MODEL ANSWER

WINTER– 18 EXAMINATION

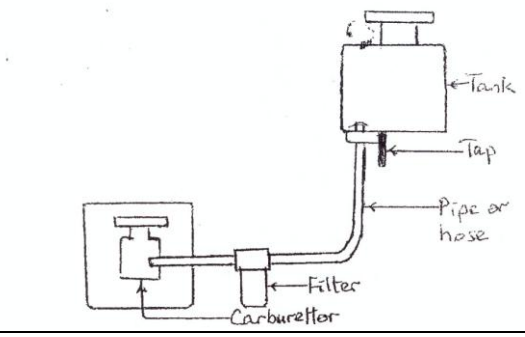
Subject Title: Automobile Engines Subject Code: 17408

Important Instructions to examiners:

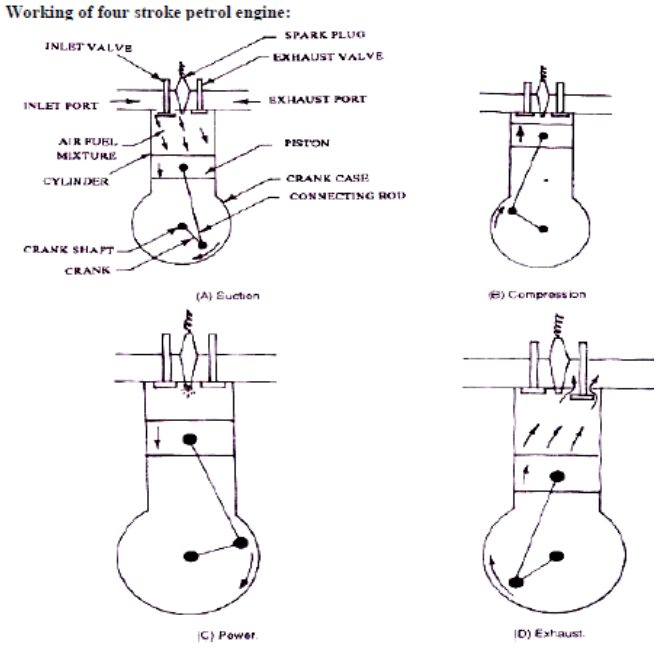
1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by 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:**	**20**
	(a)	**Write the definition of I. C. engine and give examples for external and internal combustion engine.**	**04**
	Ans	The I. C. engine means Internal combustion engine. The engine in which combustion take place inside the closed volume is called as I. C. engine. **OR** 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). **Examples of external combustion engine:** steam engines, stirling engine, gas turbines. **Examples of internal combustion engine:** Gasoline engines, diesel engines, gas-turbine engines, and rocket-propulsion systems.	**02** **01** **01**
	(b)	**Write the location and function of following components of I.C. engines.** **i)Tappet cover ii)Timing cover**	**04**
	Ans		

Components	location	function
i)Tappet Cover	The tappet cover is located on the cylinder head it is usually round in shape on a motorcycle and on car it is more commonly known as a valve cover & it is the	To cover the valve train assembly & prevent oil from being sprayed all over the engine components. It also protects the valve assembly from debris of any

			rectangular shaped cover.	kind entering the lubrication system.	**02 mark each**
		ii)Timing cover	It is located on the front of the engine. The timing cover surrounds the entire timing chain.	The timing cover is an essential component designed to protect the timing belt, timing gear, chain or cam belt of engine from road debris. Timing covers are typically designed to seal the front end of the engine block.	
	(c)	**Write about relation between speed of cam shaft and crank shaft with its reason.**			**04**
	Ans	**Relation between camshaft speed and crankshaft speed:** 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, the camshaft turns at half the speed of the crankshaft. Thus every two revolutions of the crankshaft produce one revolution of the camshaft and one opening and closing of each valve in the four cylinder engine. The gear and sprocket maintain a definite time relationship between the camshaft and crankshaft to ensure opening the valves exactly at the correct time in relation to piston position. Since the valves control the flow of the air/fuel mixture intake and exhaust gases, they must be opened and closed at the appropriate time during the stroke of the piston. For this reason, the camshaft is connected to the crankshaft either directly, via a gear mechanism, or indirectly via a belt or chain called a timing belt or timing chain.			**04**
	(d)	**Draw a layout for gravity feed fuel system used in motor cycle vehicle.**			**04**
	Ans	*(Layout with neat sketch 4M)* **consider anthor suitable layout*  			**04**

	(e)	**Write the firing order used in 4 cylinder engine with its designing parameters.**	**04**
	Ans	**Firing orders for 4 cylinder engine:** The sequence in which the power impulses occur in an engine is called the firing order. Firing order for 4 cylinder engine 1-3-4-2 **OR** 1-2-4-3 **OR** 1-4-3-2. **Designing Parameters:** Number of Cylinders, Torsional vibrations, Heat distribution, arrangement of cylinders, Crankshaft Alignment/Offset of each Crank-Journal.	**02** **02**
	(f)	**Why cooling system is required in I. C. engines?**	**04**
	Ans	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.	**04**
	(g)	**Define indicated power with its formula for 2 stroke engine and 4 stroke engines.**	**04**
	Ans	**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). 2. **Indicated Power**: It is measure on the top of piston. $$\text{I.P.} = \frac{nPLAN'}{60 \times 1000} kw$$ Where, n = Number of cylinders P = Indicated mean effective pressure in N/m^2 L= Stroke in m, D = Diameter in m. A = Area of combustion chamber = $\frac{\Pi}{4} D^2$ in m^2 N = Engine rpm N' = $\frac{N}{2}$ for four stroke and N' = N for two stroke engine.	**02** **01** **01**

2		**Attempt any four:**	**16**
	(a)	**What is scavenging of engine? What are its types?**	**04**
	Ans	**Scavenging** is process of removing the exhaust gases (combustible products) from the cylinder with help of incoming fresh charge in two stroke engine. OR **Scavenging** is the process of pushing exhausted gas-charge out of the cylinder and drawing in a fresh draught of air or fuel/air mixture for the next cycle 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. **Types of scavenging of engine:** (1) Cross Flow Scavenging (2) Back Flow or Loop Scavenging (3) Uni- flow Scavenging.	**02** **02**
	(b)	**Write the working principle of four stroke petrol engine with suitable diagram.**	**04**
	Ans	**Working of four stroke petrol engine:**  Figure: Working of 4-Stroke SI engine.	**02**

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.

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(c) **Compare 4-stroke SI and CI engine** **04**

Ans *(Any 4)*

S. no	Parameter	SI Engine	CI Engine
1.	**Definition**	It is an engine in which the spark is used to burn the fuel.	It is and engine in which heat of compressed air is used to burn the fuel.
2.	**Fuel used**	Petrol is used as fuel.	Diesel is used as fuel.
3.	**Operating cycle**	It operates on Otto cycle.	It operates on Diesel cycle.
4.	**Compression ratio**	Low compression ratio.	High compression ratio.
5.	**Thermal efficiency**	High thermal efficiency.	Less thermal efficiency.
6.	**Method of ignition**	Spark plug is used to produce spark for the ignition.	Heat of compressed air is used for the ignition.
7.	**Engine Speed**	High speed engines.	Low speed engines.
8.	**Pressure generated**	Low pressure is generated after combustion.	High pressure is generated after combustion.

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		9.	**Constant parameter during cycle**	Constant volume cycle.	Constant pressure cycle.
		10.	**Intake**	Air + fuel.	Only air.
			Weight of engine	Si engine has less weight.	CI engine are heavier.
		12.	**Noise production**	It produces less noise.	It produces more noise.
		13.	**Production of hydrocarbon**	Fewer Hydrocarbons is produced.	More hydrocarbons are produced.
		14.	**Starting**	Starting of SI engine is easy.	Starting of CI engine is difficult.
		15.	**Maintenance cost**	Low	High
		16.	**Vibration problem**	Less	Very High
		17.	**Cost of engine**	Less cost	High cost
		18.	**Volume to power ratio**	Less	High
		19.	**Fuel supply**	Carburettor	Injector
		20.	**application**	It is used in light commercial vehicles like motorcycle, cars etc.	It is used in heavy duty vehicles likes bus, trucks, ships etc.
	(d)	**Explain working of 2 stroke cycle petrol engine.**			**04**
	Ans	**Answer: Working of 2 stroke SI engine**: *(Diagram-2 marks, Description-2 marks)*			**02**

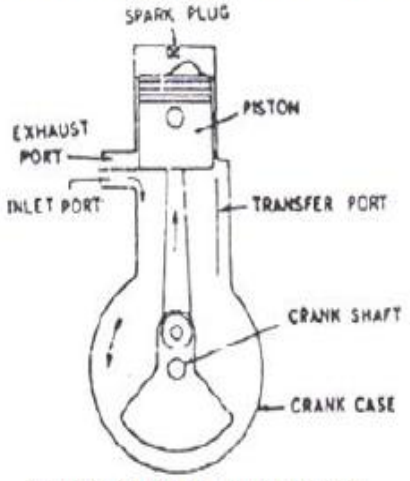

Figure: Working of 2 stroke SI engine

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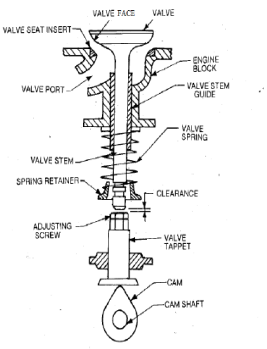
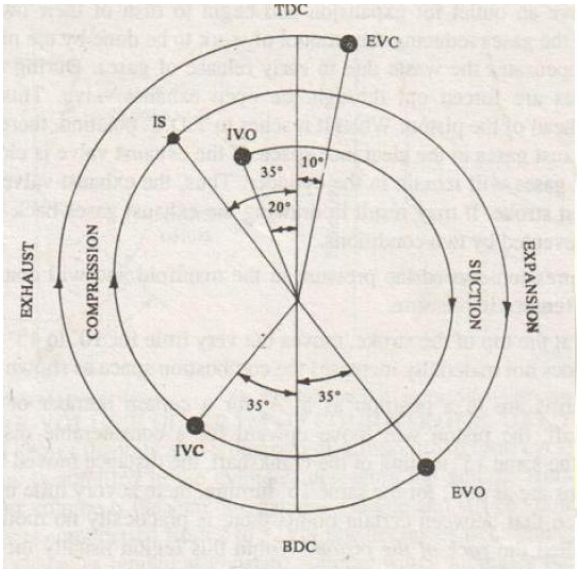
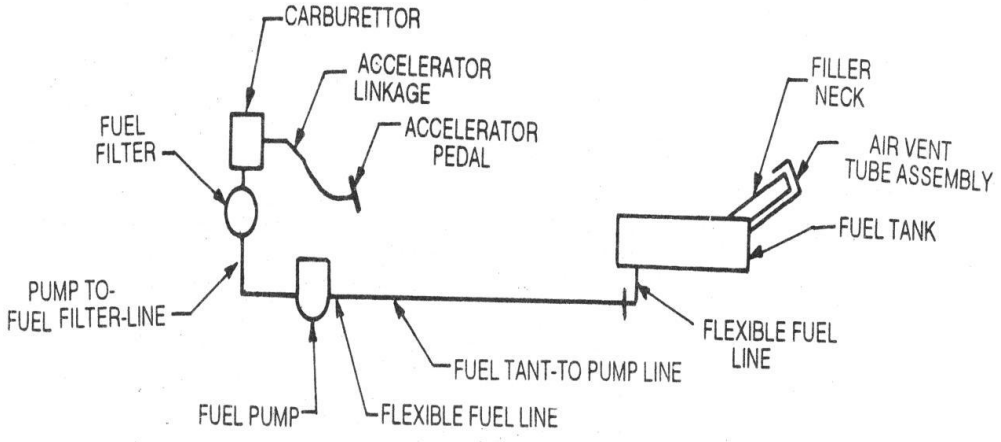
		Upward movement: The air fuel mixture from the carburetor enters the cranks case through the inlet port during the upward movement of the piston. At the same time the mixture in the cylinder is compressed, which is ignited when the piston is just at T.D.C. The combustion takes place and the piston moves imparting motion to the crankshaft. **Downward Movement:** During the downward movement of the piston the mixture in the crankshaft 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 a new charge. This process is called cross-flow scavenging. Thus the whole cycle is completed in two strokes, i.e. one revolution of the crank-shaft.	
	(e)	**Classify the I. C. engine on the basis of cycle of operation , fuel, ignition, cooling method, cylinder arrangement**	**04**
	Ans	Classification of I.C. Engine: The Automobiles engines classification on following basis: **1) Cycle of operation:-** a) Otto cycle engine b) Diesel cycle engine c) Duel combustion cycle engine or semi- diesel cycle engine. **2) Fuel:-** a) Petrol engine b) Diesel engine c) Gas engine **3) Method of ignition:-** a) Spark ignition (S.I.) engine b) Compression ignition (C.I.) engine **4) Types of cooling :** a)Air cooled engine b) water cooled engine **5) Arrangement of cylinder:-** a) Vertical engine b) horizontal engine c) Radial engine d) V-engine e) Opposed cylinder engine	**04**

	(f)	**What are the various applications of I. C. engines?**	**04**
	Ans	**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**
3		**Attempt any four:**	**16**
	a)	**Differentiate between dry and wet liner**	**04**
		Answer: **Comparison dry and wet liners** *(Any four)*	**04**

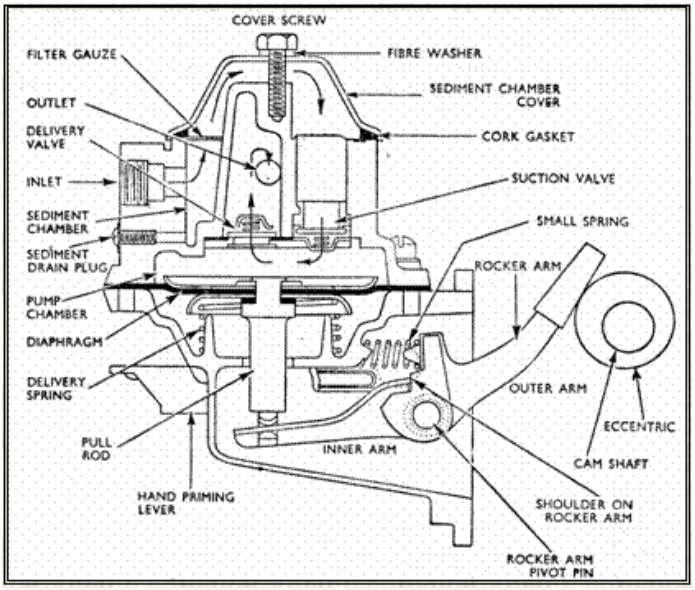
Dry liners	Wet liners
1) Dry liner is **not in direct contact of** cooling water hence it is known as dry liner.	1) Wet liners is in **direct contact with** water on the outside and hence is kno liner.
2)It is **difficult to replaced**	2)It is **easy to replaced**
3) **No leak proof joint** is provided in the case of dry liner.	3)A leak proof joint between the casting and the liner has to be provide
4)In dry liners the **casting of cylinder block is complicated**	4)In wet liners the **casting of cylinde very simplified**
5) A cylinder block with dry liners is generally more **robust**.	5)A cylinder block with wet line **robust** as compare to dry liner
6)For perfect contact between the liner and the block casting in case of dry liner, very **accurate machining of block and outer liner surface** is required,	6) Where as there is **no such necessi** of wet liner.
7) A dry liner **cannot be finished accurately** before fitting because of the shrinkage stresses produced.	7) A wet liner **can be finished a** before fitting.

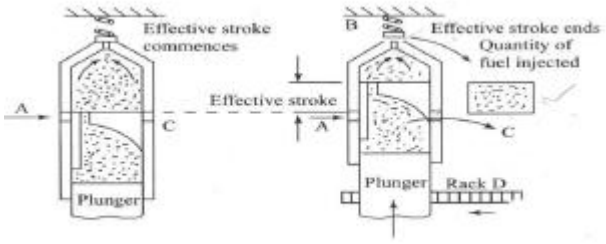
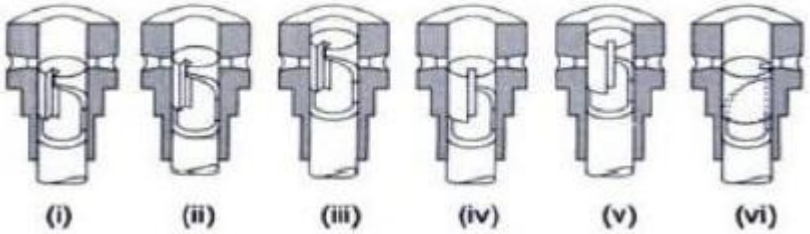
	b)	**Draw a neat sketch of straight poppet overhead valve mechanism and name the parts.**	**04**
	Ans	*(Sketch 3M, labeling 1M)* Answer: Straight poppet overhead valve mechanism:  Figure: Straight poppet Overhead valve operating mechanism	**04**

	c)	**Write the location and function of following components of the engine: i) cylinder head ii) cam shaft iii) cylinder liner iv) main bearings.**	**04**
	Ans	*(Location 2M Function 2M)* **A)Location of engine components:** i) **Cylinder Head:** A cylinder head is usually located on the top of the engine block. ii) **Cam shaft:** When an engine has the designation **OHC** (Over Head Camshaft) it means that the camshaft is located in the cylinder head. For overhead cam engines (OHC), the camshaft is mounted above the valve and stem and the lobe of the cam directly actuates the stem. **iii) Cylinder liner:** A cylinder liner is a cylindrical part to be fitted into an engine block to form a cylinder. It is one of the most important functional parts to make up the interior of an engine. **iv) Main bearings:** Crankshaft is supported in main bearings which are located in the lower portion of the engine block. **B) Function of engine components:** **i) Cylinder Head:** It provides the housing for exhaust and intake valves, threaded holes for the spark plugs or fuel injector and necessary linkages, passage for cooling jackets and passages for the fuel and air mixture. **ii) Cam shaft:** In an internal combustion engine, the cam shaft actuates the intake and exhaust valves which feed and evacuate the air/fuel mix in/from the combustion chamber. It also provides a drive for the ignition distributor and mechanical fuel pump. **iii) Cylinder liner:** The cylinder liner, serving as the inner wall of a cylinder, forms a sliding surface for the piston rings while retaining the lubricant within. The most important function of cylinder liners is the excellent characteristic as sliding surface and these four necessary points. i)High anti-galling properties ii)Less wear on the cylinder liner itself iii)Less wear on the partner piston ring iv)Less consumption of lubricant **iv) Main bearings:** The bearings hold the crankshaft in place and prevent the forces created by the piston and transmitted to the crankshaft by the connecting rods from dislodging the crankshaft, instead forcing the crank to convert the reciprocating movement into rotation.	**02** **02**

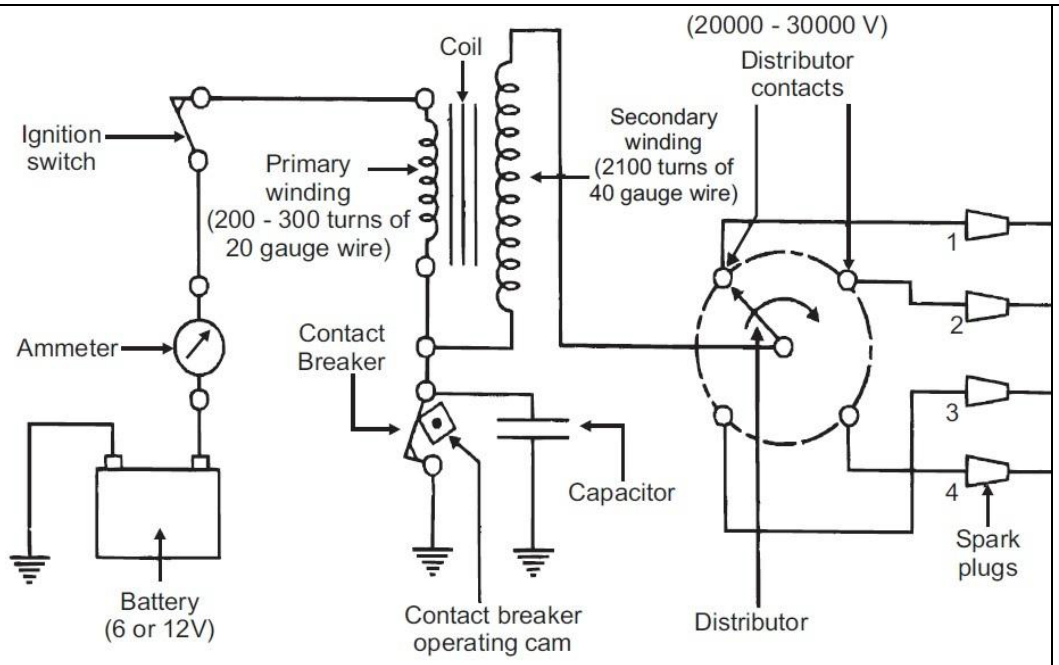
	d)	**Draw valve timing diagram for petrol engine.**	**04**
	Ans	 Figure: Valve timing diagram of 4 stroke SI engine	**04**
	e)	**Draw layout of pump feed fuel supply system of carbureted engine of a car**	**04**
	Ans	 Layout of pump feed fuel supply system for petrol engine:	**04**
	(f)	**What is meant by rich mixture, lean mixture and stoichiometric mixture air fuel ratio? Also write different air fuel ratios required.**	**04**
	Ans	Air–fuel ratio (AFR) is the mass ratio of air to a solid, liquid, or gaseous fuel present in a combustion process. i) **Rich Mixture:** - A rich mixture is a fuel/air mixture containing an	

		excessive proportion of fuel. A rich mixture has too much fuel and not enough air. ii) **Lean Mixture:** - A lean mixture is a fuel/air mixture containing a relatively low proportion of fuel. A lean mixture can be caused by too little fuel or too much air. iii) **Stoichiometric Mixture:** - A 'Stoichiometric' AFR has the correct amount of air and fuel to produce a chemically complete combustion event. For gasoline engines, the stoichiometric, A/F ratio is 14.7:1, which means 14.7 parts of air to one part of fuel. **Different Air fuel ratio Required**:- *(any two)* i) Starting:- 10:1 ii) Idling :- 12.5:1 iii) Normal Power:-16.5:1 iv) Maximum power:-13:1	**01** **01** **01** **01**
4		**Attempt any FOUR**	16
	a)	**Draw neat sketch of A.C. mechanical fuel pump used in petrol engine and write its working.**	04
	Ans	**(sketch 2Marks, working – 2Marks)** **Working of A.C. Mechanical Fuel Pump:** This is a diaphragm type of pump as shown in figure. The diaphragm used is made out of high-grade cotton impregnated with synthetic rubber. The valves are made of Bakelite, which being lighter, keeps the inertia stress minimum. The pump is usually bolted to the crankcase of the engine and operated directly by an eccentric on the camshaft, or by push rod. As the camshaft rotates, the eccentric lifts the rocker-arm which pulls the connecting rod, together with the diaphragm, downward against the pressure of the return spring, thus creating a vacuum in the pump chamber. Fuel from the tank is then sucked through the inlet connection, into the sediment chamber, through the filter and inlet valve into the pump chamber. On the return stroke the pressure of the return spring pushes the diaphragm upward forcing fuel from the pump chamber through the	02 02

		outlet or delivery valve and outlet connection to the carburettor. When the correct level in the carburettor float chamber is reached, the needle valve will close, thus creating a back pressure in the pump chamber. This pressure will hold the diaphragm downward against the return spring and it will remain in this position until the carburettor requires more fuel and the float chamber needle valve opens. When the fuel pump is subjected to a back pressure the diaphragm connecting rod forces the interior, pivoted portion or lever of the two-piece rocker arm to the bottom of its stroke. As the outer part of the rocker arm, which is in direct contact with the eccentric cam, is also secured to the same pivot centre as the lever, the rocker arm will cease to operate the lever until the diaphragm is returned to its initial position. The small spring at the rocker arm shoulder is intended to keep the rocker arm in constant contact with the eccentric, to eliminate noise.  **Fig. A.C. Mechanical Fuel Pump** **(any suitable sketch shall be considered for due credit)**	
	b)	**List the six requirements of diesel fuel injection system**	04
	Ans	**Requirements of fuel injection system (Any six-4 M)** 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	04

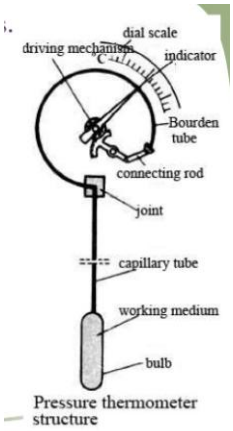
		to engine requirement 3) Pressure- The fuel injection system must pressurize the fuel to open the injection nozzle to inject fuel into the combustion chamber. 4) Atomize- The fuel must be atomized when it is supplied to the combustion chamber since atomized fuel will burn easily. 5) Distribution- In 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.	
	c)	**Draw neat sketch of jerk pump system and name the components**	04
	Ans	 OR  In Fig., (i) is the position of the plunger when it is at the bottom stroke. The position of the plunger when it is closing both the ports is shown in (ii). The maximum amount of supply is shown in (iii). Only at this position is the plunger working at full load. The position of the plunger at (iv) shows a normal load. The position at (v) shows a part load. The position at (vi) shows that no fuel is being supplied to the injector; i. e. the engine has stopped.	Sketch- 03 marks; Labels- 1Mark

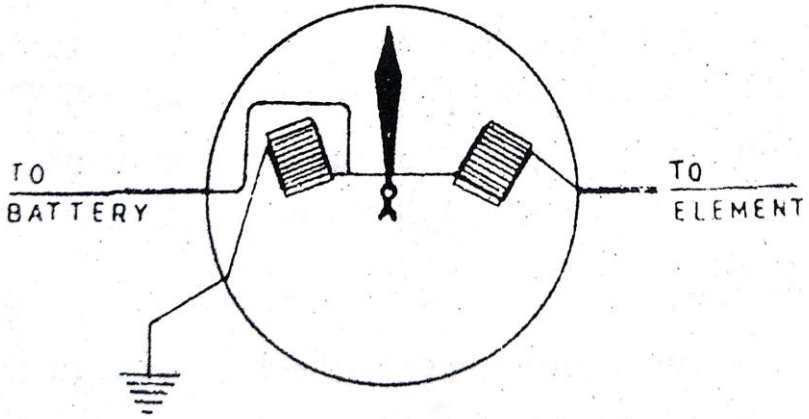
	d)`	**Write the function of inlet and exhaust manifold with its location.**	04
		Function of inlet manifold: 1) Inlet manifold carries air fuel mixture from carburetor to engine cylinders. 2) It provides large enough space to allow sufficient flow of charge for maximum power and on other hand it must be small enough to maintain adequate velocity for keeping the fuel droplets suspended in air. 3) It should provide least resistance to flow. 4) In MPFI it facilitates the injection of fuel in inlet manifold before supplied to cylinder. **Function of exhaust manifold:** 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. **Inlet manifold location:** It is mounted on engine head, In carbureted petrol engine it is between carburetor and engine head. In case of diesel engine it is between filter and engine cylinder head. In case of MPFI, mounted on engine along with injectors on cylinder head. **Exhaust manifold location:** It is mounted on cylinder head and connected to muffler.	01 01 01 01
	e)	**Draw layout of battery ignition system and name the parts.**	04
	Ans	**Battery ignition system:**	Sketch 3 Marks and labels- 1Mark

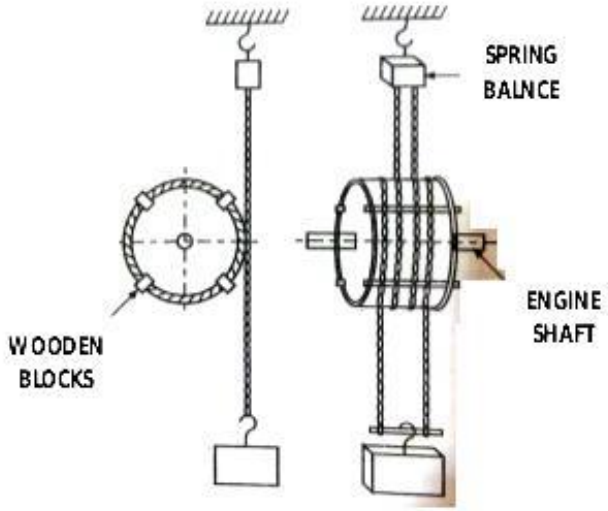
		 **Figure : Schematic Diagram of Coil/Battery Ignition System**	
	f)	**List the properties of coolants used in cooling system of engine.**	04
	Ans	**Properties of coolant:** 1. Low freezing temperature 2. High boiling point 3. Large latent heat of vaporisation 4. Non corrosive 5. Easily and cheaply available 6. Chemically inert 7. Should not deposit foreign matter on the water jackets and radiator 8. Viscosity should be less.	Any 04-1 mark each
5		**Attempt any FOUR**	**16**
	a)	**Explain the function of expansion tank used in cooling system.**	**04**
		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.	**04**

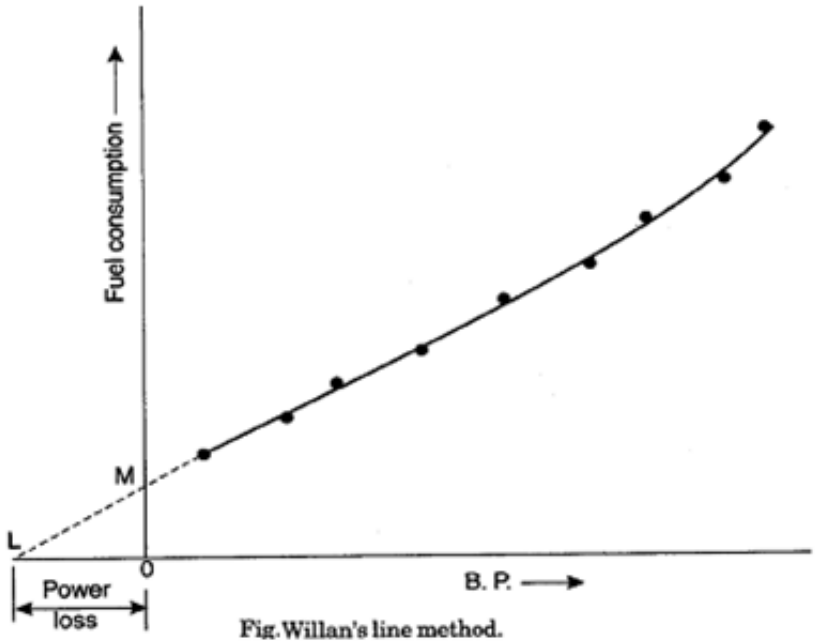
	b)	**Write the difference between water cooling and liquid cooling system of I. C. engine.**	**04**
	Ans		04Marks- any four point

Air cooling System	Water Cooling System
As compared to water cooling its efficiency is less	As compared to air cooling its efficiency is more
It is light in weight	It is heavier in weight
No maintenance is required	Regular maintenance is require
Two/Three wheeler like Motorcycles, Scooters, Auto Rickshaw etc.	Four wheelers – LMV, HMV, Heavy commercial vehicles lik Cars, trucks, buses etc.

	c)	**Explain the working of temperature gauge.**	04
	Ans	**Working of temperature gauge:** **Bourdon tube type temperature gauge:** This has bourdon tube inside, which is connected by a capillary tube to the element, containing some volatile liquid at suitable temperature and which is inserted in the cooling water circuit at appropriate point, generally on the engine side of thermostat. As the temperature of cooling water increases, the liquid in the element evaporates and exerts its pressure in the capillary, which is further transmitted to the Bourdon tube. Due to this pressure, the Bourdon tube tries to straighten out and thus tries to straighten out and thus moves a pointer attached on the scale.  **Fig. Bourdon tube type temperature gauge** **OR** **Electrically operated type:** This contains an element made of such a material that its electrical resistance decreases with increase of temperature. The element is connected to the coils inside the dash unit as shown in fig. which depicts entire electrical circuit. The gauge entire electrical circuit. The gauge element is inserted into the coolant at some appropriate point. As the cooling water temperature increases, the resistance of element decreases, which causes more current to flow in the coil (2), thus increasing the	

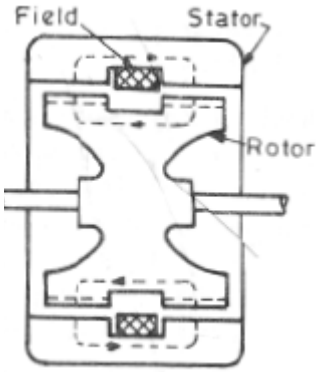
		e.m.f. built up there . the pull of coil (2) on the armature carrying indicator, pointer therefore, increases and the pointer moves show the higher temperature.  **Fig. Electrically operated type Temperature Gauge**	
	d)	**Write the function and location of thermostat valve, pressure cap, temperature indictor and fan belt.**	04
	Ans	**Function of:** Thermostat valve: To control the engine coolant temperature. Pressure cap: In modern cars, to form air tight joint and maintain the pressure of coolant at higher pressure than atmosphere. Temperature indictor: To indicate the temperature of coolant. Fan belt: To provide the drive for coolant pump and alternator. **Location of:** Thermostat valve: it is fitted in the coolant hose pipe at the engine outlet. Pressure cap: In modern cars it is fitted on radiator filler neck. Temperature indictor: It is located on the dash board of vehicle. Fan belt: It is mounted behind the radiator on same shaft on which water pump is mounted.	½ Mark each
	e)	**List the part which are to be lubricated in the I. C. engine**	04
	Ans	**List of part to be lubricated in the I. C. engine:** 1. Piston 2. Cylinder 3. Inlet valve and exhaust valve 4. Camshaft 5. Crankshaft 6. Bearing 7. Connecting rod 8. Piston ring 8. Cylinder valves 9. Crank shaft bearing 10. Connecting rod bearing 11. Big end and small end bearing 12. Gudgeon pin	½ mark for each
	f)	**Write the function of oil filter, oil pump, pressure regulator, cam shaft used in lubrication system.**	04
	Ans	**Function of oil filter, oil pump, pressure regulator, cam shaft used in lubrication system:** **Oil filter:** To remove the impurities from oil & consequently to avoid permanent damage to any or more running part of engine. **oil pump:** To supply oil under pressure to the various engines parts	01 mark each

		Pressure regulator: To maintain the predefined pressure value inside the lubricating system. **cam shaft:** A gear is present on the camshaft which drives oil pump.	
6		**Attempt any FOUR**	16
	a)	**Define-mechanical efficiency, brake thermal efficiency, volumetric efficiency and air standard efficiency.**	04
	Ans	**Mechanical efficiency,** It is the ratio of brake power available at the crankshaft to the indicated power generated inside the cylinder. **Brake thermal efficiency:** It is the ratio of energy in the brake power to the input fuel energy **Volumetric efficiency:** Volumetric efficiency is an indication of the breathing ability of the engine and is defined as the ratio of the air actually induced at ambient condition to the swept volume of the engine. **Air standard efficiency:** It is a thermodynamic efficiency which is mainly a function of compression ratio. It gives the upper limit of the efficiency obtainable from an engine	01 mark each
	b)	**Draw neat sketch of rope brake dynamometer and name the parts.**	04
	Ans	 ROPE BRAKE DYNAMOMETER	Sketch 3 Marks and labels- 1Mark
	c)	**Explain Morse test used to find IP**	04
	Ans	**Morse Test:** Used for multi cylinder engines	

		Procedure: 1. The engine is run at the required speed and the torque is measured. 2. One cylinder is cut out by shorting the plug if an S.I. engine is under test or by disconnecting an injector if a C.I. engine is under test . 3. The speed falls because of the lass of power with one cylinder cut out but is restored by reducing the load . 4. The torque is measured again when the speed has reached its original value. 5. If the value of I.P. measured simultaneously for each cylinder $I = I_1 + I_2, + I_3 + I_4$	04
	d)	**How friction power is found by Willians line method of single cylinder diesel engine**	04
	Ans	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  Fig. Willan's line method.	02 02

	e)	**Explain heat balance sheet of I. C. engine.**	04
	Ans	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, Where, m_f and C_v are mass used per minute (kg) and lower calorific value (kJ or kcal) of the fuel respectively. **ii) Heat equivalent of I.P.:** Heat equivalent of I.P. (per minute) = $I.P. \times 60$ kJ. **iii) 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, Then, heat taken away by water = $m_w \times C_w \times (t_2 - t_1)$, *Where, C_w = specific heat of water.* **iv) Heat taken away by exhaust gases:** If m_e = Mass of exhaust gases (kg/min) C_{pg} = Mean specific heat at constant pressure, t_e = Temperature of exhaust gases, and t_r = Room temperature, Then heat carried away by exhaust gases = $m_e \times C_{pg} (t_e - t_r)$ 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:	04

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	……	……

	f)	**Explain the working principle of eddy current dynamometer .**	04
	Ans	**Working principle of eddy current dynamometer**: *(Sketch - 1mark, Description-3 marks)*  Figure: Working principle of Eddy current dynamometer *(Note: Credit should be given to suitable diagram)* 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.	04