WINTER – 19 EXAMINATION

Subject Name: A E N **Model Answer** Subject Code: 17408

Important Instructions to examiners:

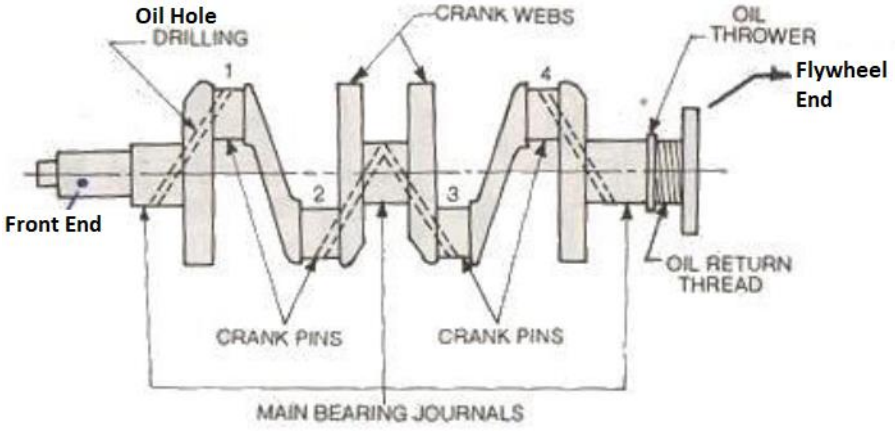
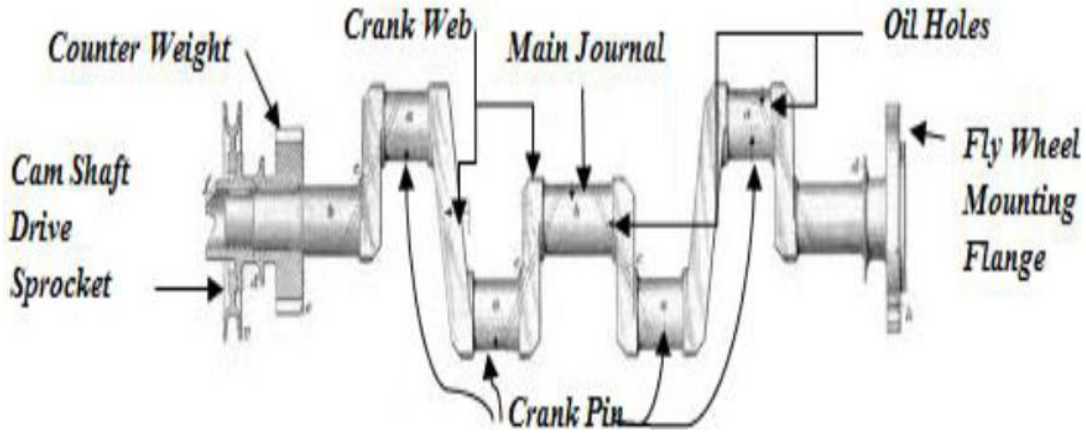
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 SIX of the Following**	12
	(i)	**List any two applications of Two Stroke Petrol Engine.**	02
	Ans	**Applications of Two Stroke Petrol Engine:** **(1)** Scooters (2) Mopeds (3) Chain Saw Cutter (4) Motor Boat etc. *(NOTE: Give equivalent weight age to any other two appropriate applications should)*	**Any Two 01 Mark Each**
	(ii)	**Define Brake Power.**	02
	Ans	**Brake Power:** It 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	**Correct Answer 02 Marks**
	(iii)	**State any two Merits of Vertical Engine.**	02
	Ans	**Merits of Vertical Engine :** 1) In case of vertical engine the crankcase is at bottom so it is easy to store lubricating oil for flash lubrication. 2) The lubricating oil which dribbles from bearing and other engine parts is easily collected in the crankcase and then reuse after filtering. 3) The weight of piston is carried by crank therefore the weight of piston does not wear cylinder liner during motion.	**Any Two 01 Mark Each**
	(iv)	**State the functions of Carburattor.**	02
	Ans	1. To keep the small reserve of fuel at a constant head 2. To vaporize the fuel to prepare a homogeneous air fuel mixture. 3. To supply correct amount of the air fuel mixture at the correct strength under all conditions of load and speed.	**Any Two 01 Mark Each**
	(v)	**Write the name of parts (PORTS) used in two stroke engine.**	02
	Ans	**Name of *Ports* in Two Stroke Engine :** (1) Inlet Port (2) Exhaust Port 3) Transfer Port **Name of *Parts* used in Two Stroke Engine :** (1) Spark Plug, (2) Piston, (3) Combustion Chamber, (4) Reed Valve, etc. ***[Note: Equivalent Marks should given to any other relevant Answer]***	**Any Four Parts 02 Marks**
	(vi)	**State any two applications of Air Cooling System.**	02
	Ans	**Applications of Air Cooling System:**	**02 Marks**

		Two / Three Wheeler like Motor Cycle, Scooters, Rickshaw etc.	
	(vii)	**State any four specifications of light motor vehicle engine.**	**02**
	Ans	**Specifications of Light Motor Vehicle Engine:** **Manufacturer: Hyundai India Ltd.** 1) Type : 1.1 Ltr, 2) Nos. Of Valve: 4 Valve, 3) Nos. of Cylinder: 3 Cylinder, 4) Engine Cooling System: Water cooled, 5) Type of Fuel : Diesel 6) Cubic capacity: 1120 cc 7) Brake Power: 70 bhp at 6000rpm 8) Torque: 160 N-m *NOTE: Any Other LMV or any other 4 Specifications should be given Similar Weightage*	**Any Four Engine Specifications 1/2 Mark Each**
	(viii)	**Why the speed of cam shaft is half of the crank shaft in four stroke engine?**	**02**
	Ans.	Camshaft is driven by the crankshaft either by a pair of meshing gears (timing gears) or by means of a pair of timing sprocket connected by a chain. The cam shaft gear or sprocket has twice as many teeth as the gear or the sprocket on the crankshaft. This gives 1:2 gear ratio, so the camshaft turns at half the speed of the crankshaft in four stroke engine.	**Correct Answer 02 Marks**
1	**B**	**Attempt any TWO of the Following**	**08**
	(i)	**Compare Two Stroke and Four Stroke Engine.**	**04**
	Ans.	**Comparison of Two Stroke and Four Stroke Engine:**	**Any Four Points 01 Mark Each**

S. N.	Two Stroke Engine	Four Stroke Engine
1	One working stroke for each revolutions of the crankshaft	One working stroke for every two revolutions of the crankshaft.
2	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.	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
3	Engine is Light	Engine is heavy
4	Engine design is Simple	Engine design is complicated
5	Less Cost	More Cost
6	More mechanical efficiency due to less friction on few parts.	Less mechanical efficiency due to more friction on many parts.
7	Less output due to mixing of fresh charge with burnt gases.	More output due to full fresh charge intake and full burnt gases exhaust
8	Engine runs hotter.	Engine runs cooler
9	Engine is air cooled	Engine is water/air cooled
10	Engine requires less space.	Engine requires more space.

	(ii)	**Classify I. C. engine on the basis of (i) Cycle of Operation (ii) Method of Cooling (iii) Fuel Used (iv) Method of Charging.**	**04**
	Ans.	**Classification of I. C. engine on the basis of** **(i) Cycle of Operation :** a) Otto cycle engine b) Diesel cycle engine c) Duel combustion cycle engine or semi- diesel cycle engine. **(ii) Method of Cooling :** a) Air cooled engine b) water cooled engine	**Correct Answer 01 Mark Each**

		(iii) Fuel Used : a) Petrol engine b) Diesel engine c) Gas engine **(iv) Method of Charging:** a) Naturally Aspirated Engine. b) Supercharged Aspirated Engine.	
	(iii)	**Write the functions of connecting rod and flywheel.**	**04**
	Ans.	**Functions of Connecting Rod :** • It converts the reciprocating motion of the piston into rotary motion of crankshaft. • It connects piston to the crankshaft. **Functions of Flywheel:** • Flywheel absorbs energy during power stroke and supplies it during remaining strokes. • Flywheel keeps the crankshaft rotating at the uniform speed throughout in spite of uneven power impulses of engine cylinders. • Flywheel carries the drive from the starting motors to crankshaft while the starting the engine.	**Any Two Functions 02 Marks** **Any Two Functions 02 Marks**
2		**Attempt any FOUR of the Following**	**16**
	(a)	**Draw neat sketch of crank shaft for four cylinder engine and label it.**	**04**
	Ans.	 **OR** 	**Neat Sketch 03 Marks & Labels 01 Mark**
	(b)	**Compare dry liner and wet liner.**	**04**

Ans.

S. N.	DRY LINERS	WET LINERS
1	Dry liners are **not in direct contact** with cooling water hence it is known as dry liners.	Wet liners are **in direct contact** with cooling water on the outside hence it is known as dry liners.
2	It is **difficult to replace**.	It is **easy to replace.**
3	**No leak proof joint** is provided in case of dry liners.	**A leak proof joint** are provided in case of wet liners.
4	In dry liners the casting of cylinder block is **complicated**	In wet liners the casting of cylinder block is **very simple.**
5	A cylinder block with dry liners is generally **more robust.**	A cylinder block with wet liners is generally **less robust compare to dry liner.**
6	For perfect contact between liner and the block casting, **very accurate machining** of block and outer liner surface is required.	No such necessity in case of wet liners.
7	A dry liner **cannot be finished correctly**, before fitting, because of the **shrinkage stress** produced.	A wet liner **can be finished accurately**, before fitting.

Any Four Points 01 Mark Each

(c) Name the manufacturing method for following: (i) Cylinder Head (ii) Crankshaft (iii) Oil Sump (iv) Cylinder Liner. — **04**

Ans.

(i) Cylinder Head:
Manufacturing Method: Casting, forming.
(ii) Crankshaft:
Manufacturing Method: Forging
(iii) Oil Sump:
Manufacturing Method: Pressed steel sheet
(iv) Cylinder Liner:
Manufacturing Method: Casted and Pressed in Engine Block and then finished using honing.

Correct Answer 01 Mark Each

(d) Draw Valve Timing Diagram for Four Stroke S. I. Engine. — **04**

Ans.

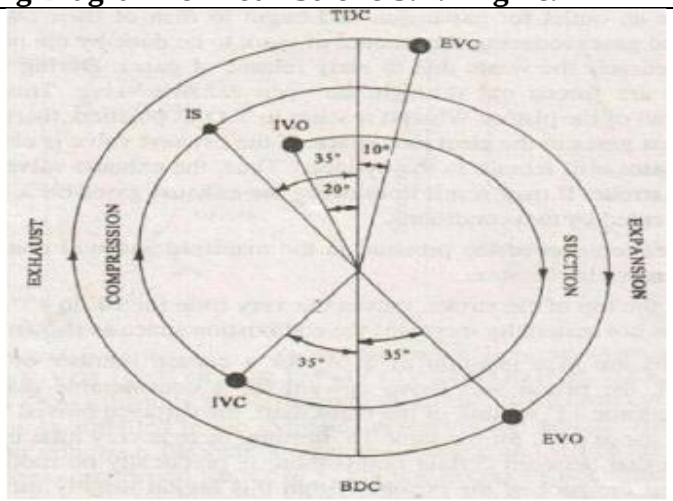
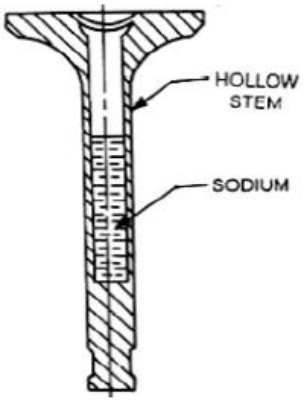
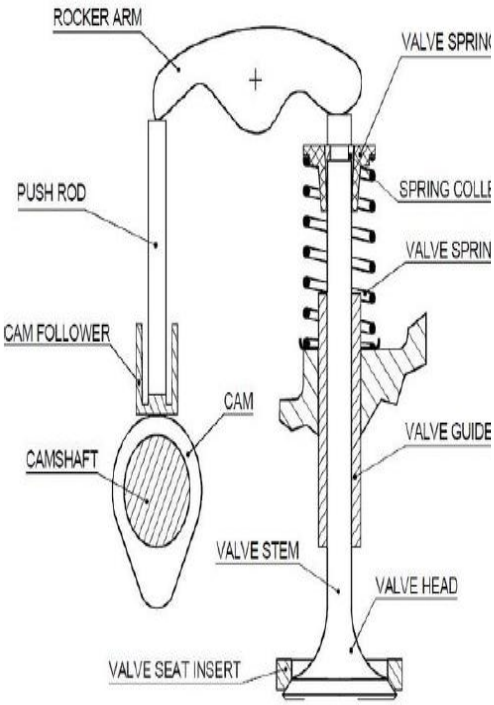
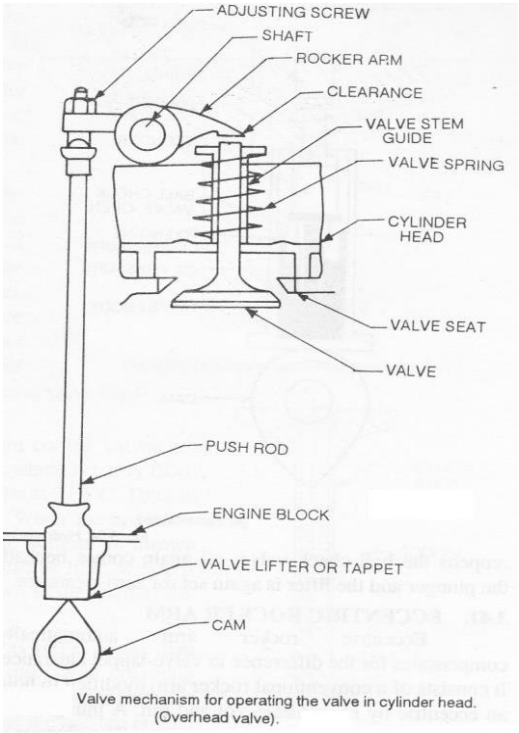
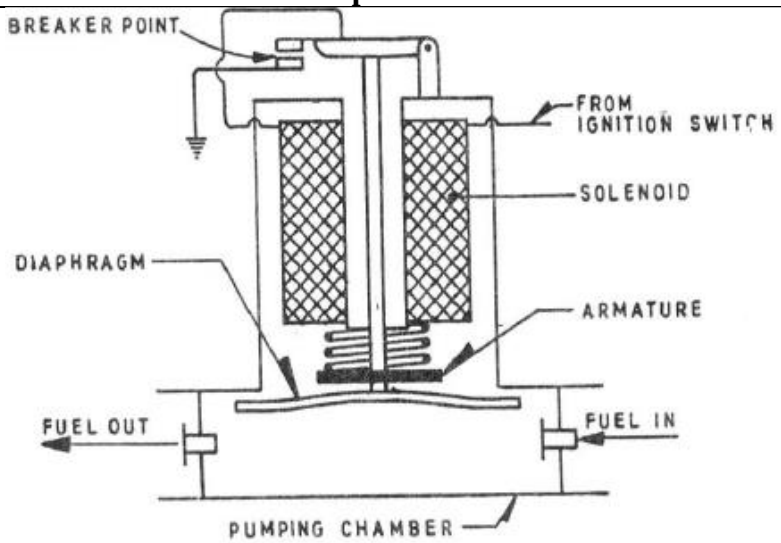
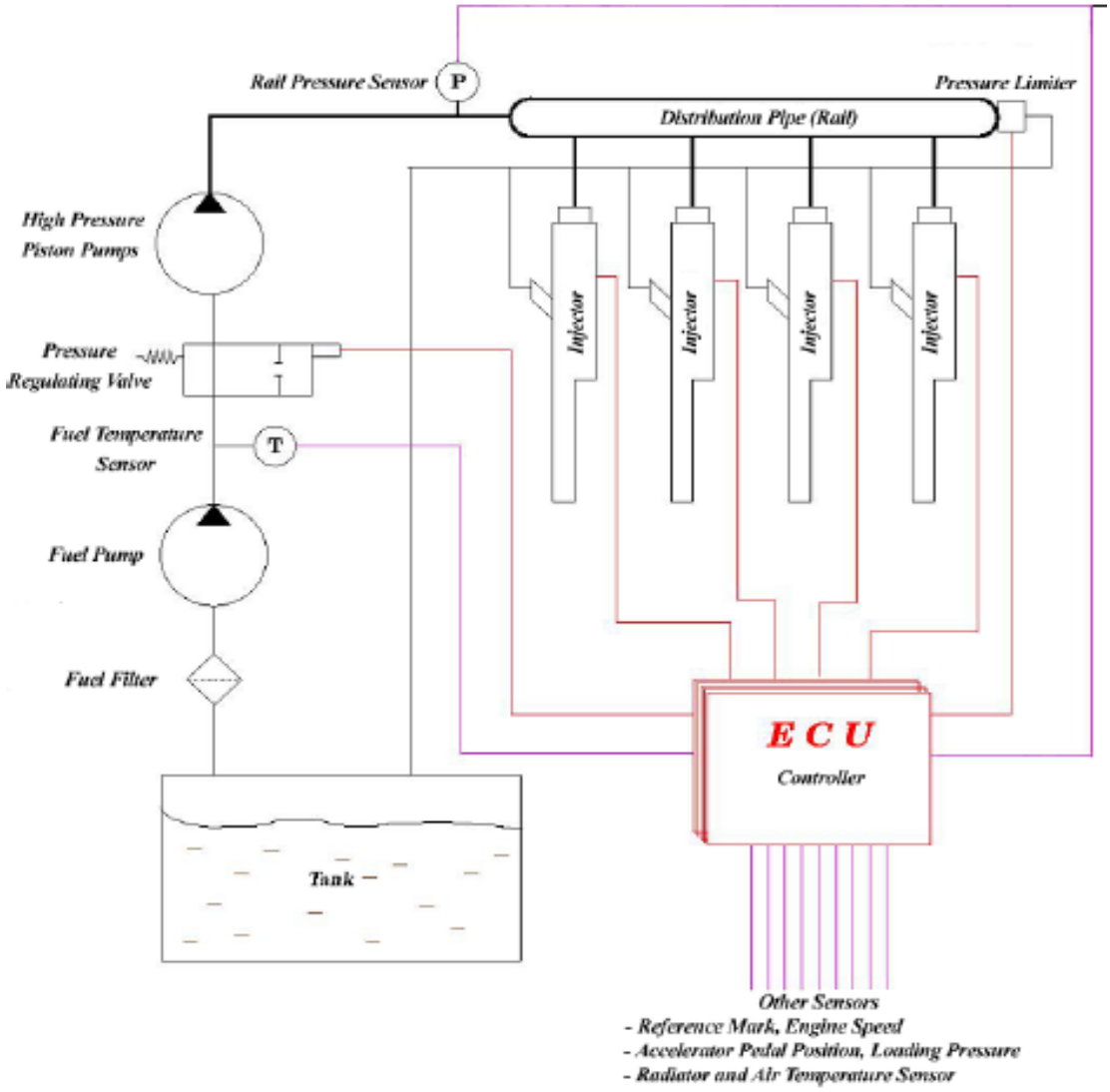


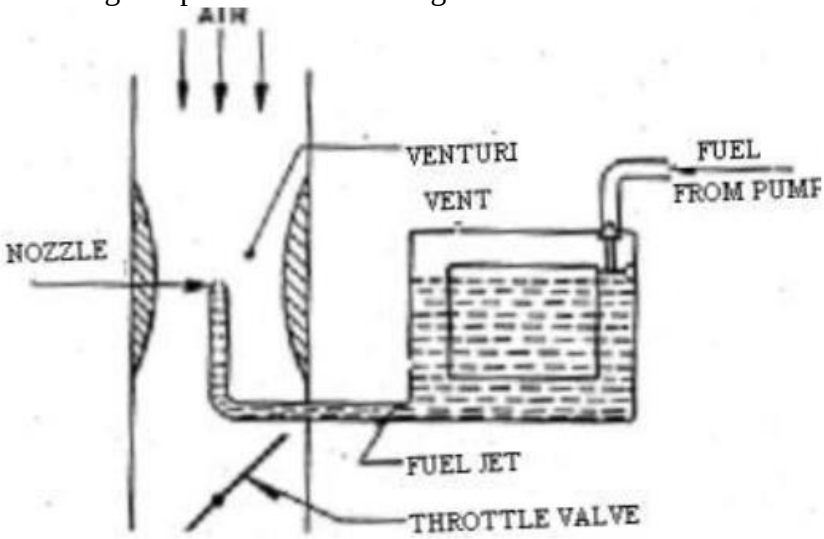
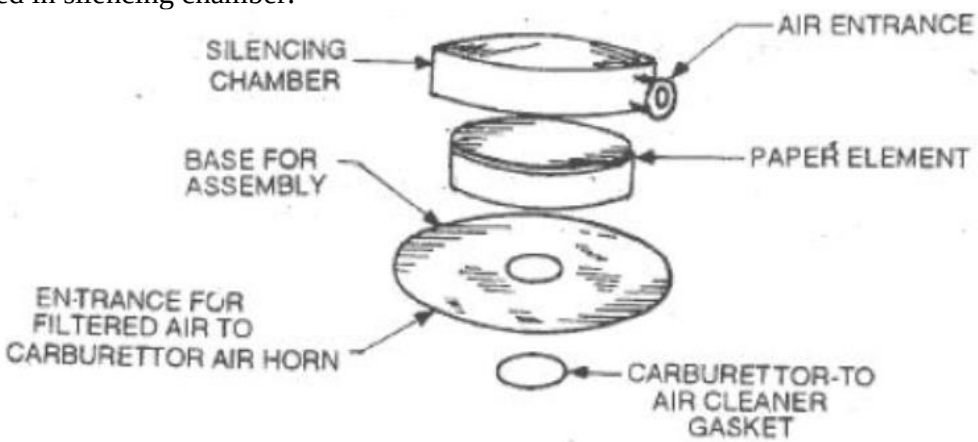
Figure: Valve Timing Diagram for Four Stroke S. I. Engine

Correct Diagram 04 Marks

(e) Describe Valve Cooling with neat sketch. — **04**

	Ans.	Exhaust valve temperature in modern engine is as high as 750^0C. 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 97.5^0C. 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 Coolant Valve**	**Sketch 02 Marks & Description 02 Marks**
	(f)	**Draw neat sketch of Over Head Valve Operating Mechanism.**	**04**
	Ans.	 **Figure: Overhead Valve Mechanism** **OR**  **Figure: Overhead Valve Mechanism**	**Neat Labeled Sketch 04 Marks**
3		**Attempt any FOUR of the Following**	**16**

	(a)	**Draw neat sketch of S. U. Electric Pump.**	**04**
	Ans.	 **Figure: S. U. Electric Pump**	**Neat Labeled Sketch 04 Marks**
	(b)	**Draw layout of Common Rail Fuel System for Diesel Engine. Name the components**	**04**
	Ans.	 **Figure: Layout of Common Rail Fuel System for Diesel Engine**	**Neat Labeled Sketch 04 Marks**
	(c)	**Explain working of simple Carburetor.**	**04**

	Ans.	**Working of Simple Carburetor:** During suction stroke air is drawn through the venture (venture is a tube of decreasing cross section area). When air passing through the venturi increases velocity of air and decreases pressure of air. The pressure in float chamber is atmospheric pressure and the same is maintained with the help of vent. This pressure differential called carburetor depression. So the fuel from the float chamber is feed to a discharge jet. This jet or nozzle delivers a spray of gasoline into the airstream which is passing through venturi same time it mixes with the air. This air fuel mixture enters into the cylinder through the intake manifold. The rate of fuel flow into the venturi tube depends upon the engine speed and load of engine.  **Figure : Simple Carburetor.**	**Working 02 Marks** **&** **Neat Labeled Sketch 02 Marks**
	(d)	**List the types of Air Cleaner and explain Dry type Air Cleaner with neat sketch.**	**04**
	Ans.	**Types of Air Cleaner:** The air cleaners generally used are of following types- 1. Oil bath type air cleaner. 2. Dry type air cleaner 3. Oil wetted type air cleaner 4. Paper pleated type air cleaner 5. Centrifugal type air cleaner **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.  **Figure: Dry Type Air Cleaner.**	**Types 02 Marks** **Explanation 01 Mark** **&** **Sketch 01 Mark**
	(e)	**List types of muffler. Explain any one with suitable sketch.**	**04**

Ans.

Types of mufflers:

1. Baffle Type
2. Wave Cancellation Type
3. Resonance Type
4. Absorber Type
5. Combined Resonance and Absorber Type

Types 02 Marks

1. Baffle Type Silencers: It consists of a number of baffles spot welded inside the cylindrical body. The purpose of these baffles is to close the direct passage of the exhaust gases, thus the gases travel a longer path in the muffler.

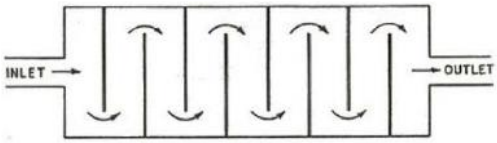
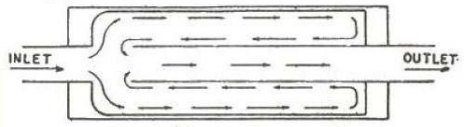


Figure : Baffle Type Silencers

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.

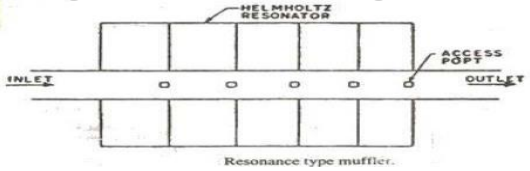


Wave cancellation type muffler.

Explanation 01 Mark

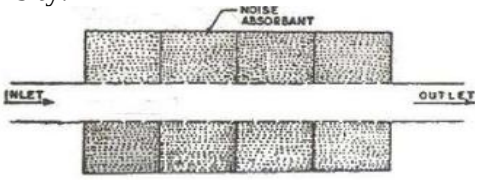
&

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



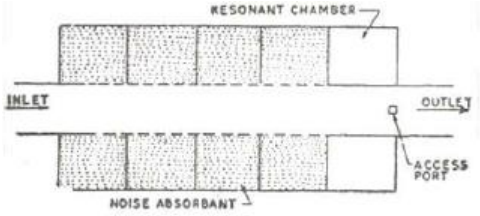
Resonance type muffler.

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



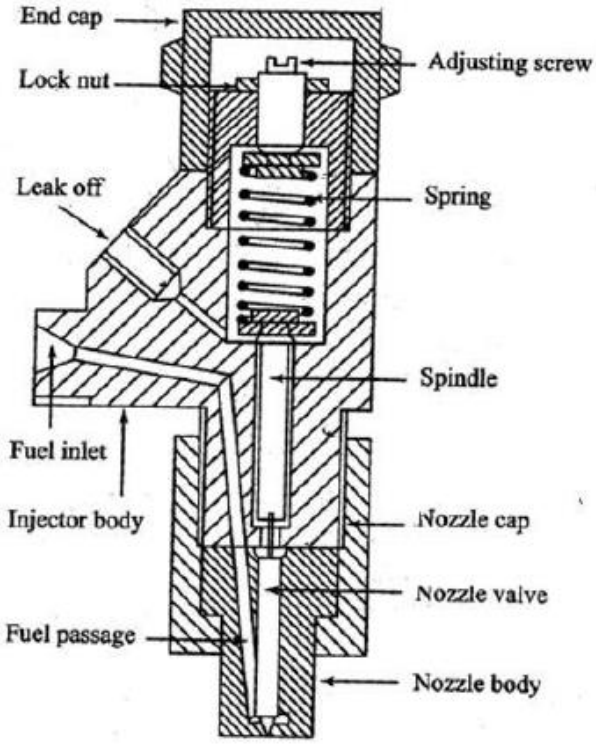
Sketch 01 Mark

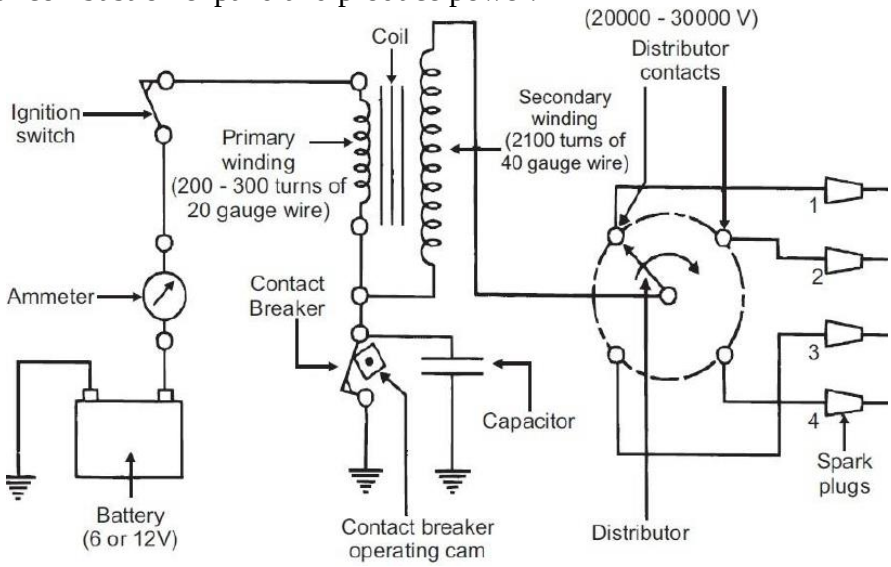
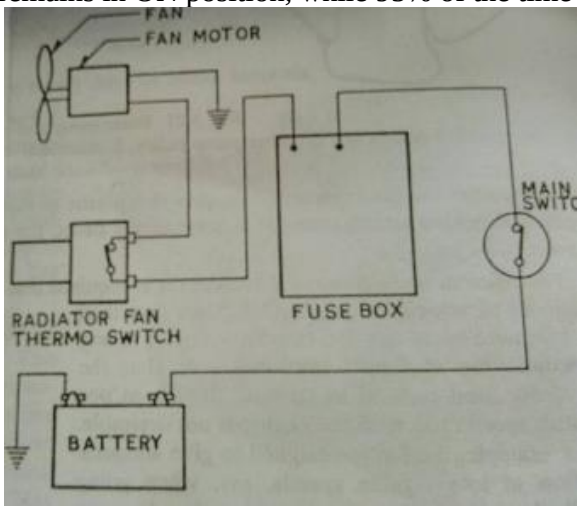
5. Combined Resonance and absorber type: Sometimes, a resonance chamber is provided at one end or in the middle of the straight through absorber type muffler, to reduce the pressure and noise still further. In some designs, the resonance chamber is a separate unit called a resonator, which is connected in series to the muffler.

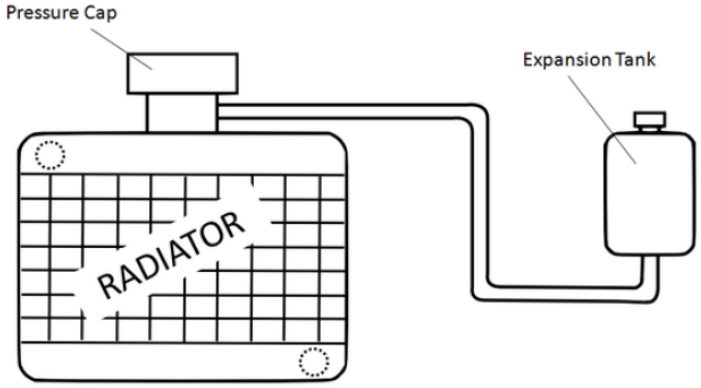
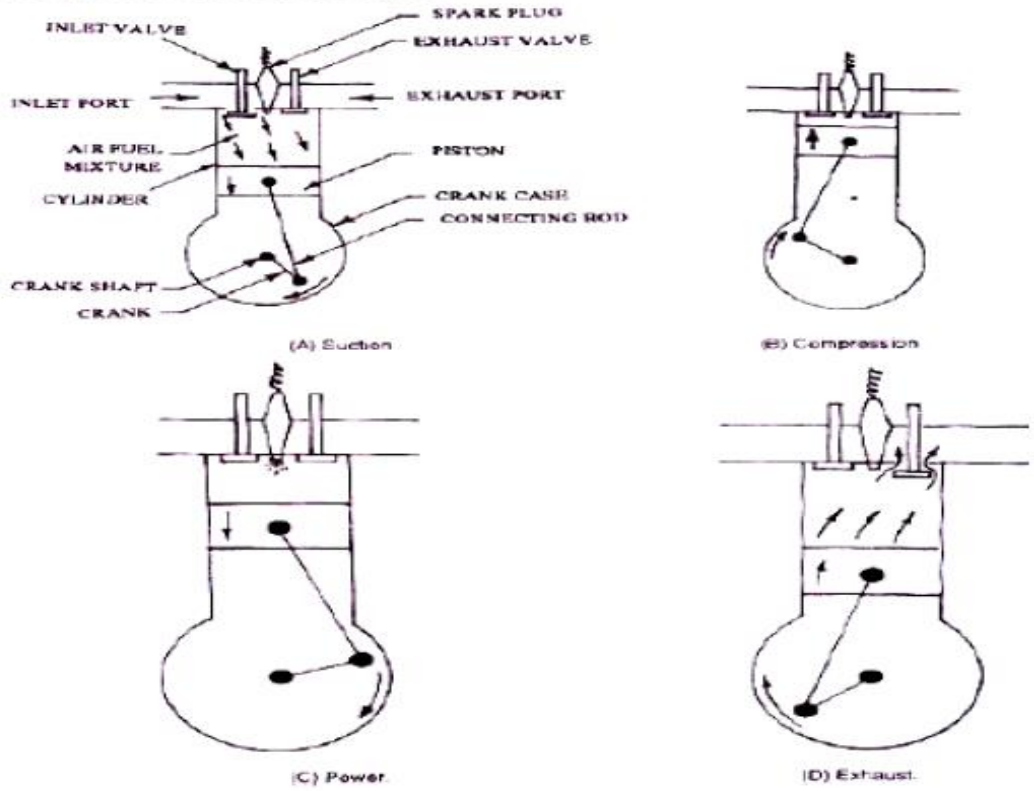


Combined resonance and absorber type muffler.

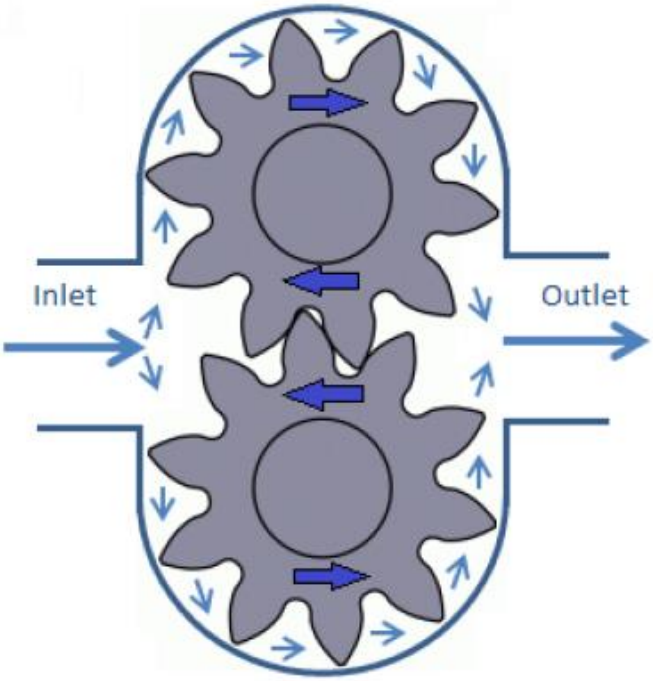
(f) **Explain construction and working of Fuel Injector in C. I. Engine.** **04**

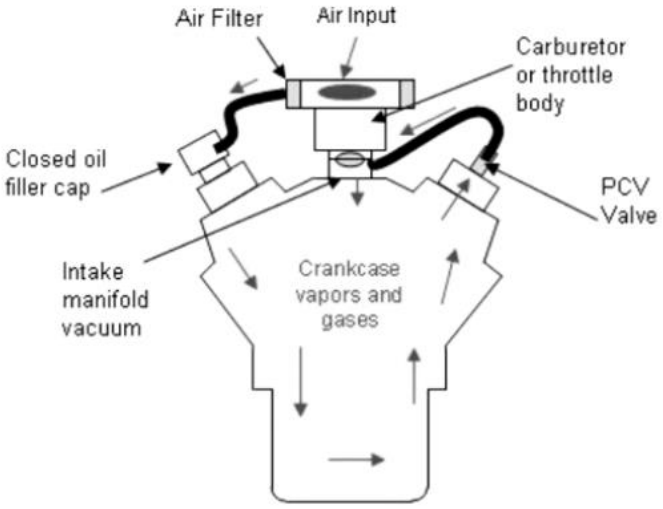
	Ans	**Diesel Fuel Injector:** The injector assembly consists of – i) a needle valve ii) a compression spring iii) a nozzle iv) an injector body When the fuel is supplied to lift the injection pump it exerts sufficient force against the spring to lift the nozzle valve, fuel is sprayed into the combustion chamber in a finely atomized particles. After, fuel from the delivery pump gets exhausted; the spring pressure pushes the nozzle valve back on its seat. For proper lubrication between nozzle valve and its guide a small quantity of fuel is allowed to leak through the clearance between them and then drained back to fuel tank through leak off connection. The spring tension and hence the valve opening pressure is controlled by adjusting the screw provided at the top.  **Figure: Diesel Fuel Injector.**	**Explanation 02 marks** **&** **Diagram 02 Marks**
4		**Attempt any FOUR of the Following**	**16**
	(a)	**Explain working of Battery Ignition System with neat sketch.**	**04**
	Ans.	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	**Explanation 02 Marks**

		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**	**and** **Sketch 02 Marks**
	(b)	**List different properties of coolant.**	**04**
	Ans	**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	**Any Four 01 Mark Each**
	(c)	**Explain electrically driven fan circuit with neat sketch.**	**04**
	Ans	**Working of Electrically Driven Fan in Cooling Engine:** The fan is driven by a separate electric motor which is supplied with power directly from the electric circuit of the engine. A thermostat switch is placed at an appropriate place in the cooling system and depending upon the cooling system temperature it operates to switch to On or OFF the fan motor. It has been found that under ordinary condition only about 5 % of the time the fan motor remains in ON position, while 95% of the time it is off.  **Figure: Electrically Driven Fan Circuit**	**Explanation 02 Marks** **&** **Sketch 02 Marks**
	(d)	**State the function of water expansion tank. Explain with neat sketch the working**	**04**

		principle of it.	
	Ans	**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.  **Figure:** **Water Expansion Tank**	**Explanation 02 Marks** **&** **Sketch 02 Marks**
	(e)	**Explain the working of S. I. Engine.**	**04**
	Ans.	**Working of four stroke petrol engine:**  **Figure: Working of S. I. 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.	**Any One Figure 02 Marks** **&** **Explanation of Each Step 1/2 Mark Each**

		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.	
	(f)	**List the requirements of ignition system used in S. I. Engine.**	**04**
	Ans.	**Requirements of ignition system:** 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	**Any Four 01 Mark Each**
5		**Attempt any FOUR of the Following**	**16**
	(a)	**List the Dynamometer types. Describe working of any one.**	**04**
	Ans.	**Types of Dynamometers:** (i) Rope Brake Dynamometers. (ii) Eddy Current Dynamometers. (iii) Prony Brake Dynamometer. (iv) Hydraulic Dynamometer **Working Principle:** 1. **Rope Brake Dynamometer**: It converts power into heat by dry friction with the help of rope. 2. **Principle of Eddy Current:** Crankshaft connected to rotor when rotor rotates Eddy current are produce in stator due to magnetic flux set up by the passage of field current in electro magnets these Eddy current oppose the rotor motion thus loading the engine. 3. **Principle of Prony Brake Dynamometer:** It converts power into heat by dry friction with the help of brake shoes 4. **Hydraulic Brake Dynamometer:** It works on the principle of dissipating the power in fluid friction created due to centrifugal action of working fluid.	**List of Four 02 Marks & Explanation of Any One 02 Marks**
	(b)	**Classify Lubricating oil using Viscocity (SAE) and load Servicity (API) rating.**	**04**
	Ans.	**Classification of Lubricating Oil:** **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	**02 Marks**

		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 depresent b) SB : Mineral oil , containing additive impart sum oxidation stability & anti- scuff protection c) SC, SD & SC**:** Meets automotive manufactures specifications.	**02 Marks**
	(c)	**Draw neat sketch of Gear type Pump used in lubricating system and Name the parts.**	**04**
	Ans.	 **Figure: Externally Mesh Gear Type Pump.**	
	(d)	**Explain any four Additives used in oil.**	**04**
	Ans.	**Four additives used in oil:** **1) Viscosity index improvers:-** long chain, high molecular weight polymers. Used to increase viscosity of oil more at high temperatures than at low temperatures. **2) Pour point depressants:-** Alkyl aromatic polymers. Used to reduces the lowest temperatures (pour point) at which oil will flow. **3) Antioxidant:-** Aromatic amine compounds. Used to minimize and delay the oxidation of lubricant & its degradation. **4) Extreme-pressure (E.P.) additives:-** Poly-sulfides, phosphate, dithio-phosphates, and Dithio-carbamates. Used to prepare a thin layer of lubricant under boundary lubrication conditions i.e. under high load condition.	**01 mark each**

	(e)	**State the need of P. C. V. System. Draw the schematic diagram for the same.**	**04**
	Ans.	**Need of Positive Crankcase Ventilation System:** Since water vapour in exhaust and blow by gases enter crankcase due to various reasons there is every chance that these contaminants will cause sludge and corrode metal parts. Therefore a mean of removing these contaminants before they can act on the oil is essential. In Positive Crankcase Ventilation system the un-burnt gases are re-circulated into the combustion chamber and burnt with the fresh charge. Another reason of using crankcase ventilation is to relieve any pressure build-up in the crankcase which may cause crankshaft seal leakage.  **Figure: PCV System**	**Need 02 Marks** **&** **Sketch 02 Marks**
	(f)	**Define Swept Volume and Compression Ratio.**	**04**
	Ans.	**ii) Swept Volume:** The volume swept by the piston in moving from T.D.C. to B.D.C. It is expressed in terms of cubic centimeter (cm^3) and given by $$Vs = \text{A X L} = \frac{\pi}{4} d^2 \text{ x L}$$ **ii) 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, $$\text{R} = \frac{V_c + V_s}{V_c}$$	**Correct Answer 02 Mark each**
6		**Attempt any TWO of the Following**	**16**
	(a)	**Write the procedure to conduct Morse Test and Willian's Line Method to calculate I. P.**	**08**
	Ans.	**Procedure to Conduct Morse Test:** Used for multi cylinder engines 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 $$\boxed{I = I_1 + I_2 + I_3 + I_4}$$	**Procedure of Morse Test 04 Marks** **&**

Willan'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 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.

Frictional power loss (F.P.) = OL

Procedure of Willan's Line 03 Marks

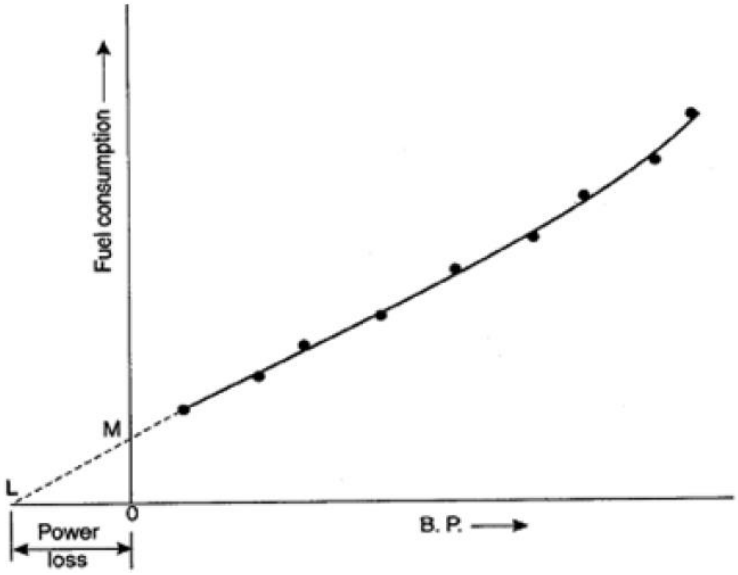


Figure: Willan's Line Method

Figure 01 Mark

(b) Write the procedure to calculate heat balance sheet of I. C. Engine. 08

Ans. Procedure to prepare Heat balance sheet supplied:

Heat supplied by Fuel:

Heat supplied to engine $Q_s = m_f \times C_v$

01 Mark

Where,

m_f and C_v are mass used per minute (kg) and lower calorific value (kJ or kcal) of the fuel respectively.

Heat distribute in various ways in the system:-

1) Heat absorbed in B.P.:

01 Mark

Heat equivalent of B.P. (per minute) $Q_{B.P} = B.P. \times 60$ kJ/min

2) Heat taken away by cooling water:

If,

m_w= Mass of cooling water used per minute

t_1= Initial temperature of cooling water, and

t_2= Final temperature of cooling water,

01 Mark

Then heat taken away by water $Q_w = m_g \times c_w \times (t_2 - t_1)$

Where = specific heat of water

3) Heat taken away by exhaust gases:

If,

01 Mark

m_g = Mass of exhaust gases (kg/min)

c_{pg} = Mean specific heat at constant pressure,

t_e= Temperature of exhaust gases, and

t_r= Room (or boiler house) temperature.

Then heat carried away by exhaust gases $Q_g = m_e \times c_{pg} \times (t_e - t_r)$

4) Unaccounted heat losses Q_{un}: $Q_{un} = Q_s - (Q_{.B.P} + Q_w + Q_g)$ in KJ / min — **01 Mark**

Heat Balance Sheet: — **03 Mark**

Item	kJ/min	Percent
Heat supplied by fuel	-----	-----
1) Heat absorbed in I.P.	-----	-----
2) Heat taken away by cooling water.	-----	-----
3) Heat carried away by exhaust gases	-----	-----
4) Heat unaccounted for (by difference)	-----	-----
Total		

(c) **While performing Morse Test on Four Stroke Petrol Engine, following results were obtained:** — **08**

B. P. with all cylinder working = 32.2 kW
B. P. with cylinder No. 1 out off = 22.0 kW
B. P. with cylinder No. 2 out off = 21.8 kW
B. P. with cylinder No. 3 out off = 22.2 kW
B. P. with cylinder No. 4 out off = 22.8 kW
Calculate : (i) I. P. of the engine (ii) Mechanical Efficiency (iii) Frictional Power

Ans. **Given Data:**

B.P. with all cylinders working (BP)engine =32.2 kW
B.P. with Cylinder no. 01 Cutout, (BP)2,3,4 = 22 kW
B.P. with Cylinder no. 02 Cutout (BP)1,3,4= 21.8 kW
B.P. with Cylinder no.03 Cutout (BP)1,2,4= 22.2 kW
B.P. with Cylinder no. 04 Cutout(BP)1,2,3 = 22.8 kW

Let,

IP of cylinder 1 2 3 and 4 be IP1, IP2 ,IP3 And IP4 Respectively.

The total IP of engine is given by, — **01 Marks**

$(IP)_{engine} = IP1 + IP2 + IP3 + IP4$

We Know That

When cylinder 1 is cut off, the IP developed by cylinders 1 is given by

$IP_1 = (BP)_{engine} - \mathbf{(BP)_{2,3,4}}$

$IP_1 = 32.2 - 22$

$\mathbf{IP_1 = 10.2\ kW}$ — **01 Mark**

Similarly , IP developed by cylinder 2 is given by

$IP_2 = (BP)_{engine} - \mathbf{(BP)_{1,3,4}}$

$IP_2 = 32.2 - 21.8$ — **01 Mark**

$\mathbf{IP_2 = 10.4\ kW}$

Similarly , IP developed by cylinder 3 is given by

$IP_3 = (BP)_{engine} - \mathbf{(BP)_{1,2,4}}$

$IP_3 = 32.2 - 22.2$

$\mathbf{IP_3 = 10\ kW}$ — **01 Mark**

Similarly , IP developed by cylinder 2 is given by

$IP_4 = (BP)_{engine} - \mathbf{(BP)_{1,2,3}}$

$IP_4 = 32.2 - 22.8$

$\mathbf{IP_4 = 9.4\ kW}$ — **01 Mark**

Total IP of the engine is given by

(i) **Total IP of Engine = IP1 + IP2 + IP3 +IP4**

Total IP of Engine = 10.2 + 10.4 + 10 + 9.4

(IP) engine = 40 kW — **01 Marks**

(ii) **Mechanical Efficiency**

		Mechanical Efficiency $= \frac{BP}{IP}$ **X 100** $= \frac{32.2}{40} \times 100$ **= 80.5 %** **(iii) The Total FP of Engine when all the cylinders are working:** **Total FP = Total IP – Total BP = 40 – 32.2 = 7.8 kW**	**01 Marks** **01 Marks**