SUMMER -2019 EXAMINATION

Subject Name: AEN **Model Answer** Subject Code: 22308

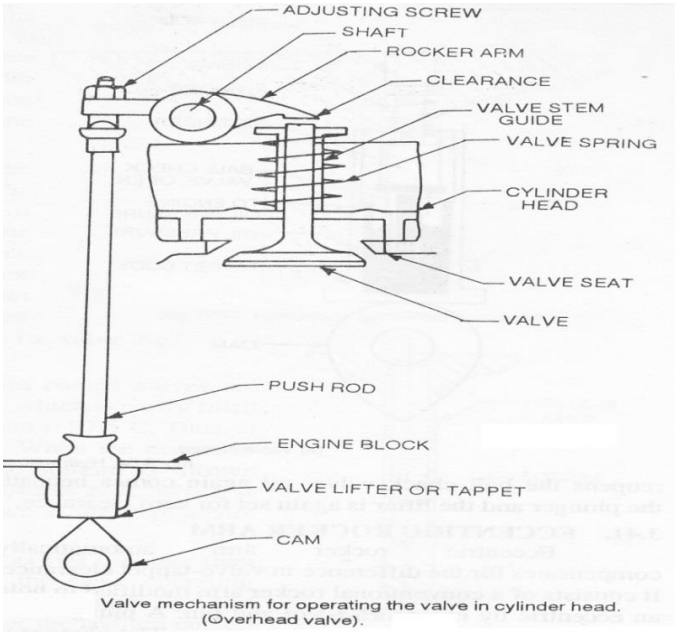
Important instructions for examiner:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the following.**	**10**
	(a)	**Define the terms: swept volume.**	**02**
		Answer **Swept Volume:** The volume swept by the piston is moving from T.D.C. to B.D.C. It is expressed in terms of cubic centimeter (cm^3) and given by $V_S = A \times L = (\pi/4)\, d^2 \times L$	02
	(b)	**Classify I.C. engine on the basis of cycle of operation and cylinder arrangement.**	**02**
		Answer: : **1) Cycle of operation:-** a) Otto cycle engine b) Diesel cycle engine c) Duel combustion cycle engine or semi- diesel cycle engine. **2) Arrangement of cylinder:-** a) Vertical engine b) horizontal engine c) Radial engine d) V-engine	01 01

		e) Opposed cylinder engine	
	c)	**List any four components of C.I. engine.**	**02**
		Answer: *(Any 4 components ½ marks each)* **Components of C.I. engine.** 1. Engine Head 2. Crankshaft 3. Camshaft 4. Engine block 5. Fuel injector 6.Fuel Pump 7.Fuel Distributor 8. Cylinder liner 9. Piston	02
	d)	**List all the components of petrol fuel supply system.**	**02**
		Answer: *(Any 4 components :-½ marks each)* **Components of Petrol fuel supply system:** 1) Fuel Tank 2) Flexible fuel line 3) Fuel tank to fuel pump line 4) Fuel pump 5) Fuel filter 6) Carburetor or Injector	02
	e)	**State four functions of exhaust system.**	**02**
		Answer: *(Any 4 function :-½ marks each)* **Functions of exhaust system:** 1. The function of an exhaust manifold is to expel the exhaust gases from the combustion chamber of each cylinder out to the atmosphere through the exhaust pipe after combustion stroke is completed. 2. To keep back pressure minimum. 3. Reduce noise of exhaust gases during expelling in atmosphere. 4. Reduce the pressure and velocity of exhaust gases. 5. Incorporate the catalytic convertor system in tail pipe	2
	f)	**State the need of cooling system of I.C.engine.**	02

		Answer: **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.	02
	g)	**Define Indicated power**	02
		Answer: **Indicated power:** (I.P.) The power developed with in the engine cylinders is called indicated power. This is calculated from the area of the engine indicator diagram. It is usually expressed in kilowatts (kW). **Indicated Power**= nPLAN/60×1000 kW	02
Q2		**Attempt any <u>THREE</u> of the following.**	**12**
	a)	**Write the specifications of I.C. engine used in a two wheeler four stroke vehicle.**	**04**
		Answer: **Engine specifications for two wheeler** **1. Engine of Bajaj Discover 125 ST** - Air-cooled, 4-stroke 124.6 cc engine - Maximum power of 12.8 Bhp at 9000 rpm - Maximum torque of 11 Nm at 7000 rpm OR 2**. Honda Livo** a) BS-IV engine, Air cooled, 4 strokes S I engine. b) Displacement -110 cc , power – 8.31 bhp , c) Max Torque – 9.09 N-m @5000 rpm. d) Bore x Stroke – 50 x 55.6 mm e) C R – 9.9 : 1, Max Speed – 86KMPH ***Note- similar specification should be considered.***	04

	b	**Explain working of over head valve mechanism with neat sketch.**	**04**
		Answer: *(Working 2 Marks, Sketch 2 Marks)* **Overhead valve mechanism:** 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.	02
		 Valve mechanism for operating the valve in cylinder head. (Overhead valve).	02
		OR **Overhead valve 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.	

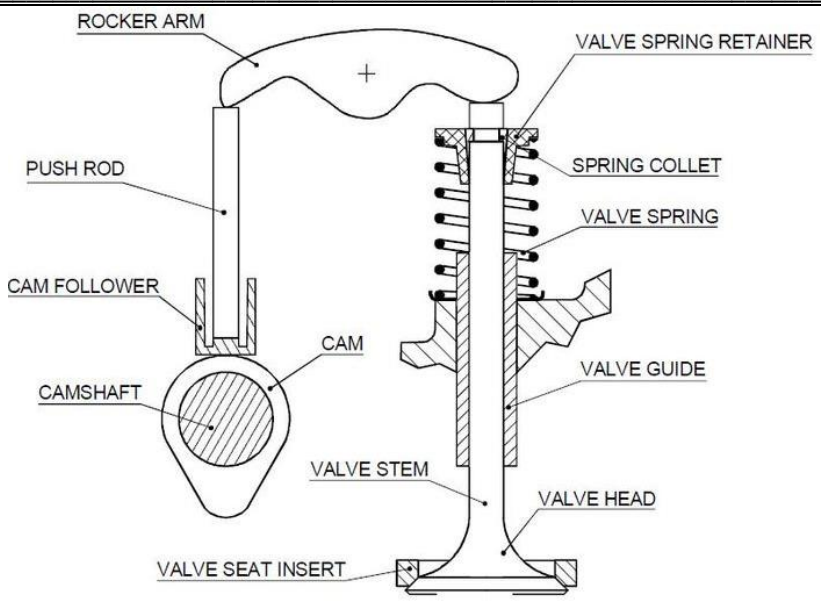


Fig. Overhead valve mechanism

c) State the functions of nozzles. Classify nozzles used in diesel engine. **04**

Answer: *(Function 2 Marks, Classification 2 marks)*

Functions of nozzle: *(Any Two)*

1) To atomize fuel by converting it in to fine droplets.

2) To convert pressure energy in to kinetic energy.

3) To inject the fuel at right quantity at right time with respect to load & speed of the engine.

2

Classification of Nozzles: *(Any Four)*

1) Single hole nozzle

2) Multi-hole nozzle 3) Long stem nozzle

4) Pintle nozzles

5) Pintuax nozzles

2

d) Distinguish between air cooling system and water cooling system. **04**

Answer: *(Any 4 points 1 mark each)*

Sr. No.	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.	Engine performance becomes more sensitive to climate conditions
4	Air cooling system has no	It requires maintenance. slight leakage

04

	maintenance	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.

3 **Attempt any THREE of the following.** **12**

a **Describe working principle of four stroke diesel engine with the help of sketches.** **04**

Answer:

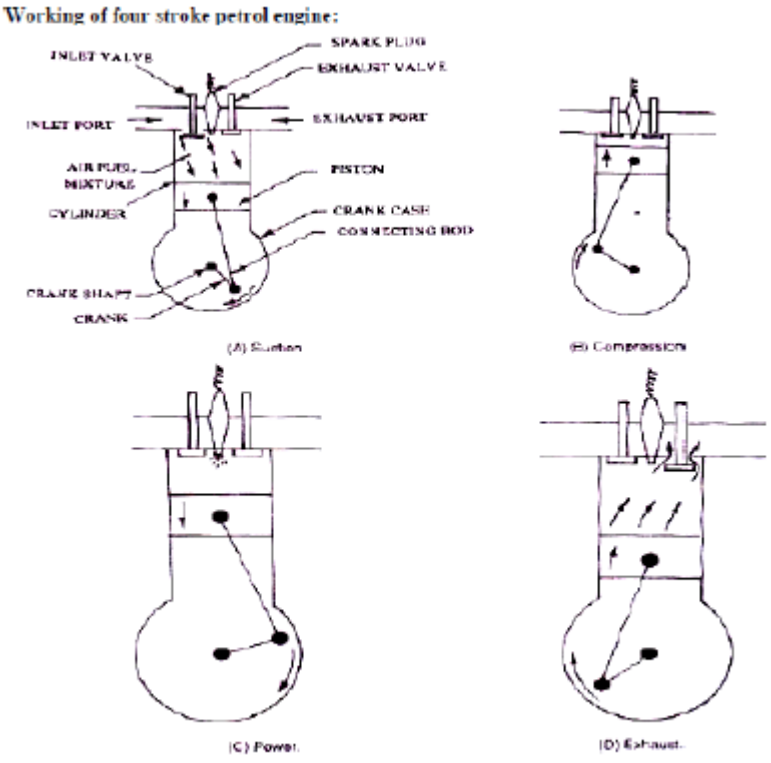


Figure: Working of 4-Stroke SI engine

02

- **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.
- **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.

- **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.
- **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.

02

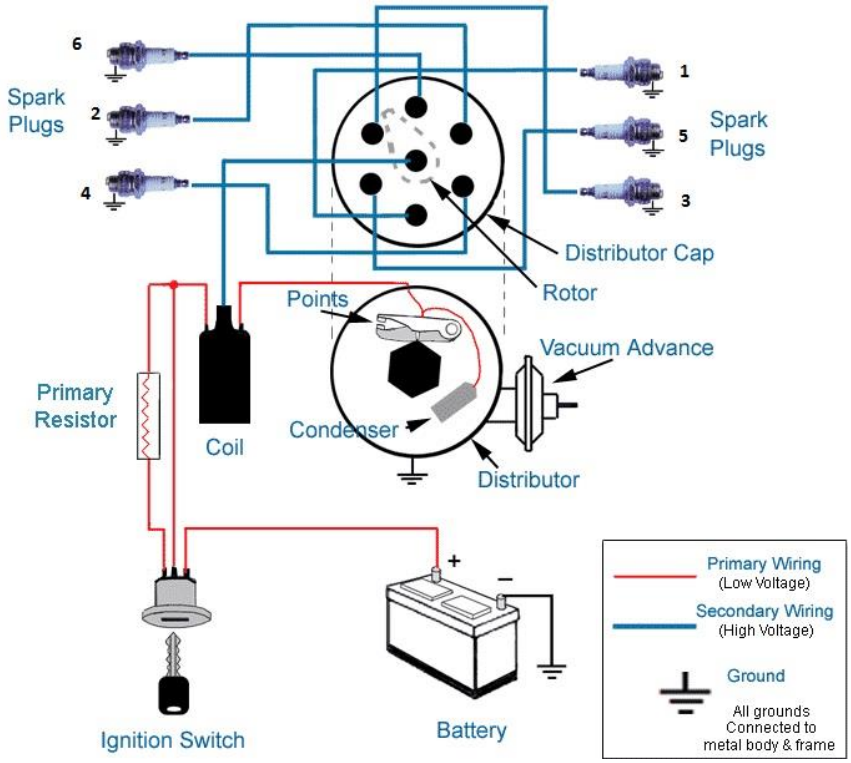
b) State the functions and materials of following engine components:
(i) Piston
(ii) Connecting rod
(iii)Crank shaft
(iv)Exhaust manifold

04

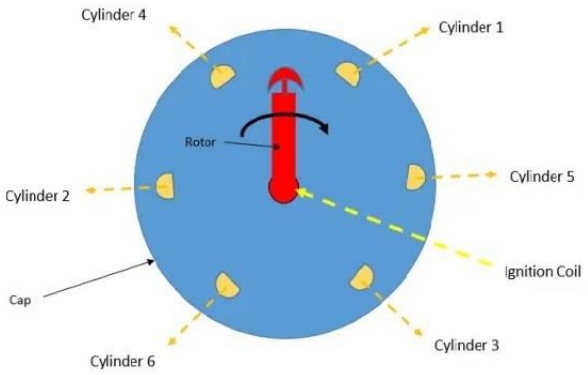
Answer: (1 mark for each component function)

Engine components	**Material**	**Functions** (any one)
Piston	Cat aluminum alloy	• To transmit the force of explosion to the crankshaft. • To form seal so that the high pressure gases in combustion chamber do not escape into crankcase. • To serve as guide and bearing for small end of connecting rod.
Connecting rod	Steel alloy, aluminum alloy and titanium	• It converts the reciprocating motion of the piston into rotary motion of crankshaft. • It connects piston to the crankshaft.
Crank shaft	Cast iron or forged steel	• It converts the reciprocating motion of piston to rotating motion. • It transmits power to flywheel. • It receives power from flywheel.
Exhaust manifold	simple cast iron or stainless steel	• The function of an exhaust manifold is to expel the exhaust gases from the combustion chamber of each cylinder out to the atmosphere through the exhaust pipe after combustion stroke is completed. • To keep back pressure minimum.

04

	c)	**State the functions following ignition system components** **(i) Ignition coil** **(ii) Distributor** **(iii)Condenser** **(iv)Spark plug**	**04**
		Answer: *(1 mark for each component)* **Functions following ignition system components**: **(i) Ignition coil:** Ignition coil receives voltage from primary circuit and convert it to very high voltage up to 28000 volts required for spark by means of primary and secondary winding. **(ii) Distributor**: Distributor rotor rotates and supplies this high voltage current to proper stark plug depending upon the engine firing order. **(iii)Condenser** The Function of the condenser is to reduce arcing at the contact breaker points. When the magnetic field is collapsing condenser gets fully charged and then it starts discharging and helps in building up of voltage in secondary winding. **(iv)Spark plug:** In S.I engine at the end of compression stroke Charge of air and petrol is ignited by means of the spark produced by spark plug.	04
	d)	**Draw a simple diagram of distributor rotor. Its direction, spark plug high voltage contact for a 6 cylinder engine. Also label numbers as per firing order.**	**04**
		Answer:  *(equivalent credit should be given only distributor)*	04

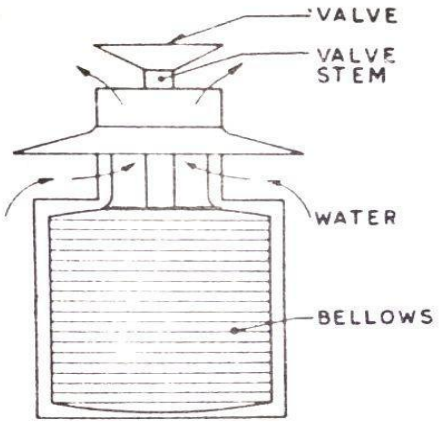
OR

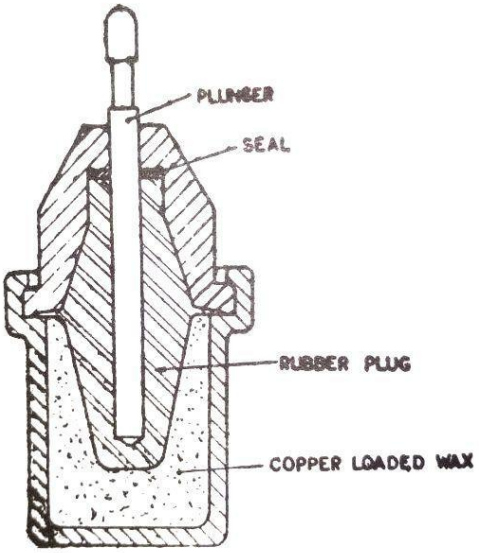


4		**Attempt any THREE of the following.**	**12**
	a)	**List different applications of I.C.engines.**	**04**
		Answer: (1 Mark for each application) **Applications of I.C engine** 1. In Automotive – i. Two stroke engine – Mopeds, Scooters. ii. Four stroke engine – Light vehicles, Heavy vehicles. 2. Marine Application – Ships, Boat. 3. Locomotive s – Railways. 4. Stationery engines – For lifting water, Generator, Material handling systems	04
	b)	**Differentiate between dry liner and wet liner,**	**04**
		Answer: *(Any 4 points 1 mark each)*	

Sr No.	Dry liner	Wet liner
1	Dry liner is not in direct contact with of cooling water	Wet liner is in direct contact with of cooling water cooling water
2	It is difficult to replace	It is easy to replace
3	No leak proof joint is Provided	A leak proof joint between cylinder casting and liner has to be provided
4	The casting of cylinder block is complicated	The casting of cylinder block is simplified
5	Block is more robust	Block is less robust

		6	Very accurate machining of block and outer liner surface is required	Very accurate machining of block and outer liner surface is not required	2
		7	A dry liner cannot be finished accurately before fitting	A wet liner can be finished accurately before fitting	
	(c)	**Select type of a muffler for a motorcycle engine with justification.**			**04**
		Answer:- **Type of a muffler for a motorcycle engine** 1. Baffle type 2. Resonance type 3. Absorber type • **Multiple Baffle Silencers** In a multiple baffle silencer, the exhaust gas escapes through holes that are punched in the walls of the silencer tube. This results in muffling the sound via pulse reflection. These are fairly restrictive. 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. • **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. • **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.			04

	(d)	**Describe the construction and working of of thermostat valve used in cooling system.**	**04**
		Answer:- *(Sketch 1 Mark, Construction 1 mark, working 2 marks)* **Bellows type thermostat valve** **Construction:** 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.	01
		 Figure: Bellows type Thermostat	02
		Working: Bellows type Thermostat 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}C -99^{0}C	01
		OR **Wax type Thermostat Valve:** **Construction:** It is made up of copper loaded wax having high coefficient of volumetric thermal expansion. A cylinder or capsule is filled with wax and thrust pin is inserted in it. A flexible rubber sleeve, which surrounds the pin is sealed at the top to prevent escape of the wax. As the wax melts and expands, the thrust pin is forced out of the capsule so opening the valve.	

		 **Working:** 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.	
	e)	**In a test on a 2 stroke single cylinder diesel engine, following observations were made:** **Bore=75mm.** **Stroke = 90mm,** **Engine speed = 1200rpm,** **Mean effective pressure =7.5bar,** **Mean brake diameter =1m,** **Net brake load = 500N,** **Calculate mechanical efficiency of engine**	**04**
		Answer:- Given data : No of stroke = 2 No of cylinders, n =1 Bore = D = 75mm = 0.075m, Stroke = L= 90mm = 0.09m, Speed = N= 1200rpm .....Two stroke IMEP= P = 7.5 bar = $7.5x10^5$ N/m^2 Mean brake diameter =1m, Net brake load = 500N,	

Mechanical efficiency

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

1

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

$$= 500 \times 0.5 = 250 \text{N.m}$$

$$B.P. = \frac{2 \times 3.14 \times 1200 \times 250}{60} = 31400 \frac{\text{Nm}}{\text{Sec}} = 31400 \frac{\text{J}}{\text{sec}}$$

1

$$= 31.400 \text{ KJ/sec}$$

$$I.P = \frac{nPLAN}{60}$$

1

$$= \frac{1 \times 7.5 \times 10^5 \times 0.09 \times (\frac{\pi}{4} \times 0.075^2) \times 1200}{60}$$

$$= 5964.117 \text{ J/sec}$$

$$= 5.96 \text{ kJ/sec}$$

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

$$= \frac{31.4}{5.96} \text{X } 100$$

1

$$\eta_{mech} = 532.2\%$$

Mechanical efficiency = 532.2 %

5.		**Attempt any <u>TWO</u> of the following.**	**12**
	(a)	**Draw the neat sketch of overhead valve operating mechanism and explain its working.**	**06**
		Answer: **Overhead valve mechanism:** 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.	**3**

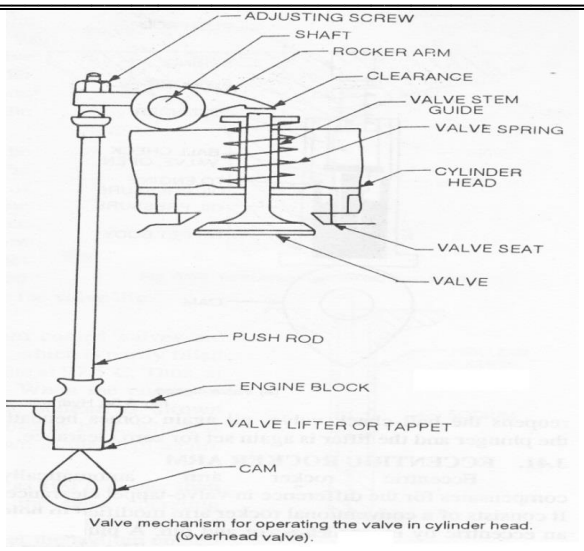


Fig. Overhead valve mechanism 3

OR

Overhead valve mechanism : 3

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.

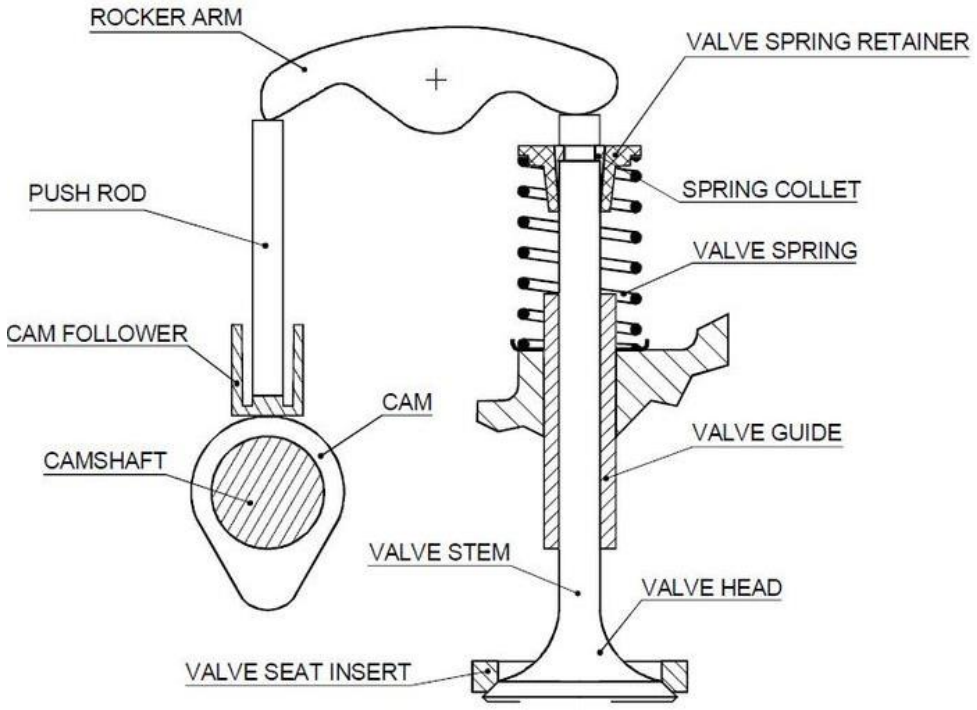
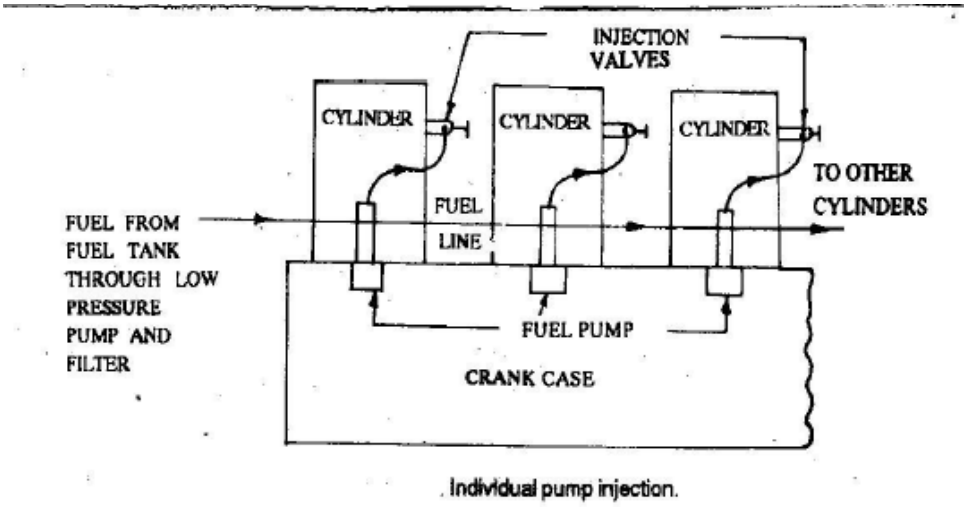


Fig. Overhead valve mechanism **3**

	(b)	**List any two major requirements of fuel injection system. Draw a layout of fuel injection system used in diesel engine.**	**06**
		Answer: **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.  Individual pump injection. **OR**	03 03

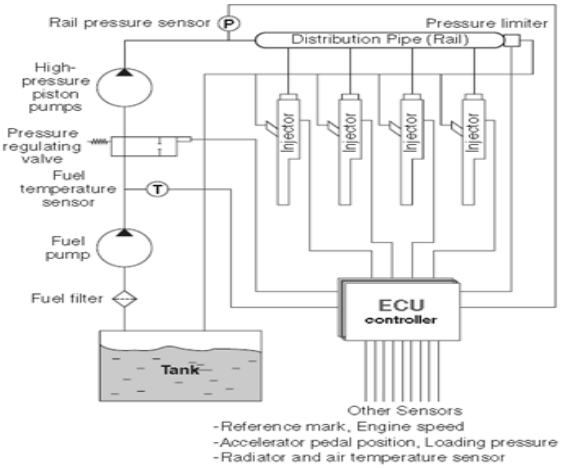
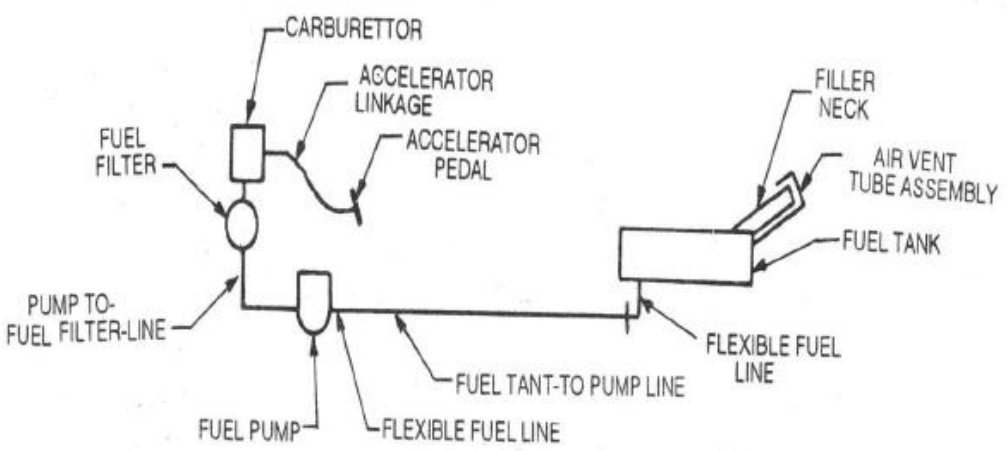


Figure A common rail fuel injection system.

	c)	**Draw a labeled sketch of pump feed fuel supply system for petrol engine and state location and function of each component.**	**06**
		 Layout of pump feed fuel supply system for petrol engine: The pump feed system is shown in the figure above. Fuel tank is for storage of fuel located above the engine of two wheeler and in case of car located at backside of the car.In this system, a steel pipe carries the fuel to the fuel pump which pumps it into the float chamber of the carburetor through a flexible pipe. If the fuel pump is mechanical, it has to be driven from the engine camshaft and hence placed on the engine itself. However electrically operated pump can be placed anywhere. Fuel pump pressurize fuel and send it to the floating chamber of carburetor. Carburetor is placed before the inlet manifold and it serves the function of mixing petrol and air as per required ratio. It is mostly located at the rear in the fuel tank reducing the tendency of forming vapor lock. The system provides the fuel requirement at various engine speeds efficiently.	03 03
6		**Attempt any TWO of the following:**	**12**

	a)	**Explain the procedure of Morse Test" to be conducted for four cylinder petrol engine.**	**6**
		Answer: **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. 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 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. 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, IP= 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	6

		IP of cylinder 4, I4 = B-B4 Total IP of Engine = I1+I2+I3+I4 **Friction Power F.P. = I.P – B.P**	
	b)	**Classify lubricating oil using viscosity (SAE) and load severity (API) rating.**	**6**
		Answer: **1.On the basis of Viscosity :** **i.** 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 **ii.** 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 e. Multi grade oils shown as SAE 20 W/50 **2.On the basis of Service Rating :** **i.** 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 turbocharger diesel engine. **ii.** 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 c. protection d. SC, SD & SE: Meets automotive manufactures specifications.	**03** **03**
	c)	**In a trail on a four cylinder engine 100mm bore, 150mm stroke and working on a four stroke cycle. The following observations were made:** **Speed=2500rpm** **Net Dynamometer load of 50 mm radius = 200N** **Mechanical efficiency = 80%** **Petrol consumption = 752g/minute** **Cooling water circulated = 200g/minute** **Temperature difference of cooling water =50 C** **Calorific value of petrol =46,000 KJ/kg** **(i) Calculate Indicated power and indicated mean effective pressure.** **(ii) Draw heat balance sheet for the test in KJ/kg**	**6**

Answer:

Given data: Trial on 4 cyl., 4-stroke Petrol engine.

n = no. of cylinder = 4.
D = Bore dia = 100 mm = 0.1 m
L = stroke length = 150 mm = 0.15 m.
N = Engine speed = 2500 rpm
W = Net Dynamometer load = 200 N.
r = Dynamometer radius = 50 mm = 0.05 m.
η_{mech} = 80% = 0.8
m_f = mass of fuel consumed = 752 g/min = 0.752 kg/min.
m_w = —"— cooling water = 200 g/min = 0.2 kg/min.
ΔT_w = cooling water temp. Diff = 50°C.
C.V. = Calorific value = 46000 kJ/kg

Find- (i) I.P. & IMEP (P_{mi}), (ii) Heat balance sheet.

(i) I.P. & IMEP.

$$\eta_{mech} = \frac{B.P.}{I.P.} \quad \therefore I.P. = \frac{B.P.}{\eta_{mech}}$$

$$B.P = \frac{2\pi NT}{60,000} = \frac{2\pi N(W \times r)}{60,000} \text{ kW}$$

$$B.P. = \frac{2\pi \times 2500 (200 \times 0.05)}{60,000} = 2.618 \text{ kW}.$$

01

$$I.P. = \frac{2.618}{0.8} = 3.273 \text{ kW}.$$

01

IMEP = ?

$$I.P = \frac{n P_{mi} \times L \times A \times N'}{60000} = \frac{4 \times P_{mi} \times 0.15 \times (\frac{\pi}{4} \times 0.1^2) \times 1250}{60,000} = 3.273$$

$$P_{mi} = \frac{3.273 \times 60,000}{4 \times 0.15 \times (\frac{\pi}{4} \times 0.1^2) \times 1250} = 33,339 \text{ N/m}^2$$

P_{mi} = 0.33339 bar

01

equivalent credit is given if student considering dianometer radius other than 50mm. As calculated Pmi is less than atmospheric pressure (it shoud be greater)

ii) Heat Balance sheet on kg/min basis.

Sl No	Parameter	KJ/min	%
A)	Heat supplied by fuel $= m_f \times CV = 0.752 \times 46000$	34592	100%
B)	Heat lost.		
	1) Heat equivalent to B.P. = B.P. × 60 (As per given data)	157	0.45%
	1)* Heat equivalent of BP. = (*) (As per assumed data	1571*	4.54%*
	2) Heat carried by cooling water $m_w \times C_p \times \Delta T = 0.2 \times 4.187 \times 50$	42	0.12%
	3) Heat unaccounted. $A - [B(1) + B(2)] = 34592 - [157 + 42)$ (As per given data)	34393	99.4%
	3)* Heat unaccounted. $A - [B(1) + B(2)] = 34592 - [1571 + 42)$ (As per assumed data)	32980	95.3%

03