b) SAE 10W c) SAE 20 W Lubricating Oils Classify in terms of Viscosity at 99 ^{0}C or in hot climates. a) SAE 20 b) SAE 30 c) SAE 40 d) SAE 50 **2. On the basis of Service Rating :** **C- series** a) CA: Use in gasoline and naturally aspirated diesel engine operated on low sulphur fuel. b) CB: Use in gasoline, naturally aspirated diesel engine operated on high sulphur fuel. c) CC: Use for lightly supercharge diesel engine. d) CD: Use in highly turbocharge diesel engine. **S- series** a) SA : Mineral oil , may contain anti-formant and poor point depressant b) SB : Mineral oil , containing additive impart sum oxidation stability & anti- scuff protection c) SC, SD & SC: Meets automotive manufactures specifications.	**2** **2**

6		**Attempt any TWO of the following.**	**16**
		a) Explain Willian's line method and Morse test for calculating frictional power.	**8**
		Answer: Willan's Line Method :(04M) At a constant engine speed the load is reduced in increments and corresponding B.P. and gross fuel consumptions readings are taken. A graph is then drawn of fuel consumption against B.P. as in Fig. The graphs draw is called the Willian's line (analogous to Willan's line for a steam engine) and extrapolated back to cut the B.P. axis at the point L. The reading OL is taken as the power loss of the engine at that speed. The fuel consumption at zero B.P. is given by OM; and if the relationship between fuel consumption and B.P. is assumed to be liner then a fuel consumption OM is equivalent to a power loss of OL.	**2**
		Frictional power loss (F.P.) = OL  Fig. Willan's line method.	**2**
		Morse Test: Used for multi cylinder engines **Procedure:** 1. The engine is run at the required speed and the torque is measured. 2. One cylinder is cut out by shorting the plug if an S.I. engine is under test or by disconnecting an injector if a C.I. engine is under test . 3. The speed falls because of the lass of power with one cylinder cut out but is restored by reducing the load . 4. The torque is measured again when the speed has reached its original value. 5. If the value of I.P. measured simultaneously for each cylinder $I = I_1 + I_2, + I_3 + I_4$ $F.P. = (I.P.)_n - (B.P.)_n$ Where n^{th} is the number of cylinders.	**4**

		b) A 4- cylinder, 4 – stroke cycle engine having cylinder diameter 100 mm and stroke 120 mm was tested at 1600 rpm and the following readings are obtained. Fuel consumption =0.27 liters/min Specific gravity of fuel = 0.74 B.P = 31.4 KW, Mech. Eff = 80 % Calorific Valve of Fuel = 44000 KJ/Kg Determine , i) bsfc ii) imep iii) Brake thermal Efficiency	**8**
		Solution : Given - 4 cylinder, 4 stroke Bore diameter -100 mm = 0.10 M Stroke length – 120 mm = 0.120 M Engine RPM = 1600 Mf = 0.27 lit/min = (0.27 x 0.74) / 60 = 0.00333 Kg/sec Sp gravity =0.74 B.P = 31.4 KW Mechanical efficiency =80 % C.V of fuel = 44000 KJ/Kg **Finding** **1. BSFC** = Mf/BP = 0.00333/31.4 = 0.3817 Kg/KW-hr **2. IMEP** =(IP x 60000)/(L x A x N/2 x n) I P = BP/η_m IP = 31.4/0.8 = 39.25 KW **IMEP** =(IP x 60000)/(L x A x N/2 x n) = (39.25x60000)/(0.120 x 3.142/4 x0 .1x.1x800x 4) = 7.80 bar **3. ηbth** = B.P / (mfxCV) = 31.4/(.003333*44000) = 0.214 *100 = 21.4 %	**1** **2** **3** **2**
		c) The following observations were recorded during a trial on 4 – stroke diesel engine : power absorbed by non-firing engine when, Driven by an electric motor (F P)= 10 KW Speed of engine = 1750 rpm Brake torque =327.4 Nm Fuel used = 15 Kg/hr C.V = 42000 KJ/Kg Air Supplied = 4.75 Kg/min Cooling water circulated = 16 Kg/min Outlet temp of cooling water = 65.8 ^{0} C Temp of Exhaust Gas = 400 ^{0} C	**8**

		Room temp = 20.8 ^{0} C Specific heat of water = 4.19 KJ/Kg.K Specific heat of exhaust gas = 1.25 KJ/Kg.K Determine, i) B P ii) Mechanical efficiency iii) BSFC iv) Draw heat balance sheet on KW basis	
		Solution: **i) B P** = 2πNT/60000 KW = (2π x 1750 x 327.4)/60000 = 60 KW **ii) Mechanical efficiency** = (BP/IP) x 100 = (60/70) x 100 = 85.714 % **iii) BSFC** = Mf/BP = 15/60 = 0.25 Kg/KW-hr **iv) Heat balance sheet on KW basis** 1. Heat in the fuel = Hf= Mf x CV = (15/3600) x 42000 = 175 KW 2.Heat goes in BP (Hp) = 60 KW 3.Heat Supplied in Cooling Water Hw = Mw x Cpw x (To – Ti) = (16/60) x 4.19 x (65.8 – 20.8) **Assume Ti = 20.8^0 C** Hw = 50.28 KW 4. Heat carried by exhaust gas Hg = Me x Cpg x (Te – Tr) Hg = (0.00416 +0.0791) x 1.25 x 379.2 Hg = 39.46 KW 5. Unaccounted Losses Ha = Hf – (Hp+Hw+Hg) Ha = 175 – (60+50.28+39.46) Ha = 25.26 KW	**1** **1** **1** **1** **1** **1**

HEAT BALANCE SHEET ON KW BASIS

Parameter	Value in KW	Percentage %
Heat in the fuel (Hf)	175	100
Heat goes in BP	60	34.28
Heat Supplied in Cooling Water (Hw)	50.28	22.85
Heat carried by exhaust gas (Hg)	39.46	22.54
Unaccounted Losses (Ha)	25.26	20.30