SUMMER – 19 EXAMINATION

Subject Name: AEN **Model Answer** Subject 17408

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 anyequivalent 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 of the Following**	**10**
	(a)	**State the meaning of Scavenging.**	**02**
	Ans.	***(Correct Answer 02 Marks)*** **Scavenging:** Scavenging is process of removing the exhaust gases (combustible products) from the cylinder with help of incoming fresh charge in two stroke engine. During the downward movement of the piston the mixture in the crankcase is compressed and pushed into the cylinder through the transfer port, which pushes out the exhaust gases through the exhaust port at the same time filling the cylinder with new charge, is called cross- flow scavenging.	*Correct Answer 02 Marks*
	(b)	**State function of (i) Cylinder Block (ii) Cylinder Head**	**02**
	Ans.	***(Function 01 Mark Each)*** **Function of Cylinder Block:** It is an integrated structure consists of the cylinders of a reciprocating engine, coolant passages, intake and exhaust passages and ports, and crankcase, etc. **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 01Mark Each*
	(c)	**List any two applications of C. I. Engine**	**02**
	Ans.	***(Any Two 01 Mark each)*** Gas Engines — Industrial Power Diesel Engines — Automotive, Railways, Power, Marine Gas Turbines — Power, Aircraft, Industrial, Marine	*Any Two 01 Mark each*

	(d)	**State any four specifications of two – wheeler engine.**	**02**
	Ans.	***(Any Four ½ Mark Each)*** ***(Note: Credit should be given to any other 2 Wh. Specifications)***	*Any Four ½ Mark Each*

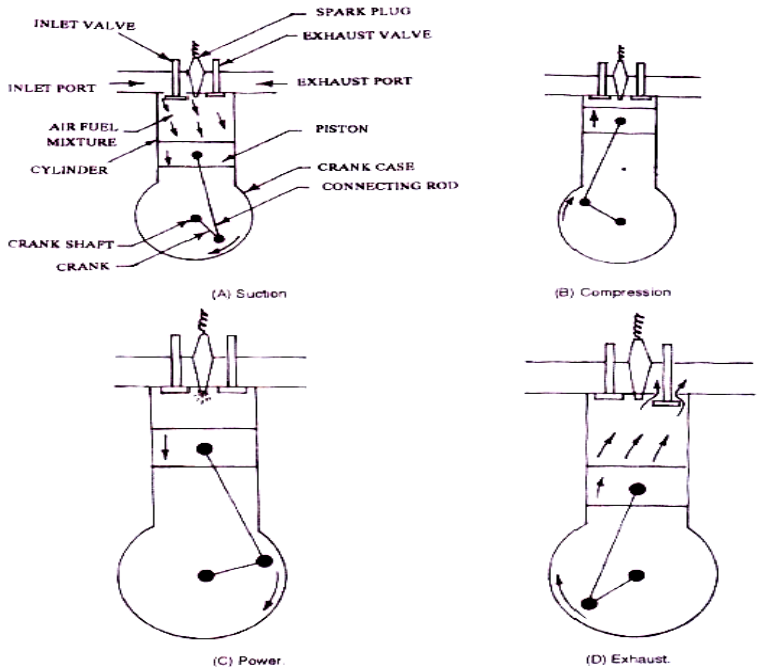
(1) Honda CD 110 Dream DX Self Start:	**(2) Hero Super Splendor:**
Displacement : 109.19 cc	Displacement : 124.7 cc
No. of Cylinders : 1	No. of Cylinders : 1
No. of Gears : 4	No. of Gears : 4
Maximum Power : 8.25 BHp @7500rpm	Maximum Power : 9 BHp @7000rpm
Maximum Torque : 8.63 N-m @ 5500rpm	Maximum Torque : 10.35 N-m @ 4000rpm
Engine Description : Air Cooled, 4 stroke, SI Engine	Engine Description : Air Cooled, 4 stroke, Single Cylinder OHC
Cooling : Air Cooling	Cooling : Air Cooling
Compression Ratio : 9.9:1	Compression Ratio : 9.1:1
Bore : 50 mm	Bore : 52.4 mm
Stroke : 55.6 mm	Stroke : 57.8 mm
Air Filter Type : Viscous Paper Filter	Fuel Type : Petrol
Fuel Type : Petrol	Gearbox Type : Constant Mesh
Bharat Stage IV (BS4) : Yes	Fuel Type : Petrol
Clutch : Multiple Wet Clutch	Clutch : Multiple Wet Clutch

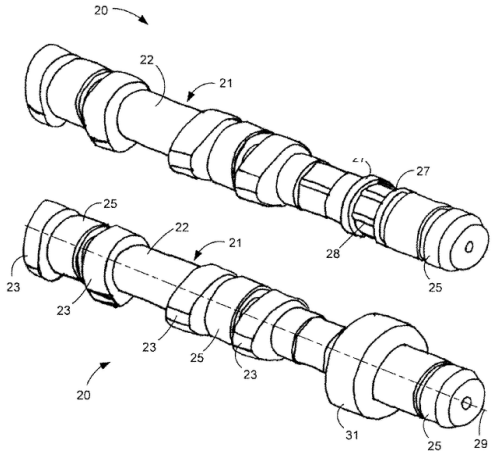
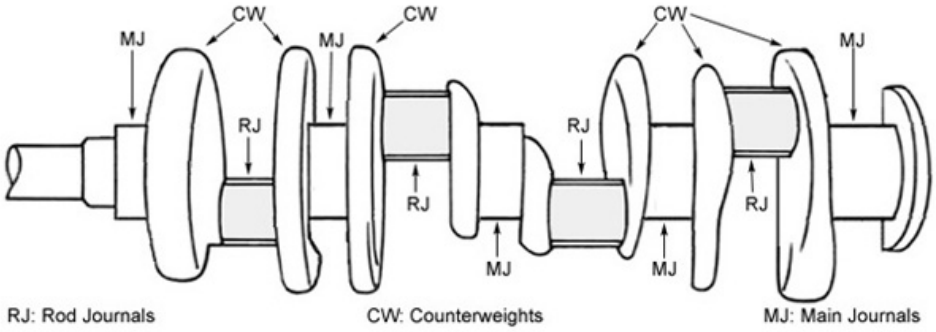
	(e)	**List any four components of water cooling system.**	**02**
	Ans.	***(Any Four ½ Mark Each)*** 1. Coolant (Antifreeze) 2. Cooling fan. 3. Cooling reservoir. 4. Heater core. 5. Hoses. 6. Radiator. 7. Thermostat. 8. Water pump.	*Any Four ½ Mark Each*
	(f)	**Define: (i) Indicated Power (ii) Brake Power**	**02**
	Ans.	***(Each 01 Marks)*** **i) Indicated Power:** It is the power developed by the engine above the piston in the combustion chamber	*Each 01 Marks*

		by burning of fuel. **ii) Brake Power:** The brake power is the power obtained at the engine flywheel and is measured with the help of dynamometer, it is measured in kW	
	(g)	**State the manufacturing method of (i) Connecting Rod (ii) Cylinder Block**	**02**
	Ans.	***(Each 01 Mark)*** **(i) Connecting Rod:** Forging **(ii) Cylinder Block :** Casting	*Each 01 Mark*
	(h)	**State the meaning of Air – Fuel (A/F) Ratio.**	**02**
	Ans.	***(Correct Answer 02 Marks)*** **Meaning of Air-Fuel Ratio:** Air - fuel ratio (AFR) is the ratio of mass of air to mass of fuel. The mixture of air and petrol burns completely only when they are mixed in particular ratio, called the air fuel ratio. $A/F\ \text{Ratio} = \frac{\text{Mass of air}}{\text{Mass of Fuel}}$	*Correct Answer 02 Marks*
1	**B**	**Attempt any TWO of the Following**	**08**
	(a)	**Classify IC engine on the basis of (i) Stroke (ii) Fuel (iii) Number of Cylinders (iv) Ignition**	**04**
	Ans.	***(Correct Answer 01 Mark each)*** **(i) Stroke:** (a) 2 Stroke (b) 4 Stroke **(ii) Type of Fuel used:** a) Petrol engine (or Gasoline engine) b) Diesel engine c) Gas engine **(iii) Number of Cylinders:** (a) Single Cylinder (b) Two Cylinder (iii) Three Cylinder (iv) Four Cylinder (v) Six Cylinder (vi) Twelve Cylinder **(iv) Ignition:** a) Spark ignition (S.I.) engine b) Compression ignition (C.I.) engine	*Correct Answer 01 Mark each*
	(b)	**Compare Four Stroke and Two Stroke Engine (Four Points)**	**04**
	Ans.	***(Any Four Points 01 Mark Each)***	*Any Four Points 01 Mark Each*

S. N.	Four Stroke Engine	Two Stroke Engine
1	One working stroke for every two revolutions of the crankshaft.	One working stroke for each revolutions of the crankshaft
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	Engine is heavy	Engine is Light
4	Engine design is complicated	Engine design is Simple

		5	More Cost	Less Cost
		6	Less mechanical efficiency due to more friction on many parts.	More mechanical efficiency due to less friction on few parts.
		7	More output due to full fresh charge intake and full burnt gases exhaust	Less output due to mixing of fresh charge with burnt gases.
		8	Engine runs cooler	Engine runs hotter.
		9	Engine is water/air cooled	Engine is air cooled
		10	Engine requires more space.	Engine requires less space.
	(c)	**Explain working of four strokes Spark Ignition (SI) Engine.**		**04**
	Ans.	***(Any One Diagram 02 marks, Description 02 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.		*Any One Diagram 02 marks, Description 02 marks*

		 **Figure: Working of Four Strokes Spark Ignition (SI) Engine**	
2		**Attempt any FOUR of the Following**	**16**
	(a)	**Define: (i) IC Engine (ii) Stroke Length (iii) TDC (iv) BDC**	**04**
	Ans.	***(Each Correct Answer 01 Mark)*** **(i) IC 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). **(ii) Stroke** Length: Distance between two extreme positions of piston. **(iii) TDC:** The topmost position of piston inside the cylinder. **(iv) BDC:** The bottommost position of piston inside the cylinder.	*Each Correct Answer 01 Mark*
	(b)	**Name the material for: (i) Piston (ii) Cylinder Block (iii) Gasket (iv) Connecting Rod.**	**04**
	Ans.	***(Each Correct Answer 01 Mark)*** **(i) Piston:** Gray cast iron, Aluminium alloy **(ii) Cylinder Block:** cast iron alloys, an automaker can use " aluminum alloys **(iii) Gasket:** paper, rubber, silicone, metal, cork, felt, neoprene, nitrile rubber, fiberglass, PTFE or Teflon or a plastic polymer **(iv) Connecting Rod:** Forged steel, Aluminium alloy	*Each Correct Answer 01 Mark*
	©	**State the function and location of: (i) Piston (ii) Connecting Rod (iii) Crankshaft (iv) Camshaft.**	**04**
	Ans.	***(Function and Location of Each 01 Mark)*** **Piston:** Located in Cylinder block of Engine Its purpose is to transfer force from expanding gas in the cylinder to the crankshaft **Connecting Rod:** A connecting rod is an engine component. It transfers motion from the piston to the crankshaft **Crankshaft:** A Crankshaft is an engine component. To translate the linear reciprocating motion of a pistons into the rotational motion required by the automobile. **Camshaft:** The camshaft is a mechanical component of an internal combustion engine	*Function and Location of Each 01 Mark*

		It opens and closes the inlet and exhaust valves of the engine at the right time, with the exact stroke and in a precisely defined sequence	
	(d)	**Draw schematic diagram of camshaft and connecting rod.**	**04**
	Ans.	***(Neat Labeled Diagram 02 Mark Each)*** ***(Note: Credit Should be given any other Suitable sketch)*** **Camshaft:**  **Figure: Camshaft** **Connecting Rod:**  **Figure: Crankshaft**	***Neat Labeled Diagram 02 Mark Each***
	(e)	**Compare dry liner and wet liner**	**04**
	Ans.	***(Any Four Points 01 Mark Each)***	*Any Four Points 01 Mark Each*

Sr	Dry liners	Wet Liners
1.	Dry Liner is not in direct contact of cooling water hence it is known as a "dry liners"	Wet Liner is in direct contact with cooling water on the outside &hence it is known as a "wet liners"
2.	It is difficult to replace.	It is easy to replace.
3.	No leak proof joint is provided in the case of dry liners.	A leak proof joint between the cylinder casting & liner has to be provided.
4.	In dry liners casting of cylinder block is complicated.	In wet liners casting of cylinder block is simplified.
5.	A cylinder block with dry liners is generally more robust.	A cylinder block with wet liners is less robust as compare to dry liners.
6.	For perfect contact between liner & the block casting in case of dry liner, very accurate machining of block & outer liner surface is required.	Whereas there is no necessity in case of wet liner.
7.	A dry liner cannot be finished accurately before fitting. Because of the shrinkage stresses is produced.	A wet liner can be finished accurately before fitting.
8	Thickness ranges from 1.5 mm to 3 mm	Thickness ranges from 3 mm to 6mm

(f) State types of camshaft drives with applications. — 04

Ans. *(Types 02 Marks and Its application 02 Marks)*

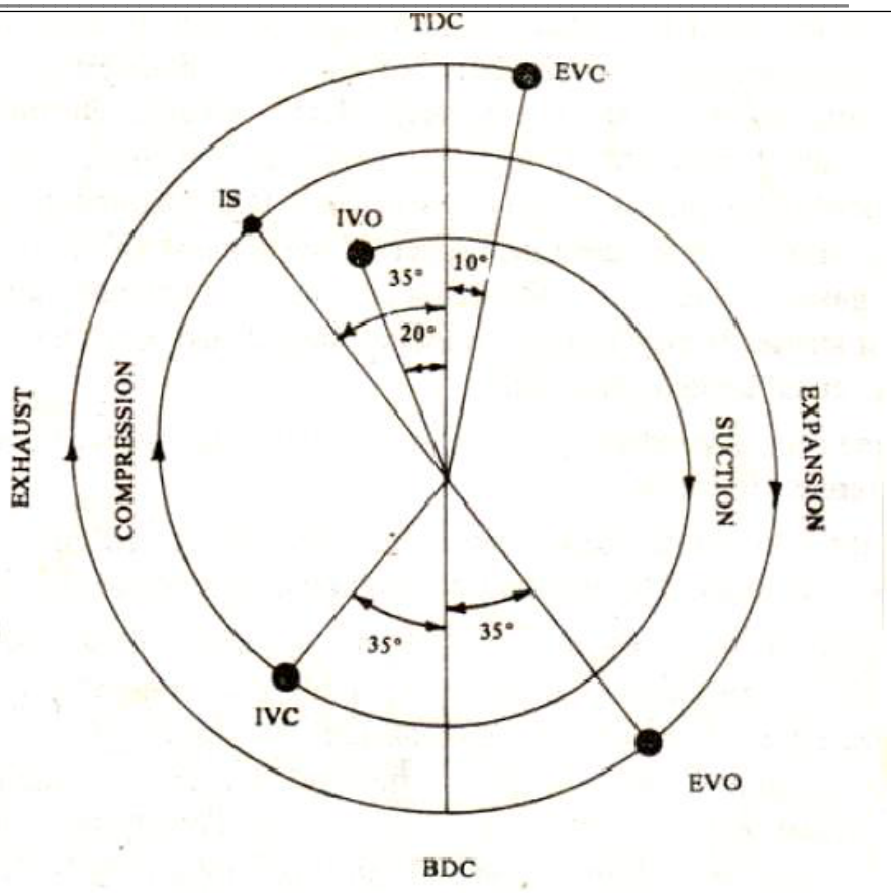
Types of Camshaft Drives	Applications
Single Overhead Camshaft (SOHC),	A SOHC or single overhead camshaft engine uses a single camshaft on the head to lift all the valves
Double Overhead Camshaft (DOHC)	A DOHC or double overhead camshaft head, two camshafts are used to lift the valves (a camshaft each for intake and exhaust valves)
Overhead Valve (OHV) Camshafts	Instead of the camshaft directly touching the rocker arms connected to the valves themselves, the camshaft touches a series of pushrods, which activate the valves instead

Types 02 Marks and Its application 02 Marks

3 Attempt any FOUR of the Following — 16

(a) Explain valve timing diagram for four stroke engine. — 04

Ans. ***(Neat Labeled Diagram 04 Marks)*** — *Neat Labeled Diagram 04 Marks*

		 **Figure: Valve Timing Diagram for Four Stroke Engine**	
	(b)	**State the approximate Air- Fuel (A/F) ratio required for (i) Idling (ii) Normal Speed (iii) Acceleration**	**04**
	Ans.	***(Correct Answer 04 Marks)*** **Air Fuel Ratio:** **Idling:** Idling requires a rich mixture about 10:1 to 12:1 **Normal Running:** For normal running it is desired to run the engine on maximum economy conditions around 16:1 to 18:1 **Acceleration:** For acceleration rich mixture 12:1 is required.	*Correct Answer 04 Marks*
	©	**List types of nozzle in diesel engine and explain any one.**	**04**
	Ans.	***(Types 02 Marks and Explanation 02 Marks)(Sketch is not Compulsory)*** **Types of Nozzles:** 1. The Single Hole Nozzle: 2. The Multi Hole Nozzle: 3. The Pintle Nozzle: 4. Pintaux Nozzle: **1. The Single Hole Nozzle:** In this type of nozzle at the center of the body there is a single hole which is closed by the nozzle valve. The size of the hole is usually of the order of 0.2 mm. Injection pressure is of order of 8-10MPa and spray cone angle is about 15 degree. One of the major disadvantages of this nozzle is that they tend to dribble. Besides, their spray angle it too narrow to facilitate good mixing unless higher velocities are used.	*Types 02 Marks and Explanation 02 Marks*

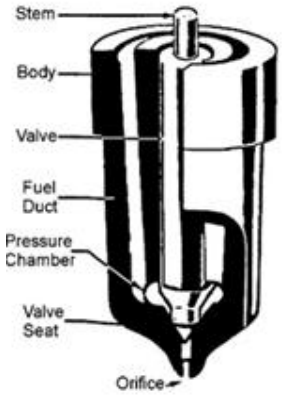


Figure: Single Hole Nozzle

2. **The Multi Hole Nozzle:**

This nozzle consists of a number of holes bored in the tip of the nozzle. The number of holes varies from 4 to 18 and the size from 35 to 200 micro meters. The hole angle may be from 20 degree upwards. These nozzles operate at high injection pressure of the order of 18 MPa. Their advantage lies in the ability to distribute the fuel properly even with lower air motion available in open combustion chambers.

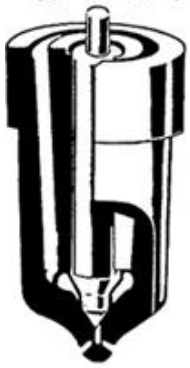


Figure: Multi Hole Nozzle.

3. **The Pintle Nozzle:**

In this type of nozzle the stem of nozzle valve is extended to from a pin or Pintle which protrudes through the mouth of the nozzle. The size and shape of the Pintle can be varied according to the requirement. It provides a spray operating at low injection pressures of 8-10MPa. The spray cone angle is generally 60 degree. The main advantage of this nozzle is that it avoids weak injection and dribbling. It prevents the carbon deposition on the nozzle hole.

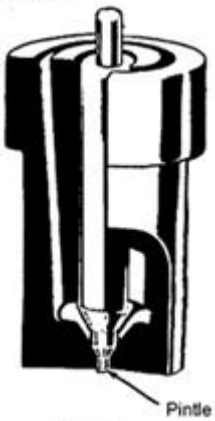
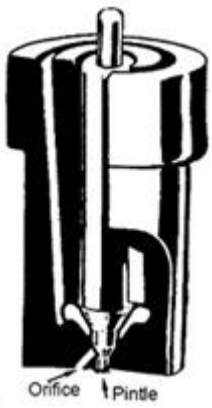


		Figure: The Pintle Nozzle **4. Pintaux Nozzle:** This type of nozzle is a type of Pintle nozzle which has an auxiliary hole drilled in the nozzle body. It injects a small amount of fuel through this additional hole which is called pilot injection in upstream direction slightly before the main injection. The needle valve does not lift fully at low speeds and most of the fuel is injected through the auxiliary hole. The main advantage of this nozzle is better cold starting performance. A major drawback of this nozzle is that its injection characteristics are poorer than the multihole nozzle.  **Figure: Pintaux Nozzle**	
	(d)	**State need and requirement of fuel injection system.**	**04**
	Ans.	*(Any two)* **Requirements of Fuel Injection System:** 1) **Metering** – The fuel injection system must measure the fuel supplied to the engine very accurately as fuel requirements vary from low to high engine speeds. 2) **Time**- Fuel injection system must supply the fuel at the proper time according to engine requirement 3) **Pressure**- The fuel injection system must pressurize the fuel to open the injection nozzle to inject fuel into the combustion chamber. 4) **Atomize**- The fuel must be atomized when it is supplied to the combustion chamber since atomized fuel will burn easily. 5) **Distribution**- In case of multi cylinder engine the distribution of metered fuel should be same to all cylinders. 6) **Control, start and stop injection-** The injection fuel must start and end quickly.	
	(e)	**Draw a neat sketch of simple Carburetor.**	**04**
	Ans.	***(Diagram-2 marks, explanation-2 marks)*** **Simple Carburetor:** 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.	

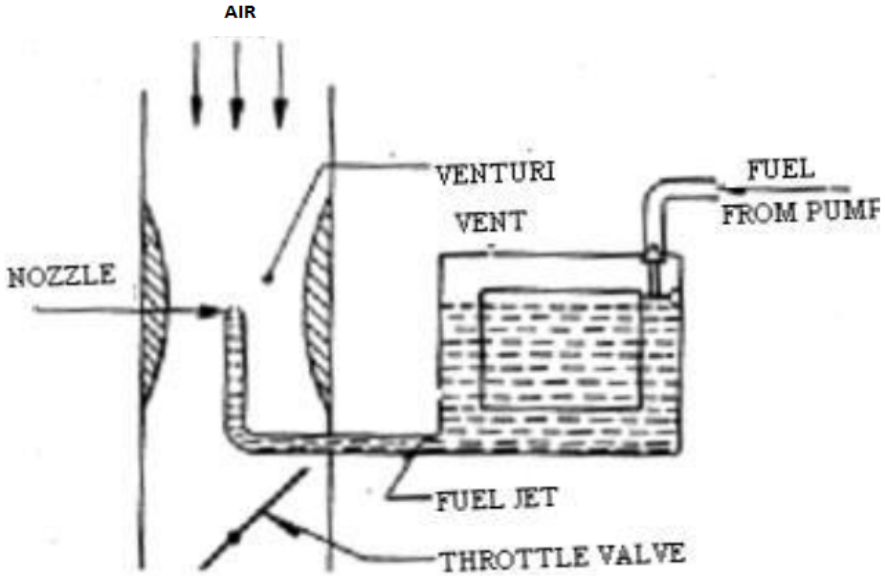


Figure: Simple Carburetor

	(f)	**State types of fuel injection system and explain any one.**	**04**
	Ans.	***(Types any four 02 Marks and Explanation of any One 02 Marks)***	

Types of Fuel Injection System:

1. Individual Pump System
2. Multi-plunger, Inline Pump System
3. Unit Injector System
4. Pressure-time Injection System
5. Distributor Injection Pump System
6. Common Rail Injection Pump System
7. Electronically Controlled Fuel Injection System

Types any four 02 Marks and Explanation of any One 02 Marks

1. Individual Pump System

The individual pump system is a small pump contained in its own housing, and supplies fuel to one cylinder. The individual plunger and pump barrel are driven off of the engine's cam shaft. This system is found on large-bore, slow-speed industrial or marine diesel engines and on small air-cooled diesels; they are not used on high-speed diesels.

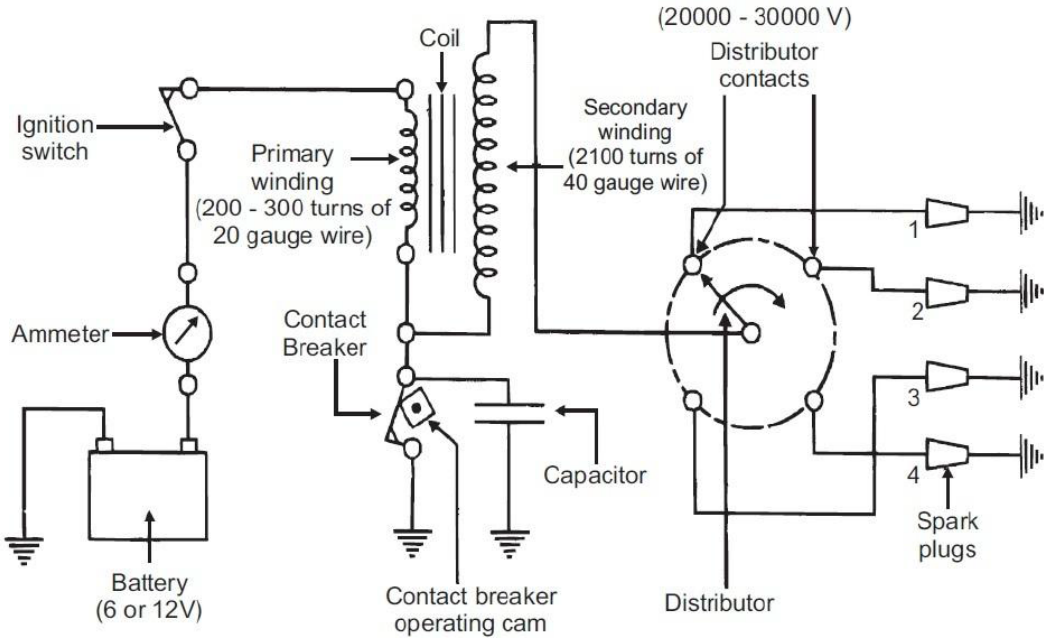
2. Multi-plunger Inline Pump System

It uses individual pumps that are contained in a single injection pump housing. The number of plungers is equal to the number of cylinders on the engine, and they are operated on a pump camshaft. This system is used on many mobile applications and is very popular with several engine manufacturers. The fuel is drawn in from the fuel tank by a pump, sent through filters, and delivered to the injection pump at a pressure of 10 to 35 psi. All pumps in the housing are subject to this fuel. The fuel at each pump is timed, metered, pressurized, and delivered through a high-pressure fuel line to each injector nozzle in firing order sequence

3. Unit Injector System

The unit injector systems utilize a system that allows timing, atomization, metering, and fuel pressure generation that takes place inside the injector body and services a particular cylinder. This system is compact and delivers a fuel pressure that is higher

		than any other system today. Fuel is drawn from the tank by a transfer pump, filtered. and then delivered. The pressure is 50 – 70 psi before it enters the fuel inlet manifold located within the engine's cylinder head. All of the injectors are fed through a fuel inlet or jumper line. The fuel is pressurized, metered, and timed for proper injection to the combustion chamber by the injector. This system uses a camshaft-operated rocker arm assembly or a push rod actuated assembly to operate the injector plunger. **4. Pressure-time Injection System** The pressure-time injection system (PT system) got its name from two of the primary factors that affect the amount of fuel injected per combustion cycle. Pressure, or "P," refers to the pressure of the fuel at the inlet of the injector. Time, or "T," is the time available for the fuel to flow into the injector cup. The time is controlled by how fast the engine is rotating. The PT system uses a camshaft-actuated plunger. This changes the rotary motion of the camshaft to a reciprocating motion of the injector. The movement opens and closes the injector metering orifice in the injector barrel. Fuel will flow only when the orifice is open; the metering time is inversely proportional to engine speed. The faster the engine is operating, the less time there is for fuel to enter. The orifice opening size is set according to careful calibration of the entire set of injection nozzles. **5. Distributor Injection Pump System** The distributor pump systems are used on small to medium-size diesel engines. These systems lack the capability to deliver high volume fuel flow to heavy-duty, large displacement, high-speed diesel engines like those used in trucks. These systems are sometimes called rotary pump systems. Their operating systems are similar to how an ignition distributor operates on a gasoline engine. The rotor is located inside the pump and distributes fuel at a high pressure to individual injectors at the proper firing order. **6. Common Rail Injection Pump System** The common rail injection is the newest high-pressure direct injection fuel delivery system. An advanced design fuel pump supplies fuel to a common rail that acts as a pressure accumulator. The common rail delivers fuel to the individual injectors via short high-pressure fuel lines. The system's electronic control unit precisely controls both the rail pressure and the timing and duration of the fuel injection. Injector nozzles are operated by rapid-fire solenoid valves or piezo-electric triggered actuators. **7. Electronically Controlled Fuel Injection System** With the exception of common rail injection systems, all of the systems described previously were designed to operate without the use of electronic controls. To meet modern performance, fuel efficiency, and emission standards, unit injectors, multiple plunger, inline pumps, and distributor pump injection systems have all been adapted for use with various levels of electronic controls. Of these systems, electronically controlled and actuated unit injectors have become the prominent choice in heavy-duty engine design.	
4		**Attempt any FOUR of the Following**	**16**
	(a)	**State the requirement of ignition system in SI engine.**	**04**
	Ans.	***(Correct Answer 04 Marks)*** **Requirement of Ignition System in SI engine:** In SI engines, as compression ratio is lower, and self-ignition temperature of gasoline is higher, for igniting the mixture for the initiation of combustion an ignition system is must. Therefore Ignition system of a SI engine is intended to ignite the	*Correct Answer 04 Marks*

		fuel mixture by an electric spark in the cylinder at the end of compression stroke. In a four stroke engine, a spark should occur in each cylinder after two revolutions of the crankshaft, whereas in a two-stroke engine spark in each cylinder is required every revolution of the crankshaft.	
	(b)	**Explain working of Battery Ignition System.**	**04**
	Ans.	***(Figure 02 Marks and Explanation 02 Marks)*** Figure shows line diagram of battery ignition system for a 4-cylinder petrol engine. It mainly consists of a 6 or 12 volt battery, ammeter, ignition switch, auto-transformer (step up transformer), contact breaker, capacitor, distributor rotor, distributor contact points, spark plugs, etc. **Working**: When the ignition switch is closed and engine is cranked, as soon as the contact breaker closes, a low voltage current will flow through the primary winding. It is also to be noted that the contact breaker cam opens and closes the circuit 4-times (for 4 cylinders) in one revolution. When the contact breaker opens the contact, the magnetic field begins to collapse. Because of this collapsing magnetic field, current will be induced in the secondary winding and because of more turns of secondary, voltage goes up to 28000 - 30000 volts. This high voltage current is brought to centre of the distributor rotor. Distributor rotor rotates and supplies this high voltage current to proper spark plug depending upon the engine firing order. When the high voltage current jumps the spark plug gap, it produces the spark and the charge is ignited-combustion starts-products of combustion expand and produce power.  **Figure: Battery Ignition System**	*Figure 02 Marks and Explanation 02 Marks*
	©	**State any four types of Silencer/mufflers and explain any one.**	**04**
	Ans.	***(Silencer Types 01 Mark, Diagram 02 Marks, Explanation 01 Mark)*** **Types of Silencer/Mufflers:** The silencers are usually of the following types: 1. Baffle type 2. Wave cancellation type 3. Resonance type 4. Absorber type 5. Combined Resonance and 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	*Silencer Types 01 Mark, Diagram 02 Marks, Explanation 01 Mark*

exhaust gases, thus the gases travel a longer path in the muffler.

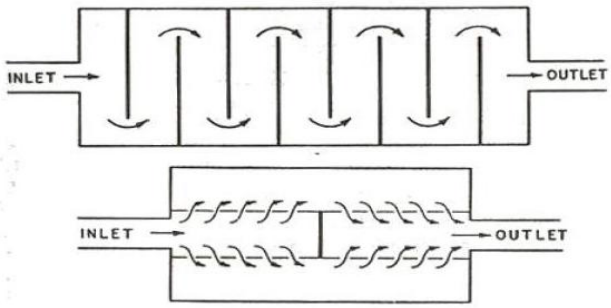


Figure: Baffle Type Silencers

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.

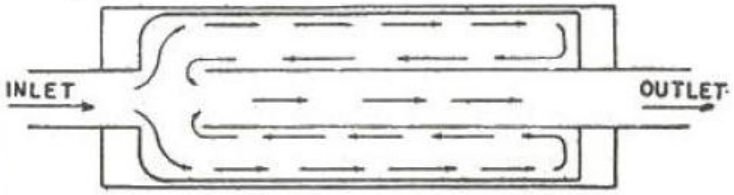


Figure: Wave Cancellation Type Muffler.

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.

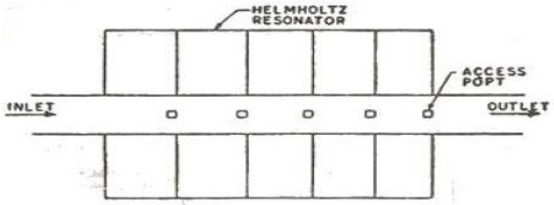


Figure: Resonance Type Muffler.

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

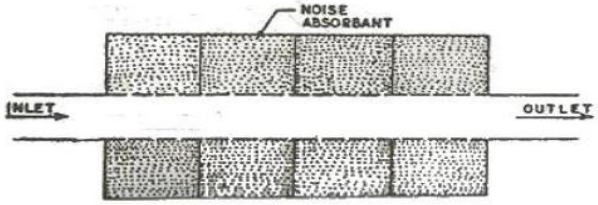


Figure: Absorber Type Muffler.

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.

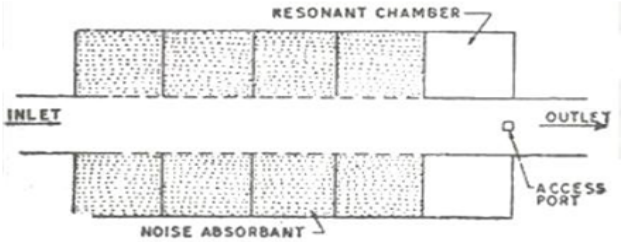


Figure: Combined Resonance and Absorber Type

(d) State different properties of lubricating oil. — **04**

Ans. *(Any four 01 Mark each)*

Essential Properties of Lubricating Oil:

(1) Viscosity (2) Flash Point (3) Resistance to corrosion (4) Physical stability (5) Pour point (6) Adhesiveness (7) Chemical Stability (8) Cleanliness (9) Resistance agents extreme pressure

Any four 01 Mark each

(e) Compare air cooling system and liquid cooling system (Four Points) — **04**

Ans. *(Any Four Points 01 Mark Each)*

Sr.	Water Cooling	Air Cooling
1	In this system cooling medium used is water	In this system cooling medium used is Air.
2	As compared to air cooling its efficiency is more.	As compared to water cooling its efficiency is low
3	It is heavier in weight.	It is light in weight.
4	Regular maintenance is required.	No maintenance is required.
5	The air cooled engine is less sensitive to climate condition. No antifreeze solution is needed. Due to greater temperature difference between cooling air and cylinder	The engine performance becomes more sensitive to climate conditions. Cold water starting requires antifreeze solution which may deposit on cylinder wall on water side and result in reduced heat transfer.
6	The engine design is complex	The engine design is simple
7	The warm up performance is poor ,this results in greater cylinder wear.	The warm up performance is better, this results in low cylinder wear
8	It is used in four wheelers, HMV,LMV, cars, buses, trucks etc.	It is used in two/ three wheelers like motorcycles, scooters, auto rickshaw etc.

Any Four Points 01 Mark Each

(f) State different types of lubricate of system and explain one of them. — **04**

Ans. *(Types 01 Mark and Explanation of any one 03 Marks)*

Types of Lubricate Of System:

(1) Dry Sump Lubrication System
(2) Splash Lubrication System
(3) Mist Lubrication

1. Dry Sump Lubrication System:

Types 01 Mark and Explanation of any one 03 Marks

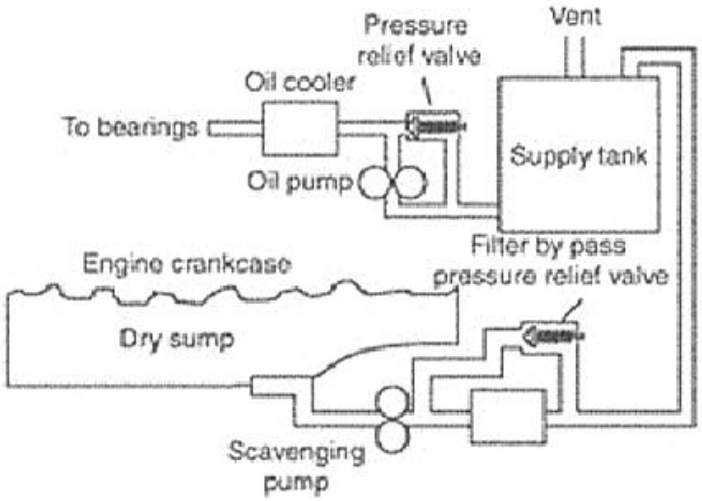


Figure: Dry Sump Lubrication System

Working of dry sump lubrication system: In this system, the lubricating oil is not stored in oil sump .The oil from the sump is carried to a separate storage tank outside the engine cylinder block. The oil from sump is pumped by means of a scavenging pump through filter to the storage tank. Oil from storage tank. Oil from storage tank is pumped to the engine cylinder through oil cooler. Oil pressure may vary from 3 to 8 bar. Dry sump lubrication system is generally adopted for high capacity engines. The pressure relief valves are used to maintain the predefined pressure value inside the lubricating system.

2. Splash Lubrication System:

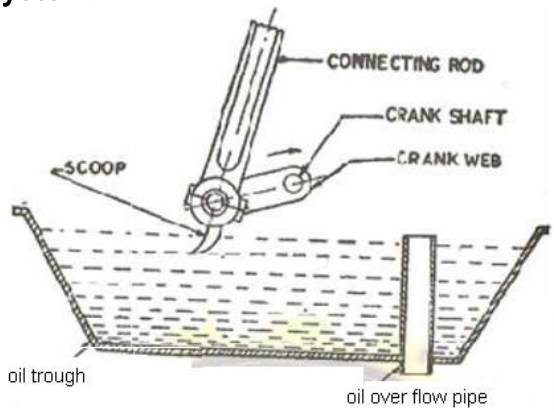


Figure: Splash Lubrication System

OR

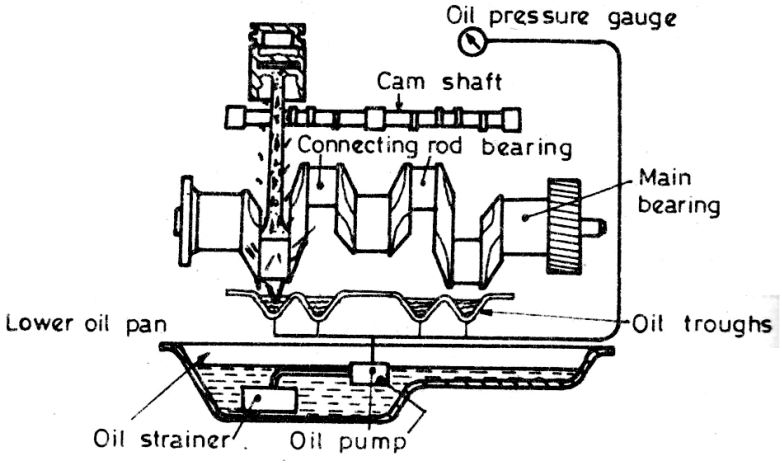
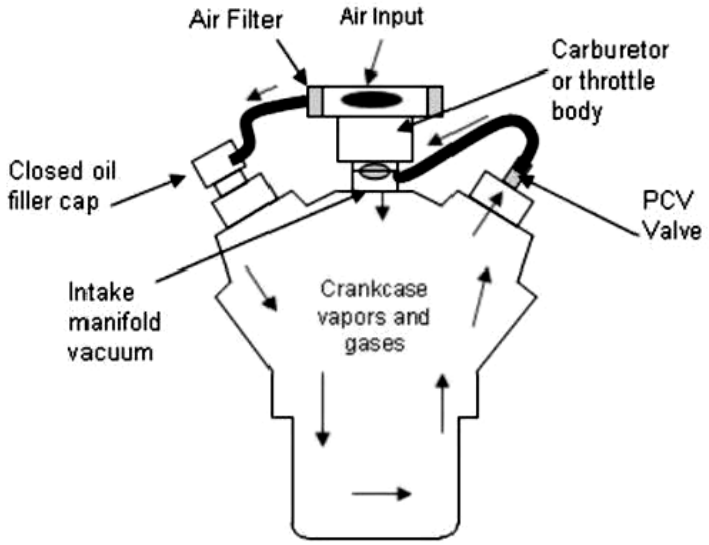
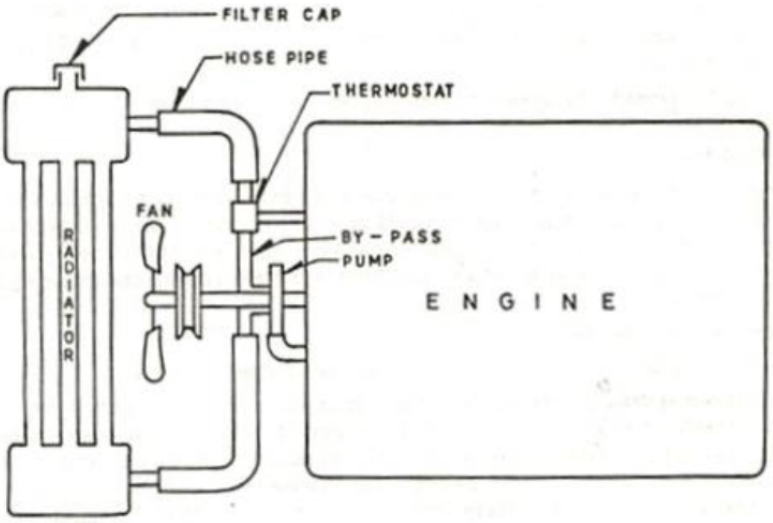
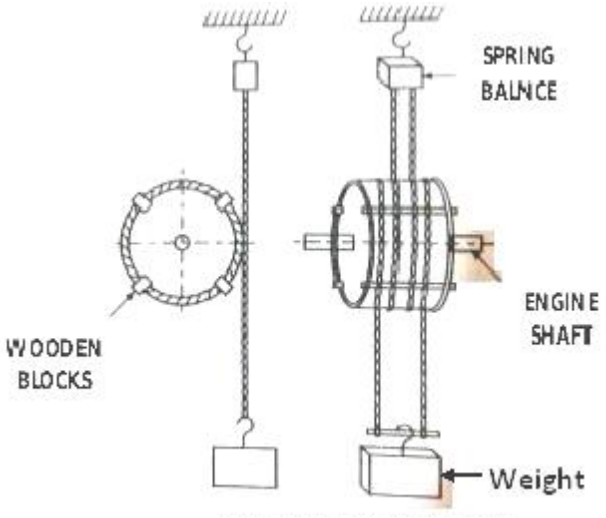
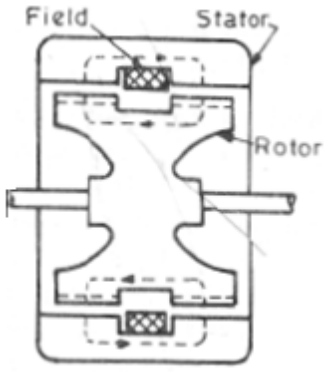
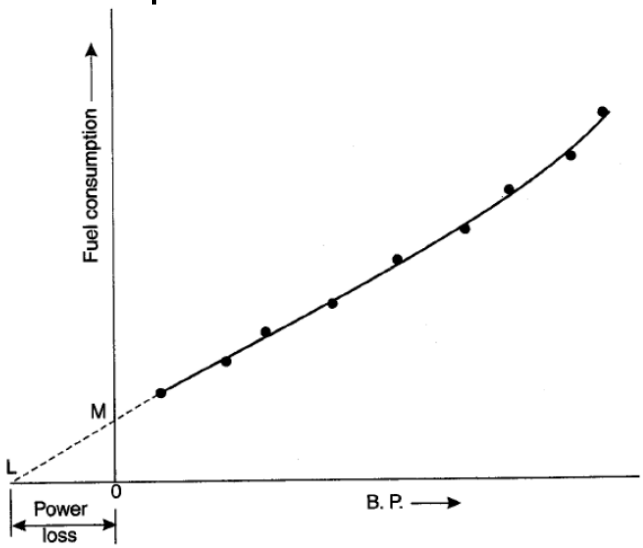


		Figure: Splash Lubrication System **Working of Splash Lubrication System**: This was employed for the engine of early vehicles. It is one of the cheapest methods of engine lubrication. A scoop is made in the lowest part of the connecting rod and the oil is stored in the oil trough. Oil is being pumped 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. **3. Mist Lubrication (Petro- Oil Lubrication):** This system is used where crankcase lubrication is not suitable In 2-stroke engine as the charge is compressed in theλ crankcase, it is not possible to have the lubricating oil in the sump In such engines the lubricating oil is mixed with theλ fuel, the usual ratio being 3% to 6% The oil and the fuel induced through the carburetor theλ fuel is vaporized and the oil is in the form of mist goes via the crankcase in to the cylinder	
5		**Attempt any FOUR of the Following**	**16**
	(a)	**State need of Cooling System.**	**04**
	Ans.	***(Correct Answer 04 Marks)*** **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.	*Correct Answer 04 Marks*
	(b)	**State any four components of lubrication system with their function.**	**04**
	Ans.	***(List of Component 01 Mark and their Function 03 Marks)*** **Four Components of Lubrication System** (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.	*List of Component 01 Mark and their Function 03 Marks*
	©	**Explain Positive Crankcase Ventilation.**	**04**
	Ans.	***(Sketch 02 Marks and Explanation 02 Marks)*** **Working of Positive Crankcase Ventilation System**: PCV system is used to reduce the HC emission and improve the fuel economy as well as to relieve any pressure build-up in the crankcase which may cause crankshaft seal leakage. The figure shows the intake manifold return PCV system. It has a tube leading from the crankcase or else the rocker arm cover through a flow control valve into the intake manifold usually just below the carburetor. To provide proper ventilation of the interior of the engine, fresh air is usually drawn through a	*Sketch 02 Marks and Explanation 02 Marks*

		rocker arm cover opposite that containing the PCV system.  **Figure: Positive Crankcase Ventilation**	
	(d)	**Draw sketch of Pump Circulation Liquid Cooling System.**	**04**
	Ans.	***(Neat Labeled Sketch 04 Marks)***  **Figure: Pump Circulation Liquid Cooling System**	*Neat Labeled Sketch 04 Marks*
	(e)	**Define Mechanical Efficiency, Brake Thermal Efficiency, Indicated Thermal Efficiency and Friction Power.**	**04**
	Ans.	***(Each definition 01 Mark)*** **(1) Mechanical Efficiency:** It is the ratio of brake power available at the crankshaft to the indicated power generated inside the cylinder. It is calculated in percentage. $$\text{Mechanical efficiency, } \eta_{mech} = \frac{B.P.}{I.P} \times 100$$ **(2) Brake Thermal Efficiency:** The ratio of brake power to the fuel power is called brake thermal efficiency. $$\eta_{Bth} = \frac{\text{B.P.}}{m_f \times \text{c.v.}} \times 100\%$$ **(3) Indicated Thermal Efficiency:** It is the ratio of indicated power to input fuel energy (i.e. product of mass of fuel and calorific value of fuel)	*Each definition 01 Mark*

		(4) Friction Power: The difference between Indicated Power and Brake Power is called Friction Power Friction Power F.P. = I.P – B.P	
	(f)	**State different types of Dynamometer and explain any one.**	**04**
	Ans.	**Rope Brake Dynamometer:**  **Figure: Rope Brake Dynamometer** Dynamometer is a device for measuring force and torque and hence power. It works on the principal of absorption Transmission, in which case it is known as Transmission Dynamometers. It measure and absorb the power output of the engine to which it is coupled. The power absorbed is usually dissipated as heat. It consists of a number of turns of rope wound around the rotating drum attached to the output shaft. One side of the rope is connected to a spring balance and the other to a loading device. The power absorbed is due to friction between the rope and the drum. The drum there for requires cooling. At constant engine speed, the power developed by an engine is equal to the power absorbed by the rope brake dynamometer. The brake power can be calculated as follows: $BP = \pi DN (W-S)/60$ (watt) Where , D = Brake drum diameter (m) W = Weight (N) S = spring scale reading.(N) N= RPM of engine. **Eddy Current Dynamometer:**  **Figure: Eddy Current Dynamometer**	

		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.	
6		**Attempt any TWO of the Following**	**16**
	(a)	**Explain Morse Test and Willian's Line Method to measure friction power.**	**08**
	Ans.	**Morse Test to Determine the Friction 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 I1, I2 I3 & I4 respectively. The total IP of engine is given by = I1 +I2+ I3 + I4 The total BP of engine when all cylinders are working BP= Total IP – Total FP B = (I1 +I2+ I3 + I4) – (F1+F2+F3+F4)----------1 When cylinder 1 is cut off, the BP developed by the remaining three cylinders, B1= (0 +I2+ I3 + I4) – (F1+F2+F3+F4)----------2 Subtracting (2) from (1) we get B- B1 = I1 Therefore, IP of cylinder 1, I1 = B-B1 Similarly , IP of cylinder 2, I2 = B-B2 IP of cylinder 3, I3= B-B3 IP of cylinder 4, I4 = B-B4 Total IP of Engine = I1+I2+I3+I4 **Friction Power F.P. = I.P – B.P**	

		Willian's Line Method: At a constant engine speed the load is reduced in increments and corresponding B.P. and gross fuel consumptions readings are taken. A graph is then drawn of fuel consumption against B.P. as in Fig. The graphs draw is called the Willian's line (analogous to Willian's line for a steam engine) and extrapolated back to cut the B.P. axis at the point L. The reading OL is taken as the power loss of the engine at that speed. The fuel consumption at zero B.P. is given by OM; and if the relationship between fuel consumption and B.P. is assumed to be liner then a fuel consumption OM is equivalent to a power loss of OL. **Frictional power loss ….. F.P.= OL × SCALE**  **Figure: Willian's Line Method**	
	(b)	**State procedure to calculate heat balance sheet of IC Engine.**	**08**
	Ans.	***(Procedure 02 mark, 01 Mark for each formulae and 02 Marks for Heat Balance Sheet)*** **The procedure to calculate Heat Balance Sheet of IC engine:** The performance of an engine is generally given by heat balance sheet. To draw a heat balance sheet for I.C. engine, it is run at constant load and at constant speed. The Indicator diagram is drawn with the help of an indicator. The quantity of fuel used in a given time and its calorific value, the amount, inlet and outlet temperature of cooling water and the mass of exhaust gases are recorded. After calculating I.P. and B.P. the heat in different items is found as follows: **(i). Heat in Fuel Supplied:** For petrol and oil engines, **Heat in Fuel Supplied /min. = M_f X C_v** Where, Mf= Mass used per minute (kg) and Cv =Lower Calorific Value (kJ or kcal) of the fuel. **(ii) Heat Equivalent of I.P.:** **Heat equivalent of I.P. (per minute) = I.P. × 60 kJ.** **(iii) Heat taken away by Cooling Water:** If , mw = Mass of cooling water used per minute, t1 = Initial temperature of cooling water, and	*Procedure 02 mark, 01 Mark for each formulae and 02 Marks for Heat Balance Sheet*

t2= Final Temperature of cooling water,
Then,

Heat taken away by water = mw × Cw × (t2– t1),

Where, Cw = specific heat of water.

(iv) Heat taken away by Exhaust Gases:
If,

me = Mass of exhaust gases (kg/min)
Cpg = Mean specific heat at constant pressure,
te = Temperature of exhaust gases, and
tr = Room temperature,
Then

Heat carried away by Exhaust Gases = me × Cpg (te - tr)

Note, The mass of exhaust gases can be obtained by adding together mass of fuel supplied and mass of air supplied. The heat balance sheet from the above data can be drawn as follows:

Item	kJ	Percent
Heat supplied by fuel	….	…..
i) Heat absorbed in I.P. ii) Heat taken away by cooling water iii) Heat carried away by exhaust gases iv) Heat unaccounted for (by difference)	…. …. …. ….	….. ….. ….. …..
Total	……	……

	©	**During a test on a Single Cylinder Two Stroke Diesel Engine, following readings were noted;** **(i) The engine is motored by an electric motor and friction power loss recorded on watt meter is 1.5 kW.** **(ii) Net Brake Load = 210 N** **(iii) Diameter of Brake Wheel = 210 cm** **(iv) Engine Speed = 595 rpm** **(v) Fuel Consumption – 2.01 kg / hr** **(vi) Calorific Value of Fuel = 44000 KJ / kg** **Find;** **(i) Mechanical Efficiency** **(ii) Brake Thermal Efficiency**	**08**
	Ans.	***(Correct Answer Each 02 Marks)***	*Correct Answer Each 02 Marks*

Given data :

No of stroke = 2

F.P. = 1.5 kW

Net Brake load = w = 210 N

Dia of brake wheel= 210cm = 2.1 m

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

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

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

C.V. = 44000 kJ/kg

(i) Mechanical efficiency

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

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

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

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

$= 13.73 KJ/sec$

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

$I.P = 13.73. + 1.5$

$= 15.23$ kJ/sec

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

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

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

Mechanical efficiency = 90.15 %

ii) Brake thermal efficiency

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

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

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

Brake thermal efficiency = 56.73%