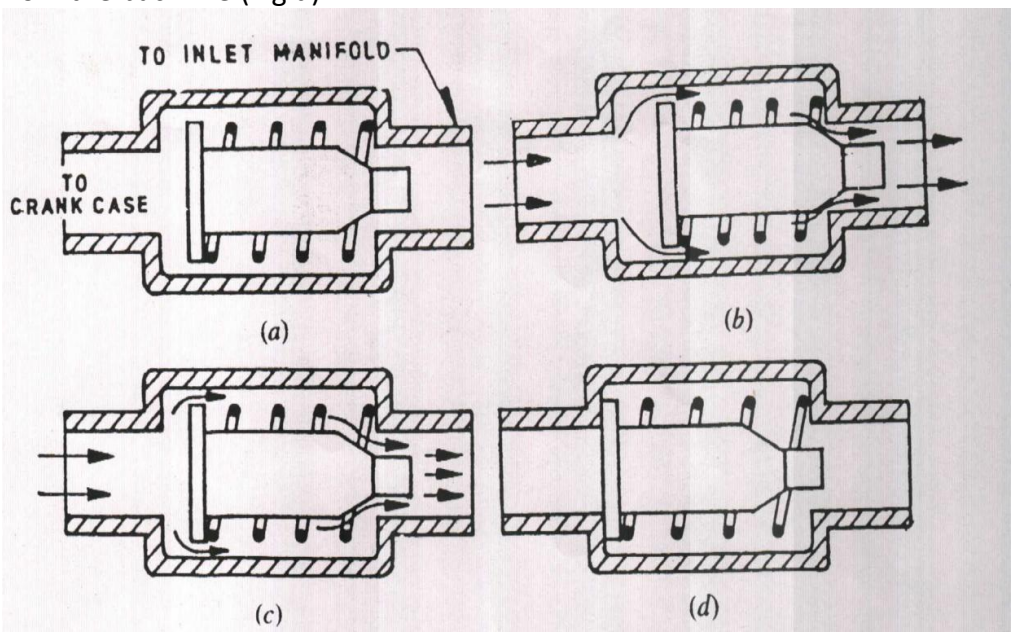
MODEL ANSWER
Summer – 17 EXAMINATION

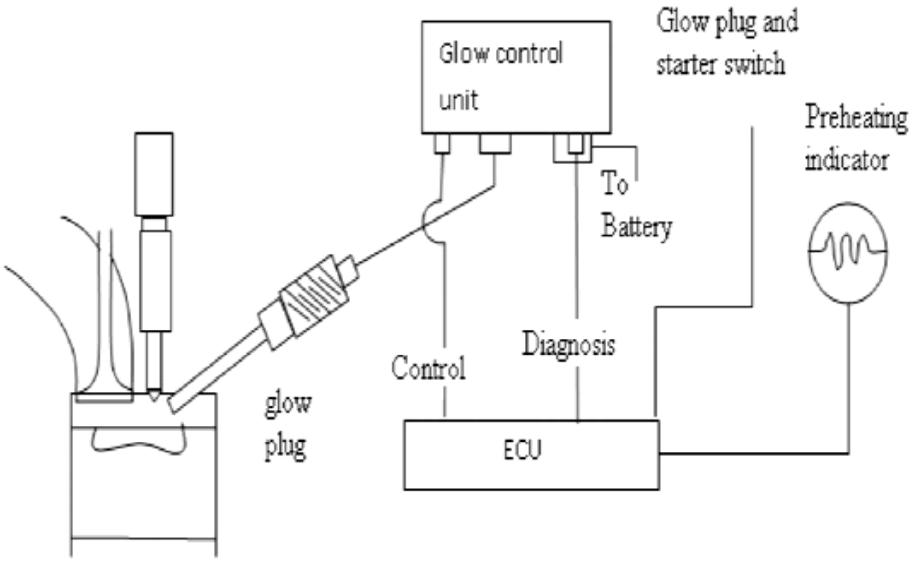
Subject Title: Advanced Automobile Engines Subject Code: 17523

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 judgment 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.

Que. No.	Sub Que.	Answer	Marking Scheme
1	A)	**Attempt any THREE of the following:**	12
	a)	**Explain features of CRDI system.**	4
		Answer: (*Any Four*) 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.	

	b)	**State how air-fuel ratio in diesel engine varies from no load to full load.**	**4**
		Answer: *(Credit should be given to an equivalent answer)* Irrespective of load at any given speed, an approximately constant supply of air enters the cylinder. With change in load, the quantity of fuel injected is changed varying the air fuel ratio. The overall air fuel ratio thus varies from about 18:1 at full load to about 80:1 at no load. The diesel engine always designed to operate with an excess air of 15 to 40% depending upon the application.	**4**
	c)	**Define detonation and surface ignition**	**4**
		Answer: **1) Detonation** Detonation is auto-ignition of last part of homogeneous charge occurring near the end of combustion, before the flame front reaches it. In auto- ignition, the burning is almost instantaneous which results in extremely rapid release of energy causing pressure of the end gas to rise almost 3 to 4 times , from about 50 bar to 150 -200 bar. This large pressure differential gives rise to a severe pressure wave which strikes the cylinder wall and sets it vibrating, giving rise to a characteristic high pitched metallic ringing sound as if stroke struck by light hammer. **2) 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.	**2** **2**
	d)	**Write the functions of actuators (any four)**	**4**
		Answer: *(1 mark for each)* 1. An actuator is a component of an engine that is responsible for moving or controlling parts of an engine. 2. An actuator requires a control signal and a source of energy. The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power. 3. When the control signal is received, the actuator responds by converting the energy into mechanical motion. 4. An actuator is the mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based a human, or any other input. 5. An electric actuator is powered by a motor that converts electrical energy into mechanical torque. 6. A hydraulic actuator consists of cylinder or fluid motor that uses hydraulic power to facilitate mechanical operation. 7. A mechanical actuator functions to execute movement by converting one kind of	**4**

		motion, such as rotary motion, into another kind, such as linear motion	
	B)	**Attempt any ONE of the following:**	**06**
	a)	**With neat labeled figure, explain the working of any two position of PCV (positive crank case ventilation) valve.**	**6**
		Answer: *(Description of any two position 2 mark each, 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 where as the spring pressure tends to keep it open.(Fig a) **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) **At normal Speed:** Blow by increases and manifold vacuum decreases due to which valve moves to left increasing the flow **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) **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.(Fig d).  **Figure : (a) PCV valve construction (b)Operation at idle and low speed (c)High speed/Load operation (d)Preventing backfire during cranking**	
	b)	**Explain the working glow plug circuit diagram with figure.**	**6**
		Operation of glow plug: Glow plug is an aid for cold starting of a C.I. engine. The self-ignition temperature of diesel is 250°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 Compression Ignition Engines. The glow plug heats to starting temperature (approx. 850°C) as rapidly as possible. **Operation of Glow Plug Circuit:** On modern vehicles, engine's central ECU controls-high electrical glow-plug current, indicator lamp, Safety override and automatic switching off the Glow- plugs. An ignition starter lock controls the current supply for the glow system. As the switch is actuated a relay connects the glow plug to the battery circuit, and the Indicator lamp comes on. When the lamp goes out turning the switch further to the starting position brings the engine to life. As long as the starter switch is held in the glow position, a holding circuit assures that the glow- plugs remain on. Then after starting, when the ignition switch is released, they are automatically switched off. A safety circuit prevents running the battery down if the engine fails to start immediately. After a maximum of 90 seconds glow time, current to the glow plugs is automatically interrupted. But starting may be attempted again as soon as the driver wishes.  **Fig: ECU controlled Glow plug System.**	**3** **3**
2		**Attempt any FOUR of the following**	**16**
	a)	**Explain the construction and working of pressure regulator.**	**4**
		Answer: *(Construction & working 2 marks, sketch 2 marks)* **Construction:** It consist of pressure spring which act as a restricting element , diaphragm and ball valve act as a loading elements .fuel inlet, return line ,vacuum hose connected to inlet	**2**

manifolds .

Working :

The fuel pump provides more fuel than the maximum required by the engine. Fuel not used by the engine is returned to the fuel tank. The fuel rail supplies all injectors. The pressure regulator keeps the pressure drop across the injector fuel line and the intake manifold as constant. It contains a diaphragm that has intake manifold pressure on one side and fuel rail pressure on the other. Normally, it is mounted at the outlet end of the fuel rail. The diaphragm operated a valve which opens at a differential pressure between 2.0 and 3.5 bar and allows excess fuel to return to the fuel tank.

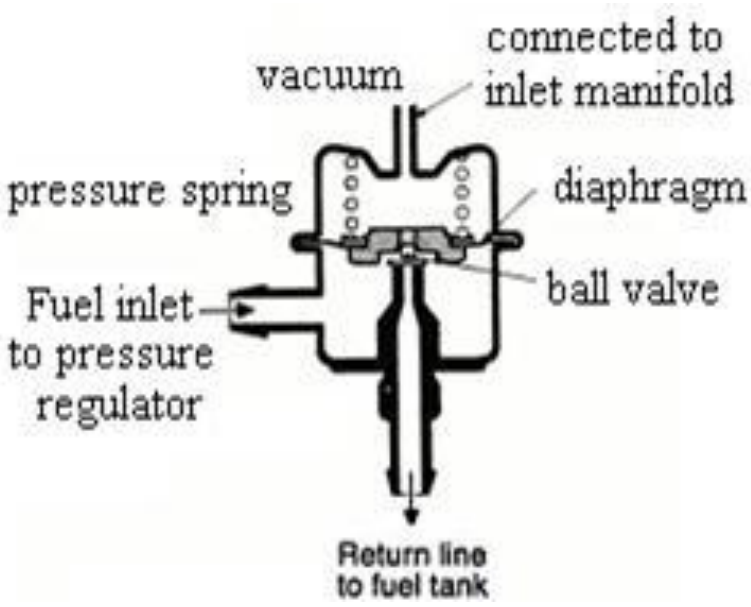


Fig.: Fuel Pressure Regulator

2

	b)	**Explain the following properties** **i) Pour point** **ii) Viscosity** **iii) Ignition quality** **iv) Fire point**	**4**
		Answer: *(each property:1 mark each)* i. **Pour point:** Pour point is the temperature below which the entire mass of fuel, solid or liquid together, freeze and thus cause flow of fuel impossible. Pour point is usually 5 to 10 °C below the cloud point. ii. **Viscosity:** Viscosity of a fuel is a measure of its resistance to flow. iii. **Ignition quality:** The ability of a fuel to ignite when it is injected into the compressed-air charge in a diesel cylinder. It is measured by an index called the cetane number **iv) Fire point:** Fire point is the temperature at which the flash will sustain itself as a steady flame for at least five seconds.	**4**
	c)	**What does VTEC stands for? State advantages of it.**	**4**
		Answer: VTEC stands for Variable valve timing and electronic lift control. In VTEC, the valve timing and the valve lift is controlled using ECU to provide efficient breathing of engine and efficient performance of engine. **Advantages:** *(Any Two-2 marks)* 1) Increased fuel efficiency and 2) High power output. 3) Emissions levels can also be more accurately controlled with the GDI system. 4) Improved Volumetric Efficiency 5) GDI allows a high compression ratio of 12, and thus improved combustion efficiency **6)** GDI is capable of using very lean mixture i.e. 65:1 while using VTEC Improve drivability	**2** **2**

	d)	**Explain the pollutants from gasoline engine**	**4**
		Answer: *(Any four)* 1. **Hydrocarbon (HC):-**They play an important role in forming NO_2 and O_3 which are health and environmental hazard. 2. **Carbon Monoxide (CO):** CO is a highly poisonous gas that can cause dizziness, headaches, impaired thinking, and death by02 starvation. It can affect the central nervous system, impairing physical coordination, vision and judgment, creating nausea and headaches, reducing worker productivity and increasing personal discomfort. 3. **Carbon dioxide:** CO_2 is a greenhouse gas and may be the major cause of global warming. 4. **Oxides of Nitrogen:** NO is unhealthy and contributes to the greenhouse effect, NO_2 is a very toxic gas and contributes to the formation of smog, ozone, and acid rain.	**4**
	e)	**Explain the working of series hybrid vehicle.**	**4**
		Answer: *(Working 2 marks, sketch 2marks)* **Series-Hybrid vehicle** In Series Hybrid vehicles, the Internal Combustion Engine (ICE) drives a generator, which charges the battery and supplies current to the electronically controlled motor. The electric motor propels the car. In this system, Internal Combustion Engine operates at constant speed with maximum efficiency, It causes low exhaust emissions. The vehicle is controlled electronically. The electric control simplifies the mechanical gears and the differential. Both Internal combustion engine and electric drive have to be rated to the maximum power. It has low overall system efficiency.	**2**

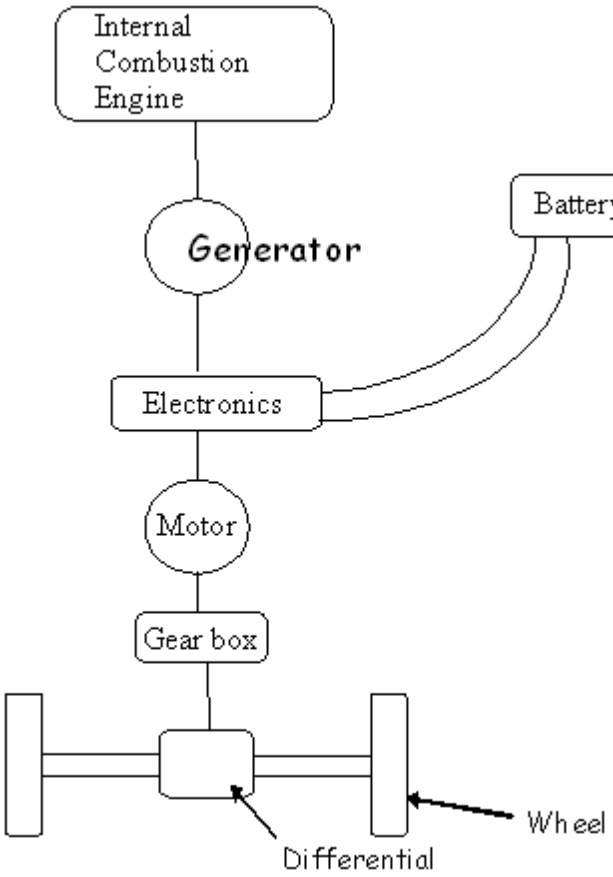


Fig. Series Hybrid Vehicle **2**

3		**Attempt any FOUR of the following:**	**16**
	a)	**Describe the concepts of Gasoline Direct Injection (GDI).**	**4**
		Answer: 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	**4**

fuel consumption considerably.

b) Compare throttle body injection with port fuel injection systems. **4**

Answer: (*Any four points, Each correct point 1 Mark*)

Sr. No.	TBI system	PFI System
1	Fuel is injected into the center of the throttle body.	Fuel is injected into the port
2	TBI uses bottom feed injector	PFI uses top feed injector
3	Fuel injector needs to be flushed continuously- to prevent formation of air bubble.	Fuel injector need not be flushed
4	1 or 2 Fuel injectors are used	Fuel injectors are equal to the number of cylinders
5	TBI is comparatively low pressure injection (differential pressure = 0.7 to 1 bar)	PFI is comparatively high pressure injection (differential pressure = 2 to 3.5bar)
6	Cheaper fuel pump is sufficient to generate the required low pressure	Costly fuel pump is required to generate the required pressure
7	Mixture mal-distribution may occur	All cylinders receive equal quantity and quality of air: fuel mixture.
8	Less accurate fuel injection control gives moderate fuel economy	More accurate fuel injection control is obtained. Therefore increased fuel economy is obtained
9	This is a cheap system.	This is costly system.
10	Exhaust emission is above the permissible emission norms.	Very low exhaust emission is achieved to meet the strict emission norms.
11	Moderate throttle response as the fuel is injected at the throttle body and longer length of travel for fuel to enter the engine cylinder	Better throttle response as fuel is injected on hot back side of intake valve and shorter length of travel for fuel – to enter the engine cylinder
12	Lower power output due to lower volumetric efficiency caused by bulky injector body at the throttle body.	Hither power output due to low resistance at intake manifold and higher volumetric efficiency.

	c)	**Draw labeled block diagram showing EDC unit of CRDI system.**	**4**
		Answer: ***(Credit should be given to an equivalent sketch)***	**4**

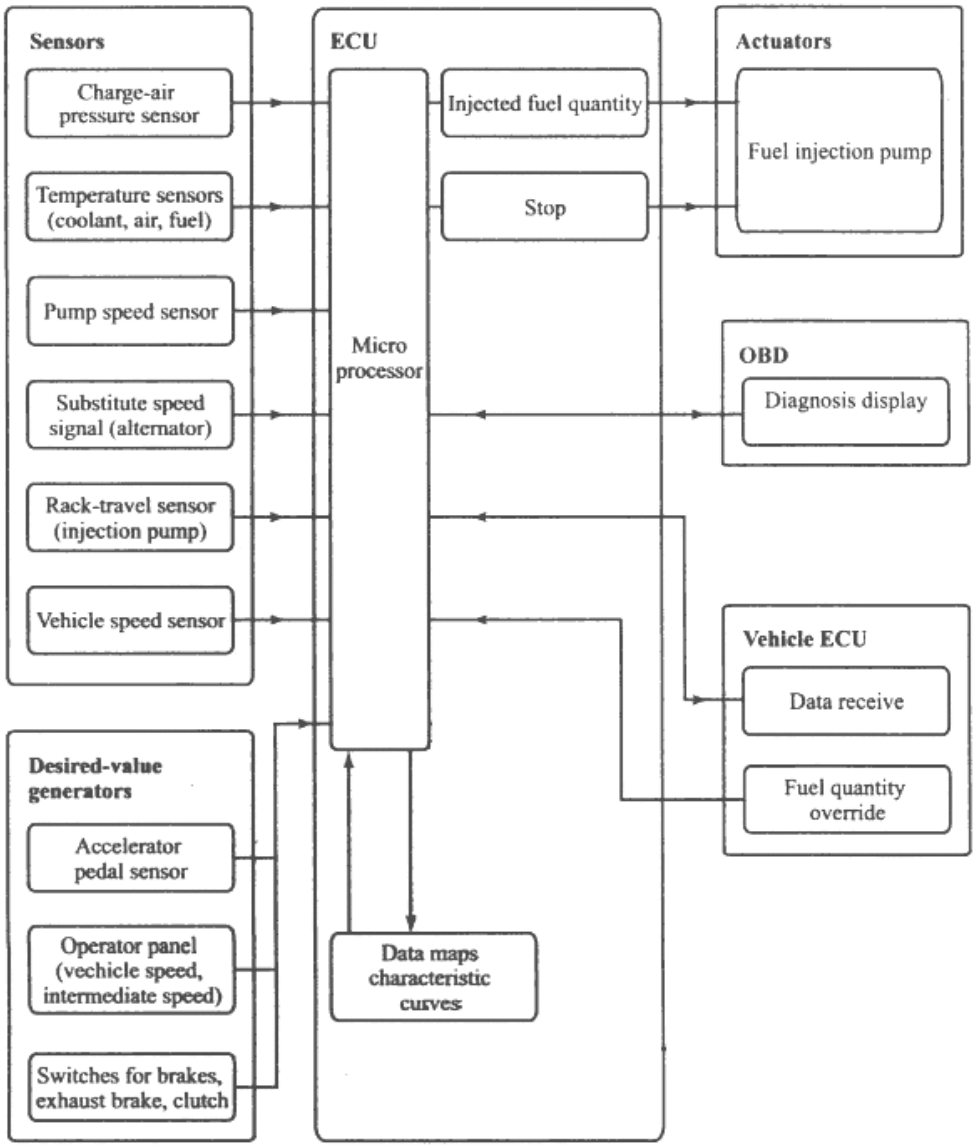
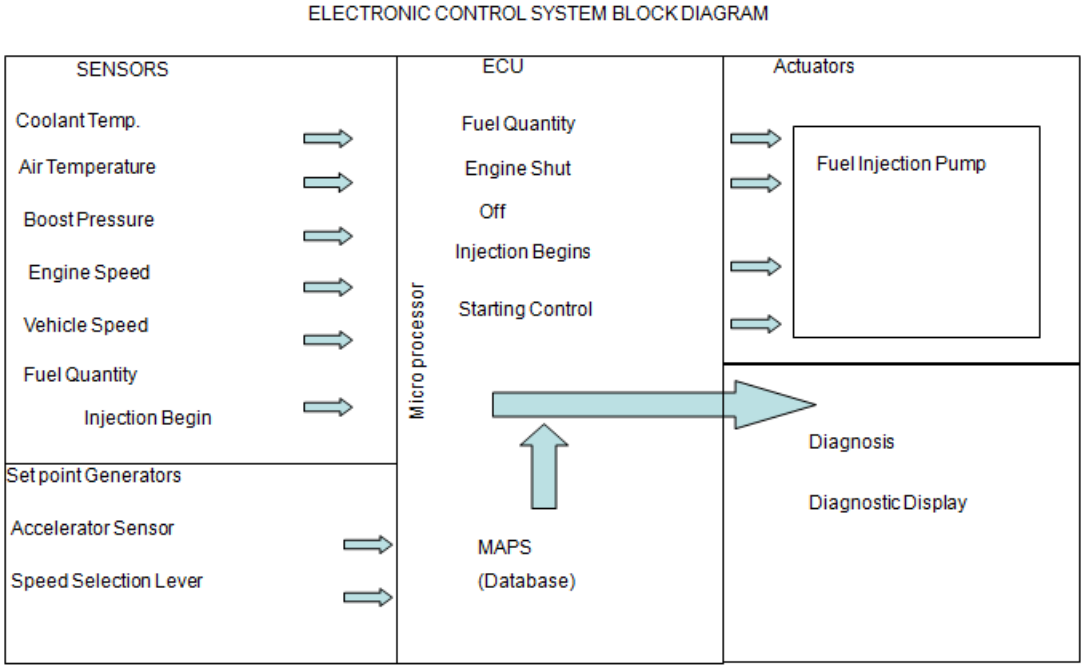


Fig: Block Diagram of EDC Unit

OR

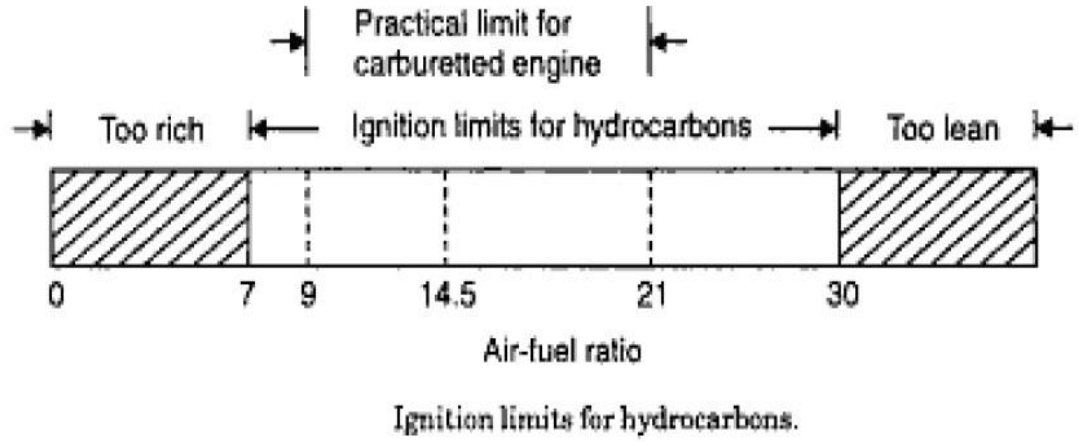


4

d) What is meant by Ignition limits? Give the ignition limit for S.I. Engine. **4**

Answer: *(Definition 2 marks, Figure, values 2 marks)* **2**

Ignition Limits: Ignition Limit corresponds approximately to that mixture ratio, at lean & rich ends of the scale, where the heat released by spark is no longer sufficient to initiate combustion in the neighboring un-burnt mixture. The flame will propagate only if the temperature of the burnt gases exceeds approximately 1500 K in the case of hydrocarbon-air mixture. The lower & upper ignition limits of the mixture depend upon mixture ratio & flame temperature. The ignition limits are wider at increased temperature because of higher rates of reaction.



Ignition limits for hydrocarbons.

2

Theoretical Ignition limits for Hydrocarbon fuels are 7:1 to 30:1
Actual Ignition limits for hydrocarbon fuels are 9:1 to 21:1

MODEL ANSWER
Summer – 17 EXAMINATION

Subject Title: Advanced Automobile Engines Subject Code: 17523

	e)	**What is diesel smoke? State two methods to control diesel smoke**.	**4**
		Answer: *(Definition 2 marks, list & Explanation each methods 1 marks)* **Diesel smoke:** Smoke is defined as visible products of combustion, is due to poor combustion. It originates early in the combustion. Rich fuel-air mixture & at pressures developed in diesel engines- produces soot. If soot is not burnt in combustion cycle it will pass in exhaust, & if in sufficient quantity, will become visible- as smoke. **2** **Methods:** **2** **1. De-rating:-** At lower loads, the air: fuel ratio obtained will be leaner & hence the smoke developed will be less. However this means a loss of output. **2. Maintenance:** - Maintaining the injection system of engine properly results in a significantly reduced smoke, best engine performance, and clean exhaust system. Other methods are changes in Combustion chamber geometry. **3. Smoke suppressant additives:-** Some barium compound, if used in fuel, reduce the temp of combustion, thus avoiding the soot formation, & if formed- they break it into the fine particles, thus appreciably reducing smoke. **4. Fumigation**: - Fumigation consists of introducing a small amount of fuel into the intake manifold. This shortens the delay period- curbs thermal cracking which is responsible for soot format	
	f)	**State the effect of compression ratio and turbulence on ignition lag.**	**4**
		Answer: *(effect of Each variable 2 marks*) **Effect of engine variables on ignition lag** **1) Compression ratio**: A higher compression ratio increases the pressure and temperature of the working mixture and decreases the concentration of the residual gases. These favorable conditions reduce the ignition lag of combustion. **2** **2) Turbulence:** Ignition lag is not much affected by turbulence intensity. It measured in degree of crank-rotation the ignition lag increases almost linearly with engine speed. For this reason. It becomes necessary to advance the spark timing at higher speed. **2**	
4	**A)**	**Attempt any THREE of the following:**	**12**
	a)	**Compare S.I. and C.I engine on the basis of performance characteristics (any four)**	**4**

Parameter	**S.I. Engine**	**C.I Engine.**	
Power output per unit weight	2.7 Kg/KW. because of lower compression ratio and lower pressure involved	6.5 kg/KW because of higher compression ratio and higher pressure involved.	**4**
Power output per unit displacement.	High. Requires less space for same power output. Delivers 30KW/lit it of piston displacement	Low. Requires more space for same power output. Delivers 15KW/ Lit of piston displacement	
Acceleration	Not so good. In modern carburetor this is overcome by acceleration pump.	Produces best acceleration due to direct control on the quantity of fuel and rapid and positive means of changing this	

				quantity.	
		Reliability	Good. Normal troubles in Carburetors and the ignition system.	Good .Greater reserve of power, rated by smoke, not Maximum power. Normal trouble in costly injection system and the complicated speed governor.	
		Fuel Economy Full load Part load	Costly fuel, density low, calorific value slightly higher, less calories per liter. Medium Poor	Cheaper fuel, density high, calorific values slightly low more calories per liter. Good Good	
		Fuel safety(Fire hazards)	Volatile fuel, more fire hazards	Less volatile, less hazards	
	b)	**Explain the methods of fuel injection used EFI system.**			**4**
		Answer : Methods of fuel injection: *(methods-1 mark, Description of any one – 3marks)* 1. Sequential fuel injection. (SFI) 2. Grouped fuel injection. 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 bars. 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.			**1** **3**

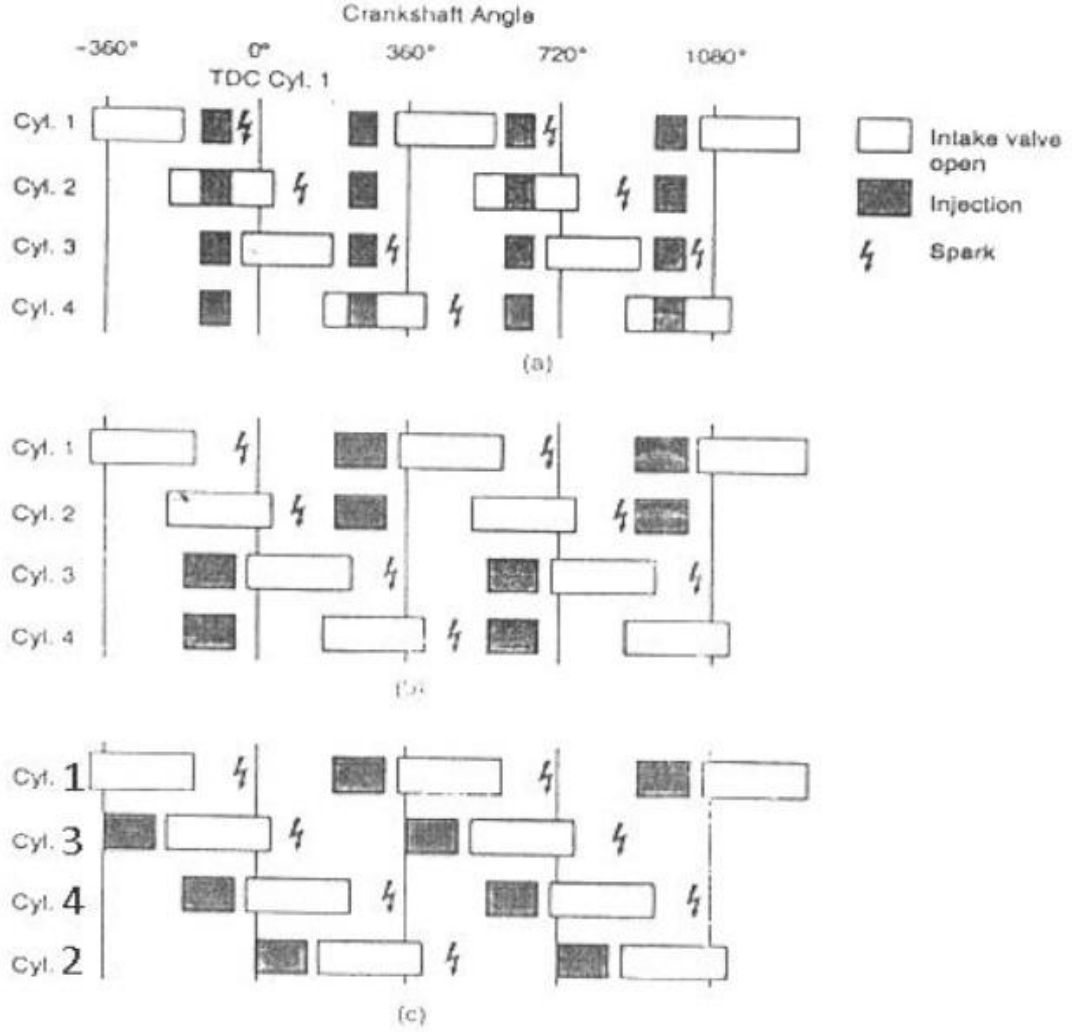
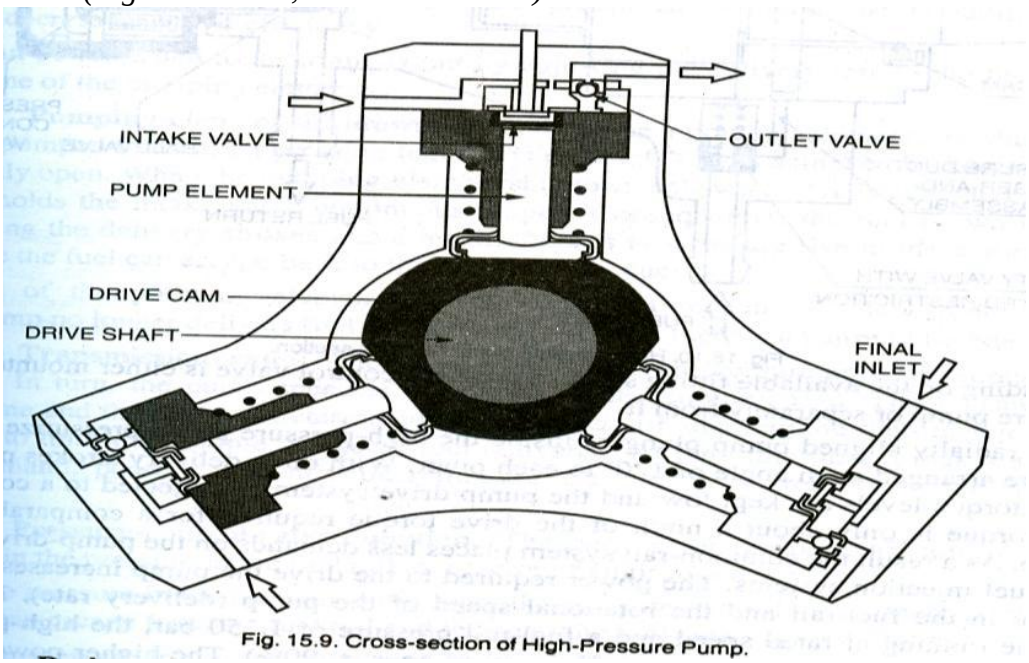
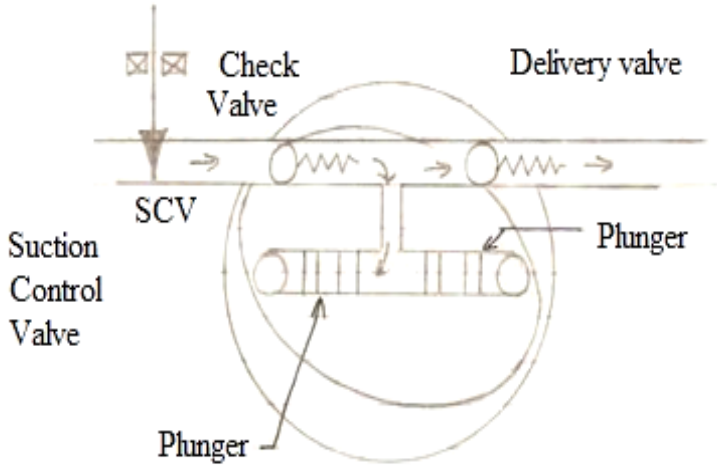
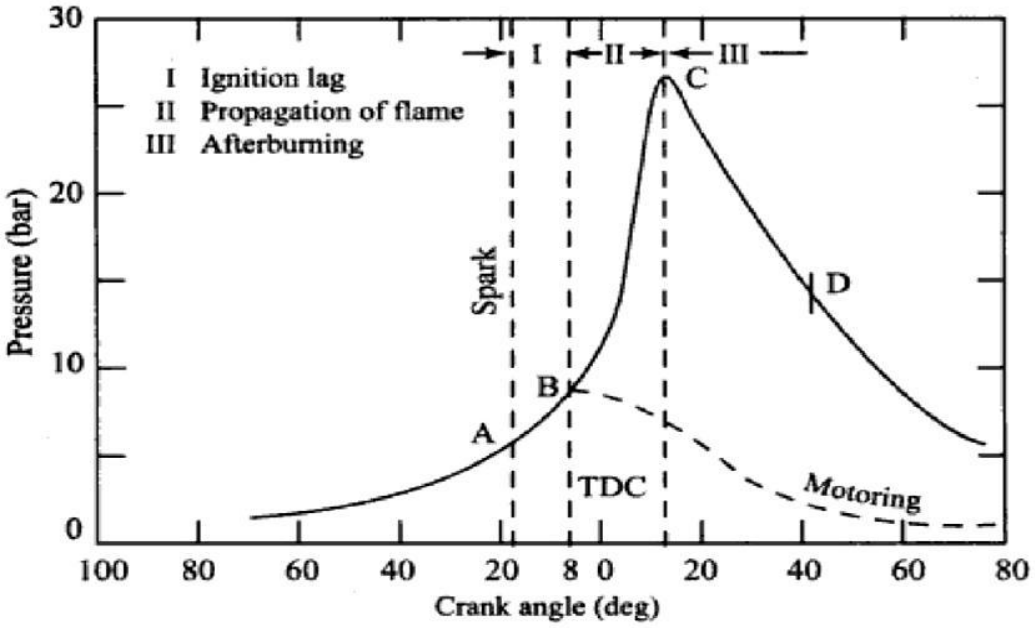
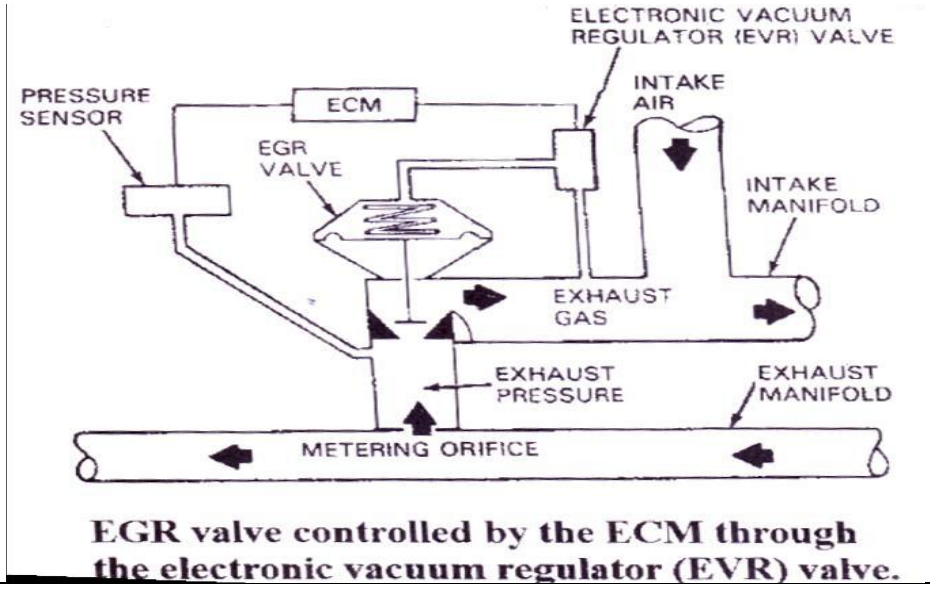


FIGURE Fuel injection strategies: (*a*) simultaneous injection, (*b*) group injection, and (*c*) sequential injection.

Note: Above diagram refers to the first three methods of injection, for continuous injection diagram is not needed. credit shall be given to suitable diagram)

	c)	**Draw and write the functions of High pressure fuel pump.**	**4**
		Answer : *(Figure 3 marks, Function 1 marks)*  Fig. 15.9. Cross-section of High-Pressure Pump.	**3**
		OR  Figure: Sectional view of High Pressure Fuel pump in CRDI system	
		Function: To pressurize fuel to maintain a constant pressure of about 1400 to 1600 bar in the common rail.	**1**

	d)	**List the various fuels used in I.C. engines. Write the properties of Biodiesel Fuels used in I. C. engine.**	**4**
		Answer : *(List 1 mark, properties 3marks)* 1 Petrol 2. Diesel 3. LPG 4. CNG 5.Hydrogen 6.Alcohol 7.Bio diesel	**1**
		Properties biodiesel *(Any3- 1 mark each)* 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) Better lubricity than petrolium diesel vi) It is an environmentally friendly fuel that an be used in any diesel engine without modification.	**3**
4	**B)**	**Attempt any ONE of the following:**	**06**
	a)	**With neat P -θ diagram, explain the S.I. engine stages of combustion.**	**6**
		Answer : *(Explanation each stage 1 mark, Diagram 3 marks)* **The stages of combustion in S.I. engine:** **Stage I**: **Ignition Lag or Preparation Phase:** It is a chemical process which depends on-nature of fuel, temperature & pressure, proportion of exhaust gas, rate of burning and temperature .It is the growth and development of a semi propagating nucleus of flame.(At the moment of spark discharge, the temperature exceeds 10,000°C) i. At the end of this stage, the first rise of pressure (on indicator diagram) can be detected. It is the point where the line of combustion departs from the compression line. ii. The start of first stage is ignition of charge (a sufficiently homogeneous mixture of vaporized fuel, air & residual gases), leaving behind a thin thread of the flame. From this thin thread combustion spreads to envelop of mixture immediately surrounding it. **Stage II**: **Propagation of flame:** It is a simple, pure and mechanical process. The starting point of the second stage is where first measurable rise of pressure can be seen on the indicator diagram. i.e. the point where the line of the combustion departs from the compression line. During second stage, the flame spreads throughout the combustion chamber. The second stage ends as maximum pressure (on indicator diagram) is reached. **Stage III**: **After burning:** End of second stage means completion of flame travel. But it does not result in complete heat release (burning of fuel). Even after the passage of	**3**

		flame, some chemical adjustments continue throughout the expansion stroke- near the walls and behind the turbulent flame front. The rate of combustion reduces due to surface of the flame front becoming smaller and reduction in turbulence.  Figure: P- Θ diagram (Stages of combustion in SI engine)	3
	b)	**Explain the working computer controlled EGR system.**	**6**
		Answer : *(Explanation 2 Marks, Figure 4 marks)* **Exhaust Gas recirculation:** EGR System is control by the ECM. A pressure sensor monitors the exhaust system pressure. The sensor signals this information of pressure to the ECM. The ECM sends the signal to electronic vacuum regulator valve (EVR) to open and close the EGR valve. Thus it controls the amount of exhaust gas recalculated.  **EGR valve controlled by the ECM through the electronic vacuum regulator (EVR) valve.**	**2** **4**

MODEL ANSWER
Summer – 17 EXAMINATION

Subject Title: Advanced Automobile Engines Subject Code: 17523

5 **Attempt any TWO of the following** **16**

a) **Compare carburettor engine fuel supply system with TBI and MPFI system.** **8**

Answer: *(Any four points)* **8**

Parameter	Carburettor Engine fuel supply system	TBI Engine fuel supply system	MPFI Engine fuel supply system
Principle	Operate on vacuum pressure.	Operate on Positive pressure.	Operates on Positive pressure.
Type of injector	No injectors are used.	Electronically controlled only one injector is used at throttle body.	Electronically controlled one injector per cylinder is used.
Fuel economy	Low fuel economy because high loss of fuel.	High fuel economy achieved because no loss of fuel.	High fuel economy achieved because no loss of fuel.
Emission	High emissions due to improper Air-Fuel ratio delivered by this system.	Lower emissions are achieved due to accurate Air-Fuel ratio delivered by this system.	Lower emissions are achieved due to accurate Air-Fuel ratio delivered by this system.
Maintenance	High	Low	Low
Cost	Low	High	High

b) **Explain engine design modification parameter to control emissions.** **8**

Answer: *(2 mark each-any four)* **8**

Methods used for improving the exhaust emission under the engine design modification are

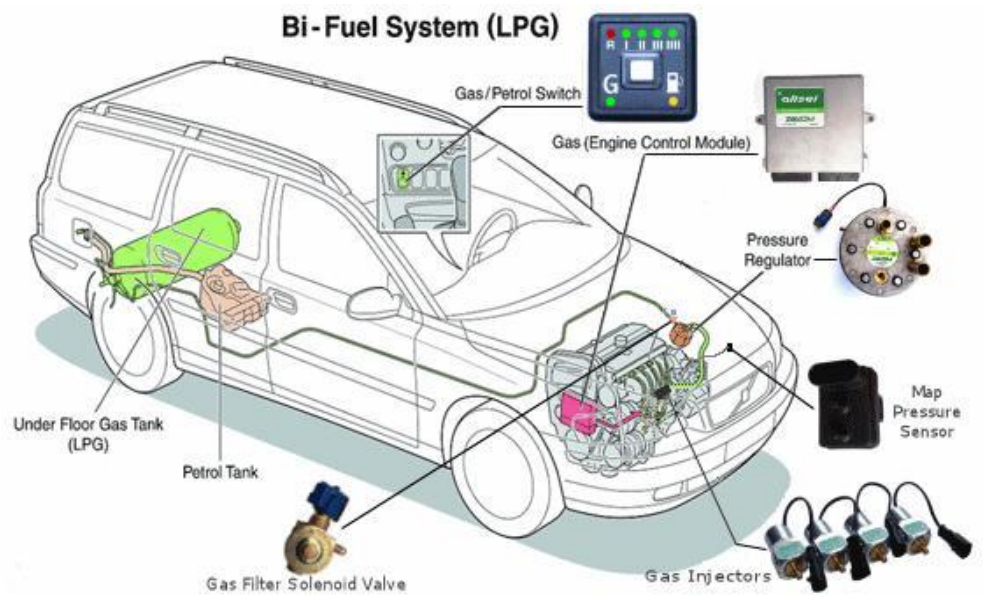
1. Use of leaner air-fuel ratios: The carburetor may be modified to provide relatively lean air fuel mixtures during idling and cruise operation. With this modification, idle speed needs to be increased to prevent stalling and rough idle. Fuel distribution is improved by better manifold design, Inlet air heating, raising of coolant temperature and use of electronic fuel injection system.

2. Retarding Ignition timing: The controls are designed to retard the spark timing at idle and providing normal spark advance during acceleration and cruising. Retarding spark reduces NOx. Emission. It also reduces HC emission.

3. Modification of combustion chamber: Modification in combustion chamber is attempted to avoid flame quenching zones, resulting in HC emission. This includes reducing surface to volume ratio, reduced squish area, reduced deal space around

		piston ring and reduced distance of the top piston ring from the top of the piston. **4. Lower compression ratio:** The lower compression ratio reduces the quenching effect by reducing quenching area reducing HC. It also reduces NOx. Emission. Reducing compression ratio results in some loss of power and fuel economy. **5. Reduced valve overlap:** Increased valve overlap allows some mixture to escape directly to increase emission level. This can be controlled by reducing valve overlap. **6. Alterations in induction system:** The supply of designed air fuel ratio to all cylinders under all operating conditions can be affected by alterations in induction. This includes inlet air heating, use of carburetor with closer tolerances and using special type of carburetors. This also includes fuel injection in manifold.	
	c)	**Explain working of LPG kit with labeled block diagram.**	**8**
		Answer: *(Working 4 marks, diagram 4 marks. Credit should be given to equivalent explanation & Figure)* **Working of LPG Kit:** • **LPG Tank**: It is used to store the LPG at 10 bar • **Filler Valve**: It allows the LPG into the tank while feeling. • **Pressure Relief Valve**: It is used to limit pressure built up inside the tank. • **Fuel Selector Switch**: This switch used to select the type of fuel (LPG/Petrol) • **Electronic Control Unit (ECU)**: It controls accurate rate of fuel delivery at right time at right cylinder. • **Pressure Regulator (Vaporizer):** It reduces the pressure from 10 bar to injection pressure 1.35 bar. • **Gas Distributor**: It supplies the gas at atmospheric pressure as per the engine requirement. • **LPG Injector**: It open & close based on the ECU signal & injects the gas accordingly.	**4**

LPG Kit Block Diagram:



4

OR

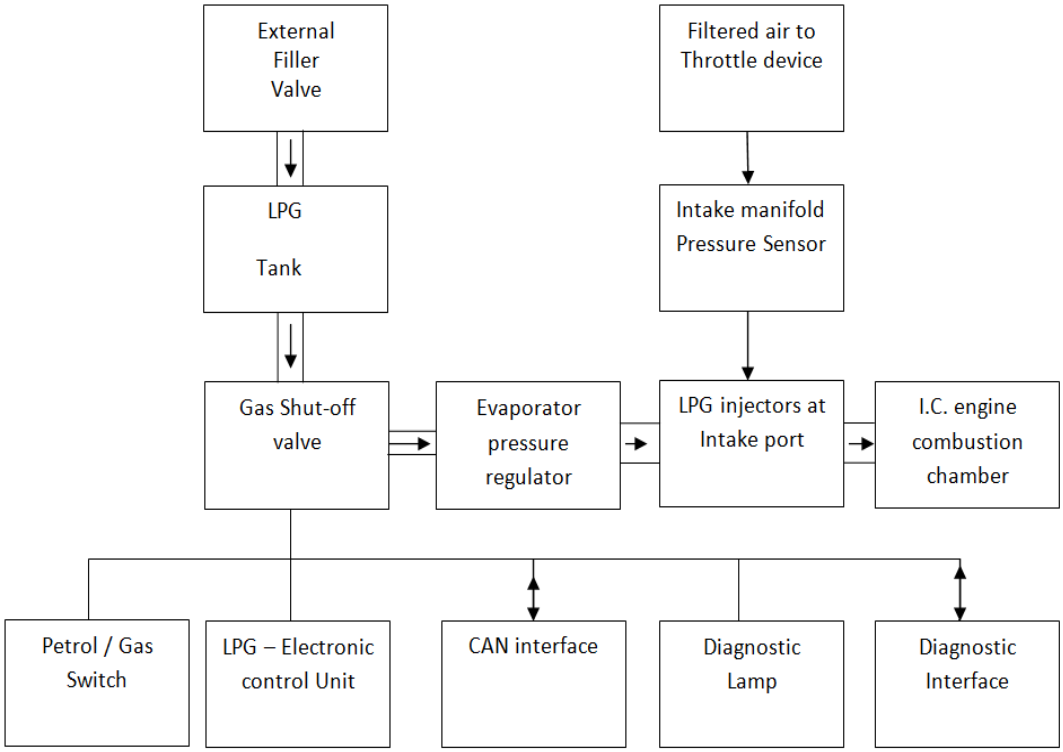
Working of LPG Kit:

The LPG 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 liters.
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.
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

MODEL ANSWER
Summer – 17 EXAMINATION

Subject Title: Advanced Automobile Engines Subject Code: 17523

		Block diagram: 	
6		**Attempt any FOUR of the following:**	**16**
	a)	**Sketch and Explain F-head combustion chamber.**	**4**
		Answer: *(Explanation 2 marks, Sketch 2 marks)* In F-head combustion chamber one valve is in head and other in the block. This design is a compromise between L-head and I head combustion chambers. Advantages are : • High volumetric efficiency • Maximum compression ratio for fuel of given octane rating • High thermal efficiency • It can operate on leaner air-fuel ratios without misfiring. Drawback • This design is the complex mechanism for operation of valves and expensive special shaped piston.	**2**

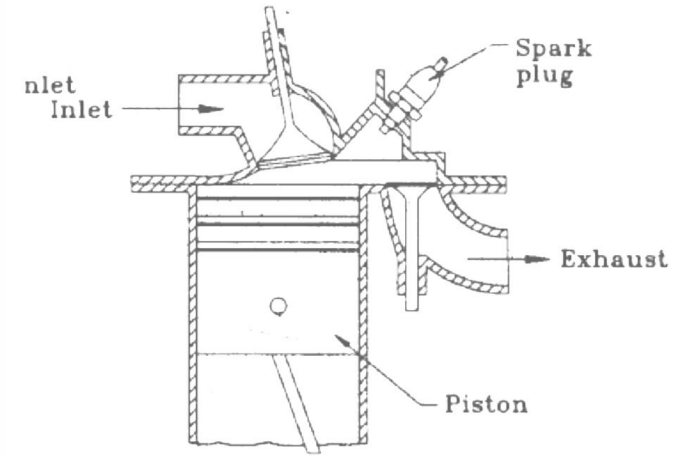
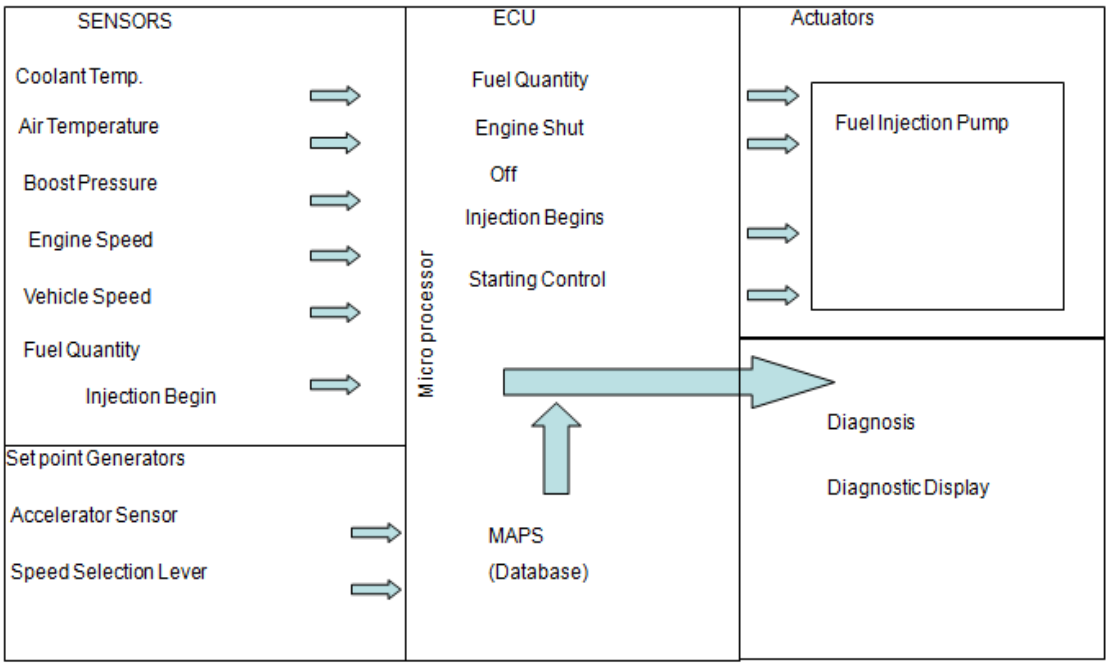


Fig: F-head combustion chamber. **2**

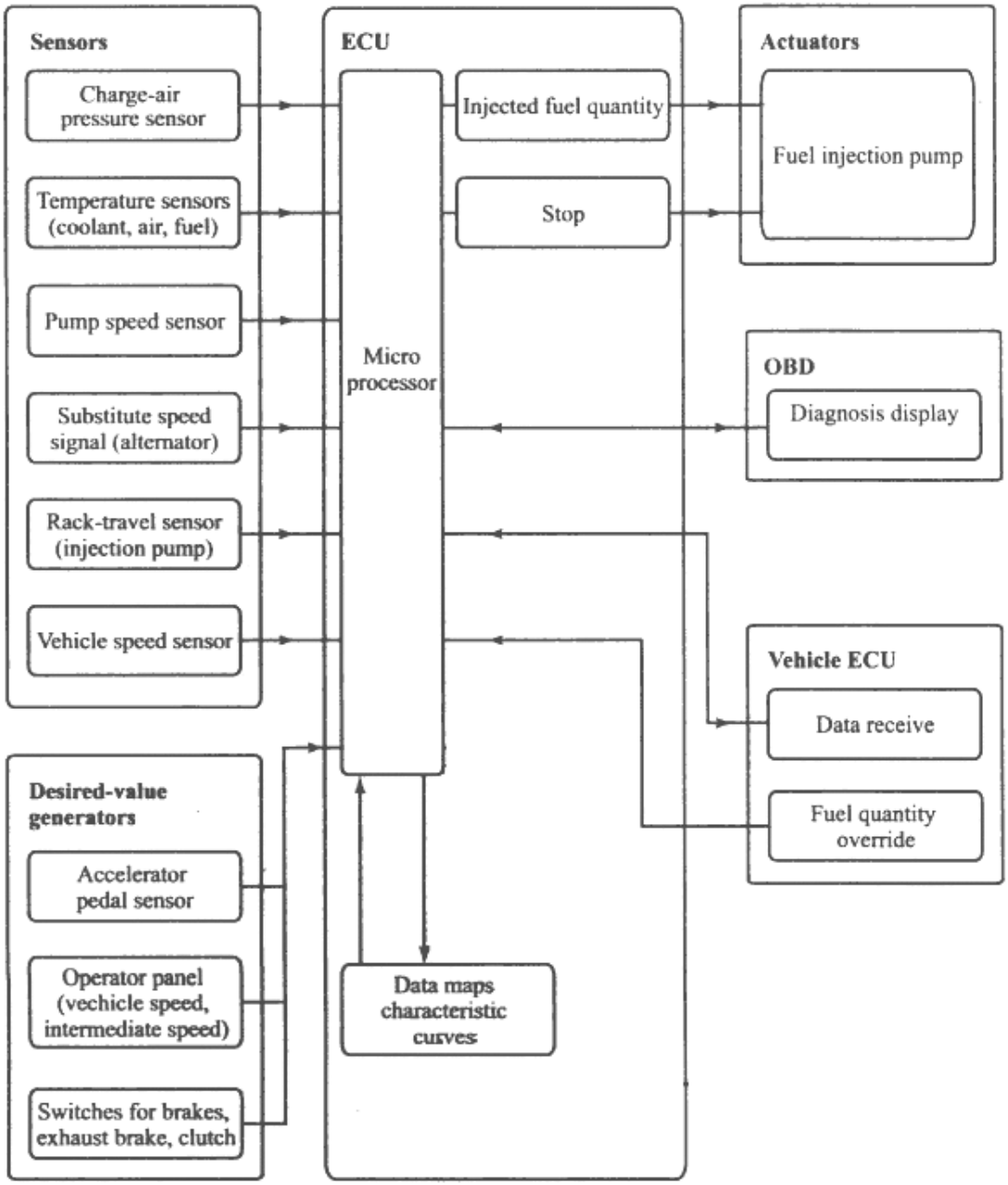
b) Draw the block diagram of electronic control system. **4**

Answer: (Credit should be given to equivalent explanation & Figure) **4**

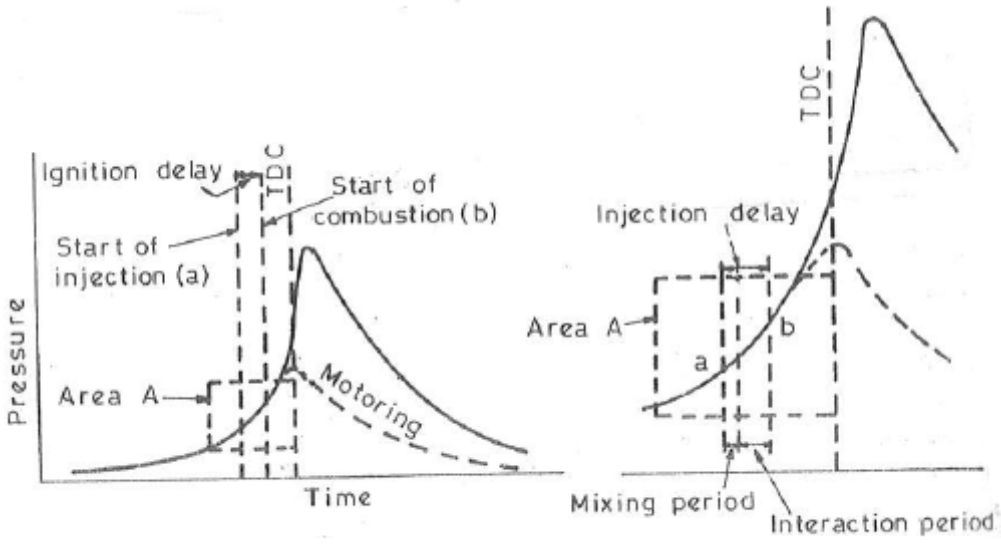
ELECTRONIC CONTROL SYSTEM BLOCK DIAGRAM



OR



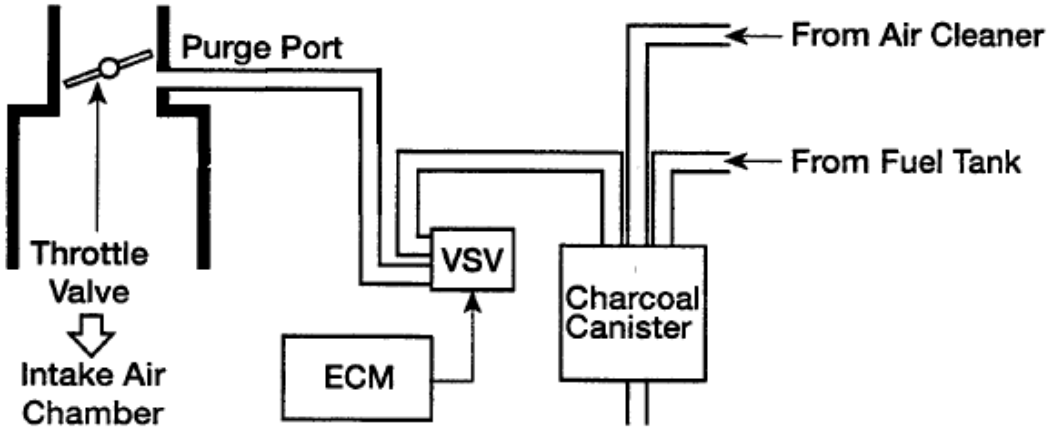
	c)	**What are the advantages of V.V.T?**	**4**
		Answer: *(Any four- 01 mark each)* **Advantages of V.V.T (Variable Valve Timing)** 1) It improves performance of an engine. 2) It increases engine flexibility under different conditions. 3) It improves fuel economy.	**4**

		4) It makes precise handling of engine valve. 5) It lowers the exhaust emission. 6) It increases torque.	
	d)	**Explain Delay Period in detail.**	**4**
		Answer: *(Explanation 4 marks, Credit should be given for sketch)* **Delay period:** Ignition delay period is the time period between start of injection and start of combustion, has a great influence on the correct optimization of a diesel engine. 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. It is period during which some fuel has been admitted but has not yet been ignited. The ignition delay is counted from the start of injection to the point where P-θ curve separates from the pure air compression curve. This ignition delay can be further divided into Physical delay and chemical delay. Physical delay includes fuel atomization, vaporization, mixing with air, and mixture rose in temperature. Pre-flame reactions occur during chemical delay  Pressure- time diagram illustrating Delay period	**4**
	e)	**Explain Evaporative emission control system.**	**4**
		Answer: *(Explanation 2marks, sketch 2 marks)* **EVAP system Operation:** When the engine is running, stored fuel vapours in fuel tank are purged from the canister whenever the throttle has opened past the purge port and coolant temperature is above 54 °C. Fuel vapors flow from the high pressure area in the canister, past check valve in the canister, through the vacuum switching valve	**2**

(ECM controlled- duty cycle controlled), to the low pressure area in the throttle body. ECM uses engine speed, intake air volume, coolant temperature, and oxygen sensor information to control EVAP operation.

Atmospheric pressure is allowed into the canister through a filter located on the bottom of the canister. This ensures that the purge flow is constantly maintained whenever purge vacuum is applied to the canister. When coolant temperature falls below 35°C, the vacuum switching valve prevents purge from taking place by blocking the vacuum signal to the check valve at canister.

Under other conditions, as fuel is drawn from the tank, a vacuum may be created in the tank. This is prevented by allowing atmospheric pressure to enter the tank through the check valve in the charcoal canister or fuel tank cap check valve. The EVAP system is designed to limit maximum vacuum and pressure in the fuel tank.



VSV: Vacuum Switching Valve ECM: Electronic Control Module

Figure: Evaporative Emission Control system

2

f) Write function and location of four engine sensors. **4**

Answer: (*Function and location – 1 mark each for one sensor- any four. Credit should be given to other sensors also*)

Sr.	Name	Function	Location
1	Oxygen sensor	Measuring the quantity of oxygen in exhaust	Located at inlet and outlet side of catalytic converter
2	Mass air flow (MAF) sensor	It is used to tell the ECU the mass of air entering the engine	Mounted between air filter and turbocharger
3	Coolant temperature sensor	Measures the temperature of the coolant in the system and sends signal to ECU.	there are two sensors fitted on water box
4	Throttle position sensor	It supplies information to the ECU about the position the throttle is in inlet manifold.	The sensor is usually located on the butterfly spindle/shaft so that it can directly monitor the position of the throttle.
5	Crank position sensor	It supplies information to the ECU about the position and rotation of the Crank shaft	This sensor is mounted on the cylinder block behind the flywheel.
6	Vehicle speed sensor	Sends electrical pulses to the ECU about the speed of vehicle.	This sensors is mounted on gear box on speedo output location
7	Cam Sensor	It senses cam position and corresponding signal is sent to the ECU.	This sensor is fitted on cylinder head cover.
8	Knock Sensor	It detects the vibrations generated during the combustion process and supplies signal to the ECU.	This sensor is fitted on cylinder block.

4