WINTER – 19 EXAMINATION

Model Answer

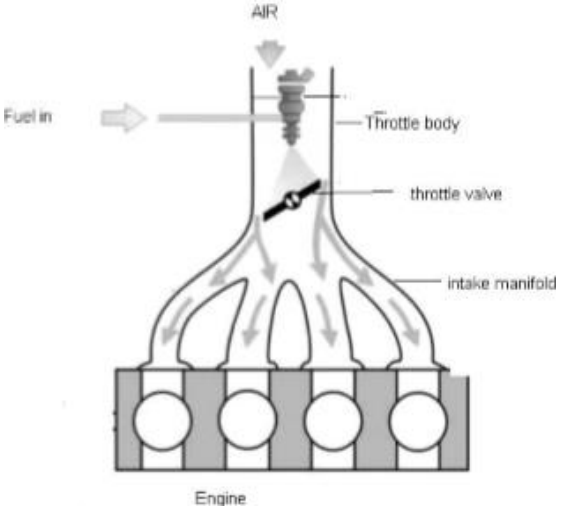
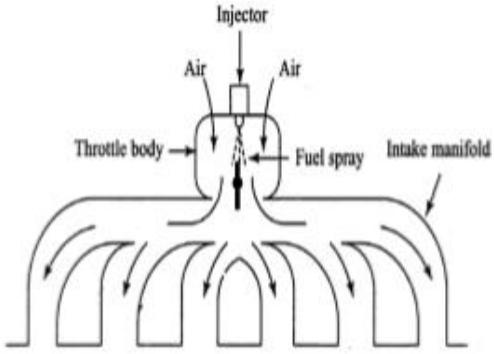
Subject Name: Advanced Automobile Engines Subject Code: 17523

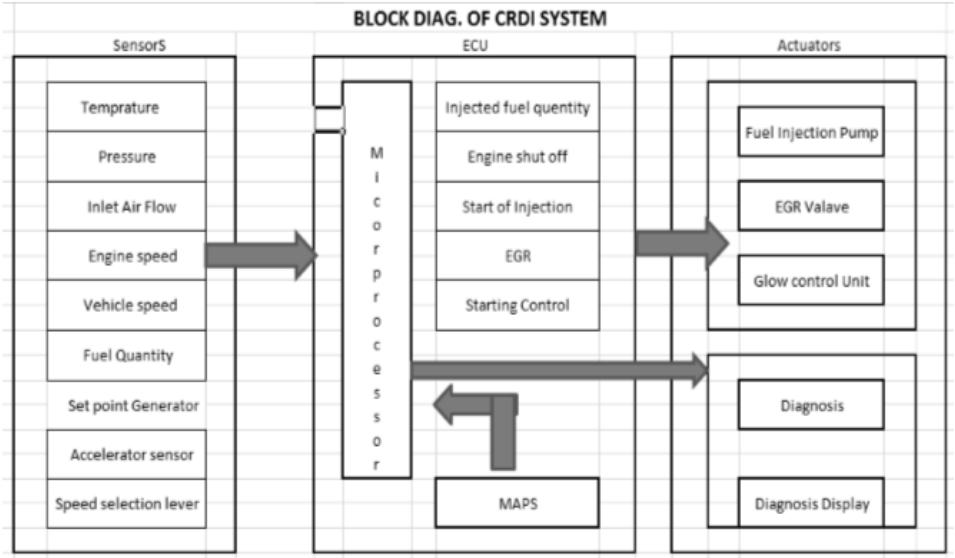
Important Instructions to examiners:

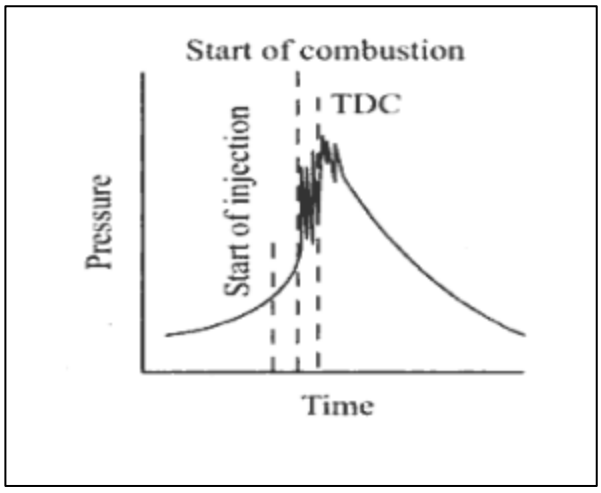
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling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

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	(a)	**Attempt any Three of the following.**	12
	i)	**Define spark ignition, auto ignition, pre ignition, and surface ignition.**	04
		Answer: **1. Spark ignition:** The term spark-ignition is ignition of charge (the air-fuel mixture) by a spark across electrodes of a spark plug. **2. Auto ignition:** It is spontaneous ignition of fuel: air mixture when introduced into the combustion chamber of an I.C. engine, as a result either of glowing carbon in the chamber or of the heat of compression. **3. Pre-ignition:** Pre-ignition is the ignition of the homogeneous mixture in the cylinder, before the timed ignition spark occurs, caused by the local overheating of the combustible mixture. Pre ignition is initiated by some overheated projecting part such as the sparking plug electrodes, exhaust valve head, metal corners in the combustion chamber, carbon deposits etc. **4. Surface ignition:** Surface ignition is the ignition of the fuel-air mixture by a hot spot on the combustion chamber walls such as on overheated valve or spark plug or glowing combustion chamber i.e. any means other than the normal spark discharge. Due to surface ignition a turbulent flame develop at each surface ignition locations and start propagates across the chamber in an analogous manner to what occurs in normal knock.	**01** **01** **01** **01**
	ii)	**List four drawbacks of carburetted S.I. engine.**	04
	Ans.	**(Any 4 – 1 Mark Each)** Drawbacks of carburetted SI engine: 1) No altitude compensation.	

		2) Mal-distribution of charge. 3) Variation in air: fuel ratio. 4) Inaccurate metering of charge. 5) Does not meet emission norms. 6) No temperature compensation. 7) No compensation of Exhaust gas recirculation. 8) Fuel atomization depends upon velocity of air in the venture. 9) Wear and tear of parts results in poor efficiency. 10) Backfiring may take place. 11) Carburetor Icing may take place	**04**
	iii)	**State four features of CRDI system.**	**04**
		Features of CRDI System: 1. CRDI engine has lower emission. So, it meets latest emission norms. Finely atomized fuel results in an efficient air-fuel mixing & reduced particulate emissions. 2. It gives improved fuel economy. 3. CRDI engine has lower engine noise level. CRDI engines have capability to deliver stable, small pilot injections can be used for decreased NOx emissions and noise. 4. All the cylinders have balanced engine cylinder pressures. (i.e. reduced torsional vibrations). 5. Separation of pressure generation and injection allowing flexibility in controlling both the injection rates and timing of CRDI. 6. In CRDI system, Common rail pressure does not depend on the engine speed and load conditions. 7. In CRDI, High injection pressures (about 1500 bar) and good spray preparations are possible even at low engine speeds and loads. 8. In CRDI system, Fuel pump operates with low drive torque. 9. High pressure accumulator (common rail) provides consistently high pressure fuel to injectors. 10. Use of high pressure pump which allows the fuel to be supply at higher pressure under all operating condition.	(**Any 4** – 1 Mark Each)
	iv)	**Explain the need of hybrid vehicles.**	**04**
		Need of Hybrid Vehicle : (any four) 1) To increase fuel efficiency. 2) To reduce gaseous emission. 3) To increase acceleration capability. 4) To reduce noise emission. 5) To provide alternate solution for fossil fuels 6) To comply the stringent Emission Norms Hybrid Vehicles are needed.	**1 mark each** **(any four)**

1	b)	**Attempt any ONE of the following**	**06**
	i)	**Describe construction and working of TBI system with suitable sketch.**	**06**
		Construction and working of TBI system: Throttle Body Injection is an electronically controlled injection system in which an electronic fuel injector injects the fuel intermittently in to the intake manifold at a central point ahead of the throttle valve. The central- injection unit operates at low pressure (0.7 to 1 bar) so, an inexpensive hydrodynamic electric fuel pump can be used (generally in the form an in-tank unit). The injector is flushed continuously by the fuel flowing through it in order to prevent the formation of air bubbles. The injector is a solenoid – controlled valve. The central injection unit uses the throttle valve to meter the intake air while injecting the fuel intermittently above the throttle valve. The intake manifold then distributes the fuel to the individual cylinders. Various sensors monitor all important engine-operating data, which are then used to calculate the triggering signals for the injectors and other system actuators.  **OR**  *Fig. Throttle Body Injection (Single Point)*	**03** **03**
	ii)	**Draw a labelled block diagram of CRDI system**	**06**
			06



2		**Attempt any FOUR of the following**	**16**
	a)	**Explain the phenomenon of diesel knocking with the help of P-Ø diagram.**	**04**
		 **Fig. P-Ø diagram**	**02**
		Explanation- The knock phenomenon of C.I. engine depends upon delay period. If delay period is small then less amount of fuel is admitted into cylinder.	
		When small amount of fuel is burns then there is smooth pressure rise, so there is no knocking. If the delay period is very long, then more amount of fuel is accumulated in the combustion chamber. When it actually burns, sudden pressure rise will cause the cylinder wall to vibrate, thus it produces noise and this is said to be knocking.	**02**
		Knocking occurs near the beginning of combustion. i.e. at the end of first stage of	

combustion.

Knocking in C I engine is of imperfectly mixed charged and hence the rate of pressure rise is normally lower than that in the detonation in S I Engine. Fuel is injected into the cylinder only at the end of the compression stroke and there is no question of pre-ignition or premature ignition. Knocking is not easy to distinguish from normal combustion. Diesel knock is reduced with increase in size of cylinder. In C.I. engines, higher compression ratio causes lesser ignition delay and hence lesser possibility of diesel knocks.

b) Compare carbureted engine fuel supply system with MPFI system. **04**

Answer: (Any four points –04 marks) **04 (Any four points)**

Sr.No.	Carbureted fuel supply system	MPFI fuel supply system
1	Mal-distribution of charge.	Uniform distribution of charge.
2	Due to resistance in intake manifold volumetric efficiency is lower.	Improvement in volumetric efficiency due to less resistance in the intake manifold.
3	Inaccurate metering of charge.	Accurate metering of charge.
4	Carburetor Icing may take place.	Formation of ice on the throttle plate is eliminated.
5	Fuel atomization depends upon velocity of air in the venture.	Atomization of fuel is independent of cranking speed therefore cranking is easier
6	Less atomization and vaporization will make the engine more knock prone.	Better atomization and vaporization will make the engine less knock prone.
7	Fuel need to be more volatile	Less volatile fuel can be used.
8	Fuel injection is take place inside the manifold.	fuel being injected into or close to the cylinder.

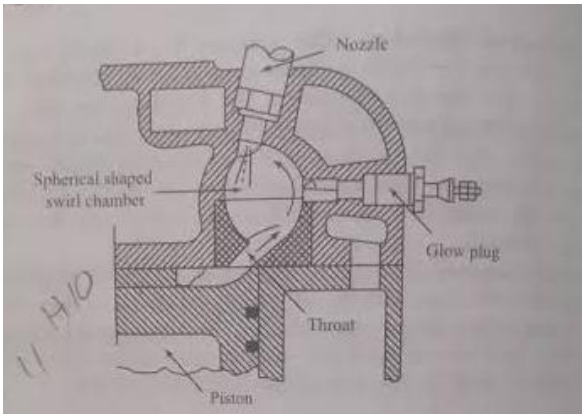
c) Describe any four variable affection detonations. **04**

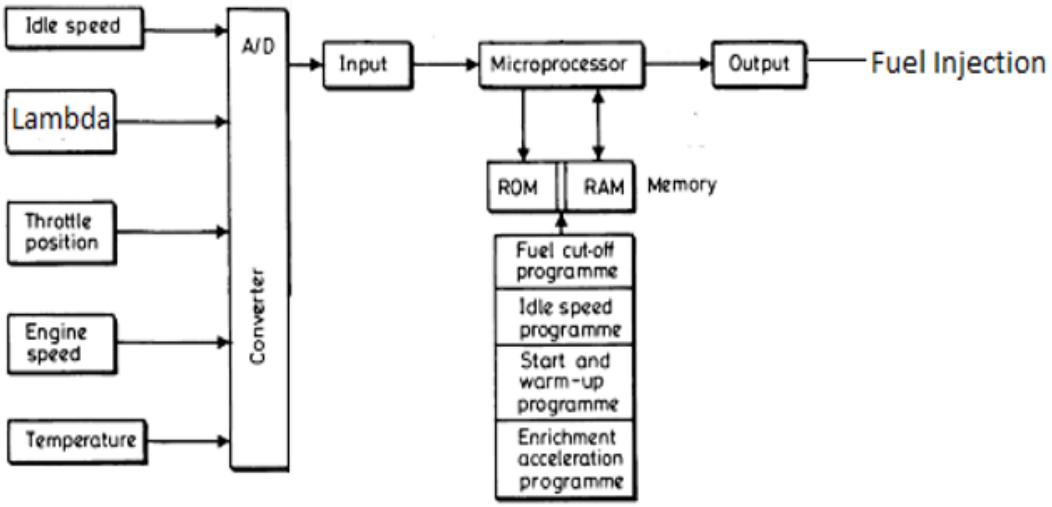
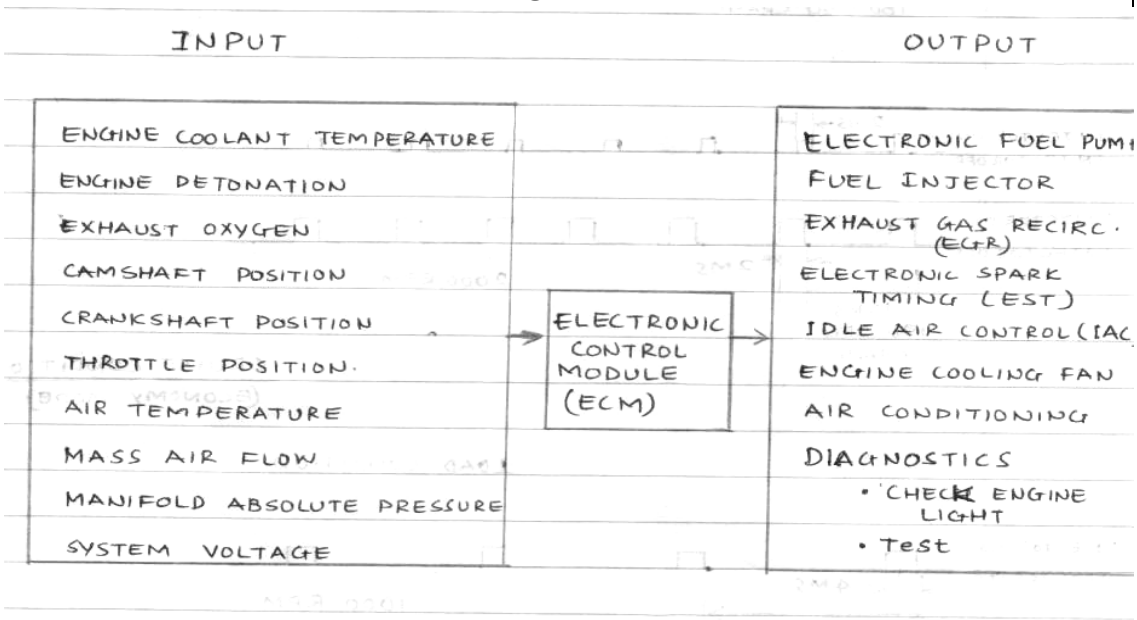
Variable affecting detonations. **01**

1. Temperature : Increasing the temperature of the unburned mixture increase the possibility of knock in the SI engine following are the effect on SI engine parameters on the temperature of the unburned mixture:

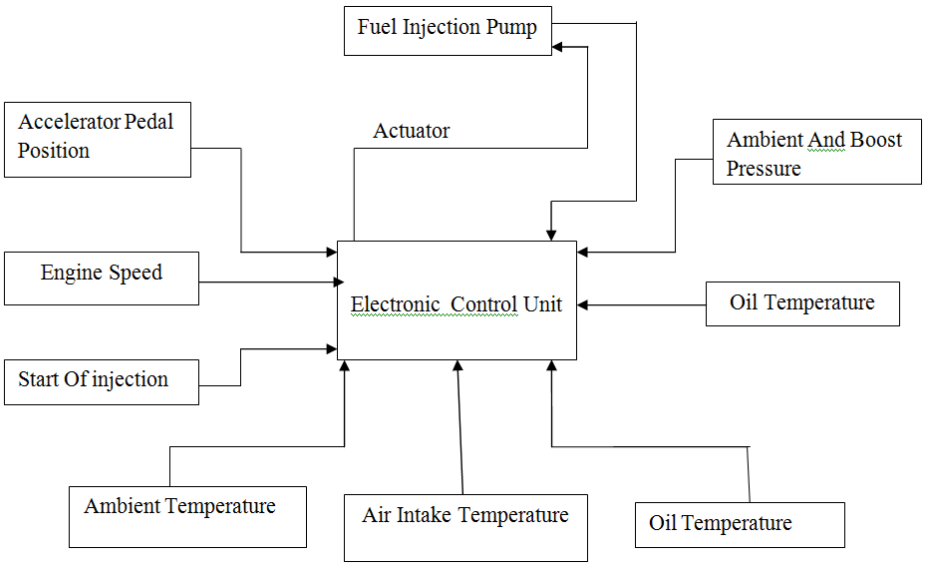
1. Increasing the compression ratio increases both the temperature and pressure.
2. Supercharging. Also increase both temperature and density, which increase the

		knocking tendency of engine. 3. Delay period decreases with increase of coolant temperature, decreased delay period increase the tendency to knock. **2. Density** : Increasing the density of unburnt mixture will increase the possibility of knock in the Engine. The engine parameters which affect the density are as follows: Increased compression ratio increase the density. Increasing the load opens the throttle valve more and thus the density. Supercharging increase the density of the mixture. Increasing the inlet pressure increases the overall pressure during the cycle. The high pressure end gas decreases the delay period which increase the tendency of knocking. Advanced spark timing: quantity of fuel burnt per cycle before and after TDC position depends on spark timing. The temperature of charge increases by increasing the spark advance and it increases with rate of burning and does not allow sufficient time to the end mixture to dissipate the heat and increase the knocking tendency **3. Time:** Increasing the time of exposure of the unburned mixture to auto-ignition conditions increase the possibility of knock in SI engines. Flame travel distance: If the distance of flame travel is more, then possibility of knocking is also more. This problem can be solved by combustion chamber design, spark plug location and engine size. Compact combustion chamber will have better anti-knock characteristics, since the flame travel and combustion time will be shorter. Further, if the combustion chamber is highly turbulent, the combustion rate is high and consequently combustion time is further reduced; this further reduces the tendency to knock. Location of sparkplug. A spark plug which is centrally located in the combustion chamber has minimum tendency to knock as the flame travel is minimum. The flame travel can be reduced by using two or more spark plugs. Location of exhaust valve. The exhaust valve should be located close to the spark plug so that it is not in the end gas region; otherwise there will be a tendency to knock. **4. Composition:** Molecular structure: Increasing the carbon-chain increases the knocking tendency and centralizing the carbon atoms decreases the knocking tendency. Unsaturated hydrocarbons have less knocking tendency than saturated hydrocarbons. Air-fuel mixture: A too rich mixture is especially effective in decreasing or eliminating the knock due to longer delay and lower temperature of compression. Humidity of air: Increasing atmospheric humidity decreases the tendency to knock by decreasing the reaction time of the fuel.	**01** **01** **01**
	d)	**Define ignition lag. State factors affecting ignition lag.**	**04**
		Ignition lag: The time elapsed between the fuel injection into the combustion chamber and starting of combustion. It is a chemical process in which the growth and development of a self-propagating nucleus of flame is produced. **Factor affecting the ignition lag**: 1) Self-Ignition Temperature of the fuel 2) Injection timing 3) Compression ratio 4) Engine speed 5) Air fuel ratio 6) Initial Temperature and pressure. 7) Presence of residual gases.	**02** **02**

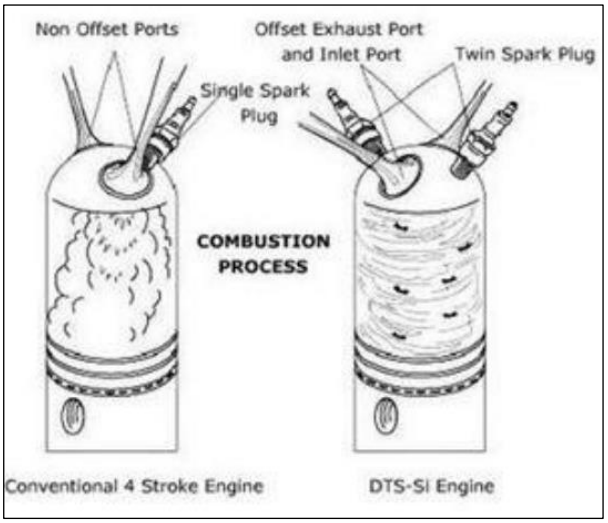
		8) Engine size	
	e)	**State four advantages of I head combustion chamber.**	**04**
		Answer: (Any four Advantages) **Advantages of I-Head combustion chamber**: 1. Lower pumping losses and higher volumetric efficiency. 2. Lesser distance of flame travel therefore low octane requirement. 3. More uniform cooling of cylinder and piston. 4. Lower surface to volume ratio and therefore less heat loss. 5. Easier to cast and hence lower casting cost.	**04**
	f)	**Draw neat sketch of swirl type combustion chamber of IDI engine.**	**04**
		(Relevant figure should be given appropriate marks)  **Fig. swirl type combustion chamber of IDI engine.**	**04**
3		**Attempt any FOUR of the following:**	**16**
	a)	**Write function of canister purge control and idle speed control in S.I. engine.**	**04**
	Ans.	**Function of canister purge control –** 1. The purge valve is the part of the vehicle Evaporative Emission Control (EVAP) system. 2. The EVAP system prevents fuel vapors in the fuel tank from escaping into the atmosphere. 3. The EVAP system traps fuel vapors from the fuel tank and temporarily stores them in the charcoal canister. **Function of idle speed control-** The idle speed control is used to prevent engine stall during idle and to allow the engine	**02** **02**

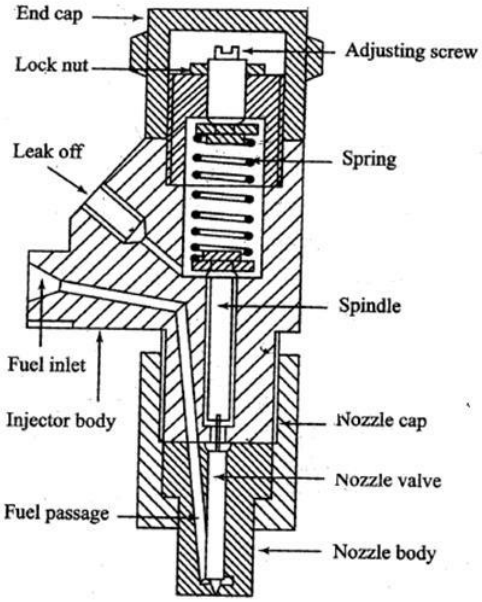
		to run at low RPM.	
	b)	**Draw a neat block diagram indicating the inputs and outputs of ECM.**	**04**
	Ans.	 ECM Block diagram and fuel injection control function **OR**  **Fig. Input and Output of ECU**	**04**
	c)	**List three method of fuel injection. Describe any one.**	**04**
	Ans.	**Answer: (List-02 marks and description of any one – 02 marks)** **Methods of fuel injection:** 1. Sequential fuel injection. (SFI) 2. Grouped fuel injection.	**02**

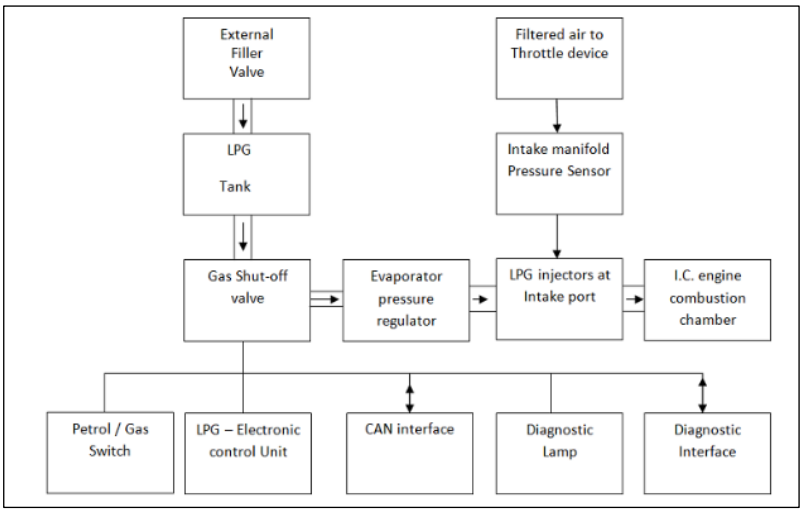
		3. Simultaneous fuel injection. 4. Continuous injection. **1) Simultaneous Injection:** Injection of fuel occurs at the same time for all cylinders every revolution of the crankshaft. Therefore, fuel is injected twice within each four-stroke cycle. The injection timing is fixed with respect to crank/ cam shaft position**.** **2) Group Injection:** The injectors are divided into two groups that are controlled separately. Each group injects once per four-stroke cycle. The offset between the groups is one crankshaft revolution. This arrangement allows. **3) Sequential Injection:** Each injector is controlled separately. Injection timing, both with reference to crank/ camshaft position and pulse width, can be optimized for each individual cylinder. **4) Continuous injection:-**This system usually has a rotary pump. The pump maintains a fuel line gauge pressure of about 0.75 to 1.5 bar. The system injects the fuel through a nozzle located in manifold immediately downstream of the throttle plate. In supercharged engine, fuel is injected at the entrance of the supercharger. The timing and duration of the fuel injection is determined by ECU depending upon load and speed.	**02**
	d)	**Describe glow plug. Why and where it is used.**	**04**
	Ans.	**Glow Plug:** Some diesel engines use an electric heater called glow plug inside the cylinders to heat the intake air and help ignite fuel: air mixture. Glow plug is an aid for cold starting of a C.I. engine. Modern glow plugs heat to required temp in just 4 seconds. **Purpose of using a Glow Plug:** The self-ignition temperature of diesel is @ 200°C. For compression ignition, the charge (air + diesel) should reach a temperature of about 550°C. Cold weather conditions make it difficult to happen. So, a glow plug is used in C.I. Engines. The glow plug heats to starting temperature (approx. 850°C) as rapidly as possible. **Location of Glow Plug:** In Pre-chamber engine, glow plugs are installed which extend into the secondary chamber. On D.I engines, the glow element extends into the main combustion chamber.	**02** **01** **01**
	e)	**Explain the working of high pressure accumulator in CRDI system.**	**04**
	Ans.	**(Relevant answer should be given appropriate marks)** • In common rail systems, a high-pressure pump stores a reservoir of fuel at high pressure — up to and above 2,000 bars (psi). • The term "common rail" refers to the fact that all of the fuel injectors are supplied by a common fuel rail which is nothing more than a pressure accumulator where the fuel is stored at high pressure. • This accumulator supplies multiple fuel injectors with high-pressure fuel. This simplifies the purpose of the high-pressure pump in that it only has to maintain a commanded pressure at a target (either mechanically or electronically controlled).	

		• Since the fuel pressure energy is stored remotely and the injectors are electrically actuated, the injection pressure at the start and end of injection is very near the pressure in the accumulator (rail), thus producing a square injection rate. • If the accumulator, pump and plumbing are sized properly, the injection pressure and rate will be the same for each of the multiple injections. This accumulator supplies multiple fuel injectors with high-pressure fuel. • This simplifies the purpose of the high-pressure pump in that it only has to maintain a commanded pressure at a target (either mechanically or electronically controlled).	**04**
	f)	**Describe the working of electronically controlled diesel injection pump.**	**04**
	Ans.	**Answer: Electronically controlled diesel injection pump:** This is similar to conventional pumps, but its injection is controlled by Electronic Control Unit (ECU) which control solenoid valve in the injection pump**.** The pump speed and timing sensor is mounted on the end of the pump camshaft. The ECU receives signals like accelerator pedal position, engine and road speeds, gear selected, start of injection, control rod position, induction manifold, and fuel temperatures etc. Generally ECU output is the current to the solenoid valve for actuating the pump control rod, and to the injection advance and retard mechanism. Based on these data, the ECU accordingly modifies the current to the solenoid valve, to supply fuel as per requirement.  	**02** **02**
4	**(a)**	**Attempt any THREE of the following**	**12**
	i)	**Describe four properties of gasoline as a fuel for SI engine**	**04**
	Ans	**(Relevant answer should be given appropriate marks)** **Volatility:** volatility depend upon fractinal composition of fuel. Method of measuring volatility has been standardized by ASTM (American society of Testing Materials) and	

		the graohical representation of the result is generally referred as ASTM distillation curve. **Vapour Lock characteristics:** High rate of evaporation may cause vapour lock and stop fuel supply. It must be compromise between contradictory requirements. **Octane Rating:** The octane rating of a specific gasoline is measured by using it in a single-cylinder test engine with a variable compression ratio and adjusting the ratio to produce a standard knock intensity as recorded by an instrument known as a knock-meter. By comparison to tabulated results from similar testing of various mixtures ofiso-octane and n-heptane at the same compression ratio, the octane rating of the gasoline is determined. **Vapor pressure:** The vapor pressure of a gasoline is a measure of its propensity to evaporate (i.e., its volatility) and high vapor pressures result in high evaporative emissions of smog-forming hydrocarbons which are undesirable from the environmental viewpoint **Sulfur content :**When gasoline is combusted, any sulfur compounds in the gasoline are converted into gaseous sulfur dioxide emissions which are undesirable from the environmental viewpoint. Some of the sulfur dioxide also combines with the water vapor formed when gasoline combusts and the result is the formation of an acidic, corrosive gas that can damage the engine and its exhaust system. **Storage stability:** Gasoline stored in fuel tanks and other containers will, in time, undergo oxidative degradation and form sticky resins referred to as gums. Such gums can precipitate out of the gasoline and cause fouling of the various components of internal combustion engines which reduces the performance of the engines and also makes it harder to start them. Relatively small amounts of various anti-oxidation additives are included in end-product gasoline to improve the gasoline stability during storage by inhibiting the formation of gums.	**04**
	ii)	**LPG is used as an alternative fuel for SI engine. Justify your answer**	**04**
	Ans	LPG is used as an alternative fuel for SI engine because of following advantages. 1. The exceptional advantages of LPG as an alternative engine fuel have been mainly from the simplicity of its production. 2. It is cheaper than petrol 3. It is highly detonation resistant and does not pre-ignite easily. 4. It gives better manifold distribution and mixes easily with air. 5. Crankcase oil dilution is less/ nil, resulting in increased engine life. 6. Residue and oil contamination is small as it burns cleanly: implies longer lubricating oil change period. 7. LPG is lead free – implies- less exhaust emission. 8. Life of spark plug is increased. 9. Fuel supply system can be easily modified by introducing a conversion kit.	**04**
	iii)	**State four environmental benefits of biodiesel in comparison to petroleum based fuels.**	**04**
	Ans	**Environmental benefits of biodiesel in comparison to petroleum based fuels *(Any 4- 1 mark each)***	**04**

		i) It is a renewable substitute fuel for petroleum diesel. ii) It has lower exhaust emissions iii) It is biodegradable fuel iv) It is non-toxic. v) It is free of sulphur and aromatics. vi) It is an environmentally friendly fuel that can be used in any diesel engine without modification.	
	iv)	**Describe DTSI system. Write two advantage of it.**	**04**
	Ans	***Explanation – 2 marks, Advantages – 02 marks*** **)** **DTSI** technology provides a combination of the light weight and twice the power offered by two-stroke engines with a significant power boost, i.e. a considerably high "power-to-weight ratio" compared to quite a few four-stroke engines. Moreover, such a system can adjust idling speed & even cuts off fuel feed when the accelerator is released, and provides enrichment of the air-fuel mixture for cold starting and acceleration; if necessary; it also prevents the upper rev. limit from being exceeded. At higher speeds the over boost will enhance full power delivery and will stay on as long as the driver exercises acceleration. A microprocessor continuously senses engine speed and load, then it respond by altering the ignition timing. It optimizes power and fuel economy.  **Benefits of DTSI system over conventional Ignition system are as follows. (Any two)** 1. Optimized power. 2. Reduced emission level. 3. Less vibrations and noise. 4. Long life of the engine parts such as piston rings and valve stem. 5. Decrease in the specific fuel consumption. i.e. better fuel economy. 6. No overheating. 7. Increased Thermal Efficiency of the Engine & even withstands high load. 8. Better starting of engine even in winter season & cold climatic conditions or at very	**02** **02**

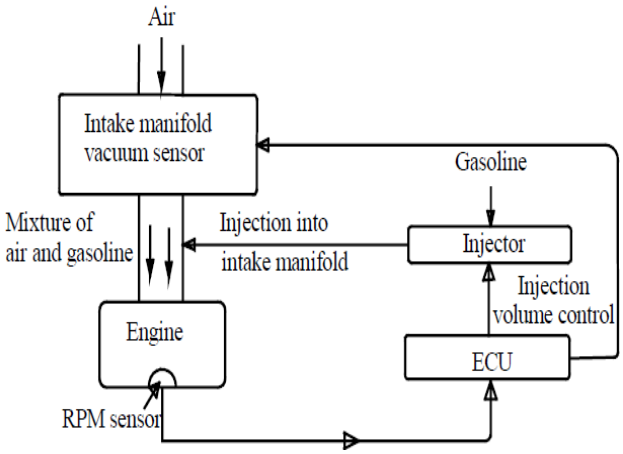
		low temperatures because of increased Compression ratio	
4	**(b)**	**Attempt any one of the following**	**06**
	i)	**Describe the working of fuel injector with neat sketch**	**06**
	Ans	**Answer:** *(Diagram-2 marks, explanation-2 marks)*  Figure: Diesel Fuel Injector **Fuel Injector:** The injector 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.	**03** **03**
	ii)	**Draw a labeled block of LPG conversion kit. Describe its working.**	**06**
	Ans	(Credit should be given to equivalent explanation & Figure) The LPG conversion kit contains a duel fuel conversion system which comes with the following components – 1. Tank, which contains the highly pressurized LPG in liquid form, comes in capacities of 30 to 100 ltrs. 2. The multivalve which controls and checks the filling of the tank comes with a 80% stop-fill safety feature. That's means the valve closes not allowing further filling when 80% of the tank is filled. 3. A device which automatically shuts of the tank and the fuel supply in the event of a ruptured line.	**03**

		4.LPG solenoid valve 5.Gasoline solenoid valve 6.Electronic control module which controls of the flow of LPG in fuel injection systems 7.LPG / Petrol switch, which enables the driver to choose which fuel he wishes to use 8.Pressure regulator Mixer / gas injection which flows the LPG into the combustion chamber  	**03**
5		**Attempt any TWO of the following**	**16**
	a)	**How the following factor will affect the delay period in C.I. engine.** **(i) Ignition quality of fuel** **(ii) Injection timing** **(iii) Compression ratio** **(iv) Engine speed** **(v) Air fuel ratio** **(vi) Load** **(vii) Engine size chamber** **(viii) Type of combustion**	**08**
	Ans	**factors affecting delay period:-**	**1 mark each**

Sr. No	Parameter	Effect on the Delay Period in C.I. Engine
i	Ignition quality of fuel	A lower self ignition temperature means a lower delay period.
ii	Injection timing	Delay period increases with increase in injection advance angle.
iii	Compression ratio	Increased Compression Ratio reduces delay period and vice versa.
iv	Engine speed	As engine speed increases, delay period decreases.
v	Air fuel ratio	As air: fuel ratio decreases, delay period decreases.
vi	Load	Delay period increases with load.
vii	Engine size	Large engines operate at low speed thus increasing delay period in terms of crank angle
viii	Type of combustion chamber	A pre-combustion chamber gives a shorter delay period as compared to an open type of combustion chamber.

b) Describe the construction and working of D-MPFI and L-MPFI with help of neat sketch. **08**

Answer: D-LMFI System: It is Manifold fuel injection system.In this type, the vacuum in the intake manifold and volume of air by its density are sensed in this type of MPFI system .As air enters into intake manifold the manifold pressure is sensor detects the intake manifold vacuum and sends the information to the ECU. **02**



D-MPFI System **02**

L-MPFI System: The L-MPFI System is a Port injection system. In this system fuel metering is regulated by the engine speed and amount of air that actually enters in the engine. This is called air-mass metering of air flow metering. As air enters into the intake manifold , the air flow sensor measures the amount of air and sends information to ECU. **02**

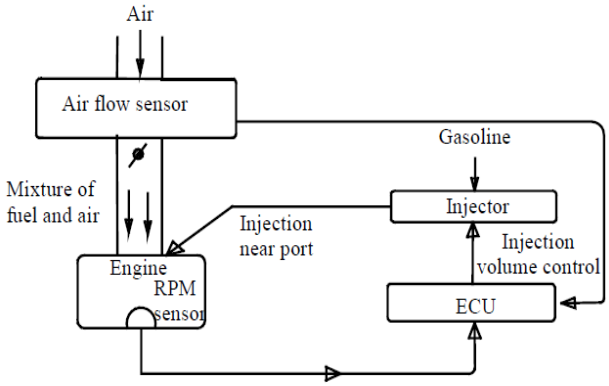


Fig. L-MPFI System — **02**

c) Describe with neat sketch operation of PCV valve under different engine operating condition to control/ emission — **08**

Ans

Answer: ***(Description of each condition 1 mark , Figure: 1 mark for each case)***

PCV Valve: It consists of a spring loaded tapered valve for flow control. The crankcase pressure and manifold vacuum act together to close the valve whereas the spring pressure tends to keep it open.(Fig a)

1. **At idle and low speed**: At idle and low speed, crank case emissions are very less due to lower cylinder pressure and manifold vacuum is high. Therefore only a small flow through PCV would be sufficient to keep the crank case clean. High manifold vacuum at idle and low speed would pull the valve to right to maintain the small flow.(Fig b)
2. **At normal Speed:** Blow by increases and manifold vacuum decreases due to which valve moves to left increasing the flow
3. **At high speed or Heavy loads:** No manifold vacuum acting on the valve, valve opens to maximum, increasing the flow to maximum capacity. (Fig c)
4. **In case of backfire:** During cranking, high pressure will be produced in to the intake manifold which causes valve to back seat sealing the inlet and crankcase is protected from the back fire.

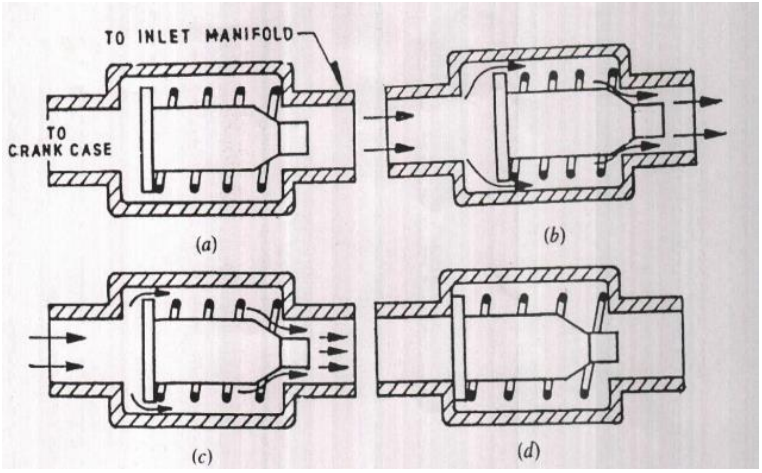
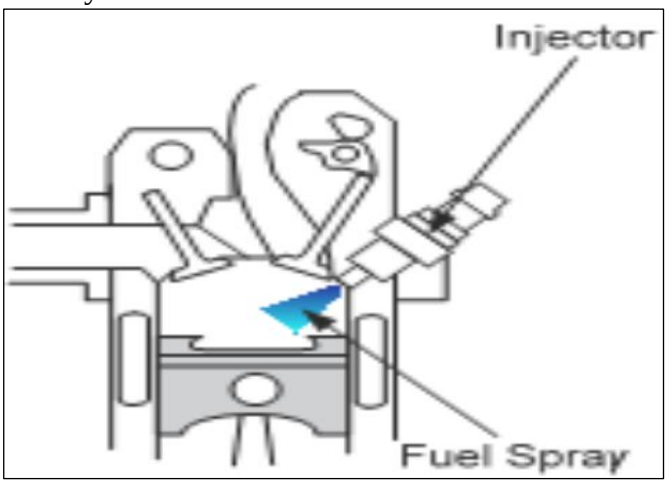
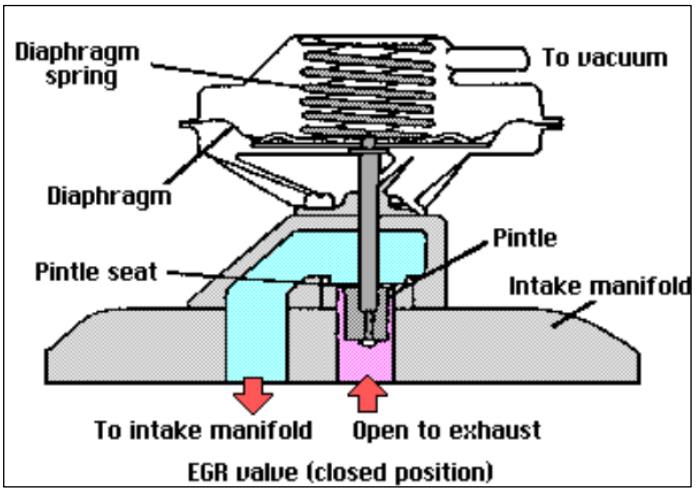
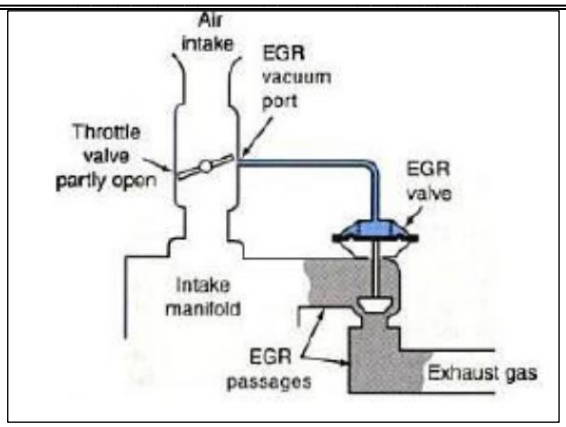


Figure : (a) PCV valve construction (b)Operation at idle and low speed
(c)High speed/Load operation (d)Preventing backfire during cranking

08

6		**Attempt any FOUR of the following**	**16**
	a)	**Describe the concept of Gasoline Direct Injection (GDI)**	**04**
	Ans.	**Gasoline Direct Injection (GDI)**, also known as Petrol Direct Injection. This system is employed in modern two-stroke and four-stroke gasoline engines. The gasoline is highly pressurized, and injected via a common rail fuel line directly into the combustion chamber of each cylinder, Directly injecting fuel into the combustion chamber requires high pressure injection. The GDI engines operate on full air intake; there is no air throttle plate. Engine speed is controlled by the engine control unit. In this only the combustion air flows through open intake valve on the induction stroke. The engine management system continually chooses among three combustion modes: ultra-lean burn, stoichiometric, and full power output. Each mode is characterized by the air-fuel ratio. The stoichiometric air-fuel ratio for gasoline is 14.7:1 by weight, but ultra-lean mode can involve ratios as high as 65:1 (or even higher in some engines, for very limited periods).These mixtures are much leaner than in a conventional engine and reduce fuel consumption considerably.  Fig. GDI	**02** **02**
	b)	**Write advantage of VGT over conventional turbocharger.**	**04**
	Ans	**Answer:** *(For each benefit 1 mark)* **Advantages:** 1. VGT is very effective for improving combustion efficiency. 2. Exhaust smoke decreases and BSFC is improved by about 3 to 10 percent at low engine speed region of 1000 to 1500 rpm. 3. With the VGT it is possible to raise the boost pressure(intake pressure) 4. Higher air fuel ration and high peak torque at low engine speed. 5. Improved engine vehicle acceleration 6. Ability to raise exhaust temperature for after-treatment system management. **OR** 1. Reduced turbo- lag time. 2. Increased efficiency of engine/ lower fuel consumption. 3. Higher rated power output. 4. Enhanced low speed power. 5. Lower engine emissions. 6. Power output of VGT is higher even at lower speed than conventional turbocharger.	**04**

	c)	**Describe the working of EGR valve with neat sketch.**	**04**
	Ans	**Answer: Exhaust Gas Recirculation Valve** *(Operation-2 marks, Sketch-2 marks)* When the engine is idling, the EGR valve is closed and there is no EGR flow into the manifold. The EGR valve remains closed until the engine is warm and is operating under load. As the load increases and combustion temperatures start to rise, the EGR valve opens and starts to leak exhaust back into the intake manifold. This has a quenching effect that lowers combustion temperatures and reduces the formation of NOx.  EGR valve (closed position) OR **Exhaust Gas Recirculation Valve** The EGR system is used to reduce the amount of NOx in the exhaust. Nox production increases as the temperature inside the combustion chamber rises due to acceleration or heavy engine loads, because high temperature encourages the nitrogen and oxygen in air to combine. Therefore, the best way to decrease the production of Nox is to hold down the temperature in the combustion chamber. The EGR system re-circulates exhaust gases through the intake manifold in order to reduce the temperature at which combustion takes place. When the air: fuel mixture & exhaust gases are mixed together, the proportion of fuel in the air: fuel mixture naturally falls (mixture becomes leaner), & in addition, some of the heat produced by combustion of this mixture is carried away by the exhaust gas. The maximum temperature attained in the combustion chamber therefore falls, reducing the amount of Nox produced. The EGR system allows a small amount of exhaust gas (less than 10% of total) to be supplied into the incoming air: fuel mixture	**02** **02**



d) State Bharat stage IV norms for cars in India. **04**

Ans

Answer:

(Bharat Stage Norms): Passenger Cars in India

•Norms	CO (g/km)	HC+ NOx (g/km)	RSPM	Sulphur in Diesel
•EURO IV or BS IV	1	0.18 (Combined)	0.025	50 PPM

RSPM- (Respirable Suspended Particulate Matter) **04**

e) List four methods to improve fuel economy. **04**

Ans

Answer: Methods of improving fuel economy. *(Any Four)*

1) Use of multi-functional fuel additives will provide 3 to 4% fuel economy.
2) Good driving habits.
3) Properly maintained fuel supply system.
4) Use of computer controlled fuel injection system.
5) Use of computer controlled ignition system.
6) Use of higher voltage automotive electrical system (42 volts system). **04**