SUMMER – 19 EXAMINATION

Subject Name: AAE **Model Answer** Subject Code: 22440

Important Instructions to examiners:

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

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Attempt any FIVE of the Following**	10
	(a)	**List four types of Direct Combustion (Open) chambers used in CI engine.**	02
	Ans.	**(Any Four Types ½ Mark each)** **Direct Combustion Chamber:** 1. Shallow depth chamber. 2. Hemispherical chamber. 3. Cylindrical chamber. 4. Toroidal Chamber.	Any Four Types ½ Mark each
	(b)	**Write air fuel ratio in CI engine under Idle and Full Load Condition.**	02
	Ans.	**(Correct Answer 01 Mark Each)** **Air Fuel Ratio in CI Engine under Idle and Full Load Condition:** Air Fuel Ratio in CI Engine under Idle Condition = 80:1 Air Fuel Ratio in CI Engine under Full Load Condition = 18:1	Correct Answer 01 Mark Each
	(c)	**State the function and location of oxygen sensor and knock sensor in multi port fuel injection.**	02
	Ans.	**(Function ½ Mark each and Location ½ Mark Each)** **Oxygen Sensor:** **Function:** Measuring the quantity of oxygen in exhaust **Location:** Located at inlet and outlet side of catalytic converter **Knock Sensor**: **Function:**It detects the vibrations generated during the combustion process and supplies signal to the ECU. **Location:**This sensor is fitted on cylinder block.	Function ½ Mark each and Location ½ Mark Each
	(d)	**State function of inlet metering valve in MPFI engine.**	02
	Ans.	**(Correct Answer 01 Mark Each)** **Function of Inlet Metering Valve in MPFI Engine:**	Correct Answer 01

		This valve controls the flow of fuel to HP pump.	**Mark Each**
	(e)	**Enlist four methods of improving fuel economy.**	**02**
	Ans.	**(Any Four Types ½ Mark each)** **Methods of Improving Fuel Economy:** 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).	**Any Four Types ½ Mark each**
	(f)	**Enlist four properties of diesel.**	**02**
	Ans.	**(Any Four ½ Mark Each)** 1) **Volatility: -** The fuel should be sufficiently volatile in the operating range of temperature to produce good mixing and combustion. 2) **Viscosity:** Viscosity of a fuel is a measure of its resistance to flow. 3) **Flash Point:** Flash point is the temperature at which a flammable liquid will produce, with a standardized apparatus and procedure, a mixture of its vapour and air which will ignite to give a visible flash by contact with an open flame. 4) **Fire Point:** Fire point is the temperature at which the flash will sustain itself as a steady flame for at least five seconds. 5) **Cetane Number:** The Cetane rating of a diesel fuel is measure of its ability to auto-ignite quickly when it is injected into the compressed and heated air in the engine. 6) **Calorific Value:** It is about 50 MJ/Kg 7) **Sulphur Content:** High sulphur content in diesel fuel causes corrosion, wear of engine parts, especially the cylinder walls, and tends to increase the rate of sticky and sludge - like deposits. 8) **Contamination:** The contents of sand and rust particles can clog small openings and abrasive particles can damage injector surface piston rings and cylinder walls. 9) **Cloud Point:** The temperature below which the wax content of the petroleum oil separates out in the form of a solid is called cloud point. Such waxy solid can clog fuel lines and fuel filters. 10) **Pour Point:** Pour point is the temperature below which the entire mass of fuel, solid or liquid	**Any Four Types ½ Mark each**
	(g)	**List four pollutants emitted from SI engine**	**02**
	Ans.	**(Any Four Types ½ Mark each)** 1. Hydrocarbon 2. Carbon Monoxide 3. Carbon Dioxide 4. Oxide of Nitrogen	**Any Four Types ½ Mark each**
2		**Attempt any THREE of the Following**	**12**
	(a)	**Describe stages of combustion in CI engine with the help of pressure crank angle diagram.**	**04**
	Ans.	**(Description 02 Marks And Diagram 02 Marks)** **Stages of Combustion in CI Engine:** The combustion in CI engine is taking place in four phases: • Ignition Delay period /Pre-flame combustion • Uncontrolled combustion • Controlled combustion	**Description 02 Marks And Diagram 02 Marks**

• After burning

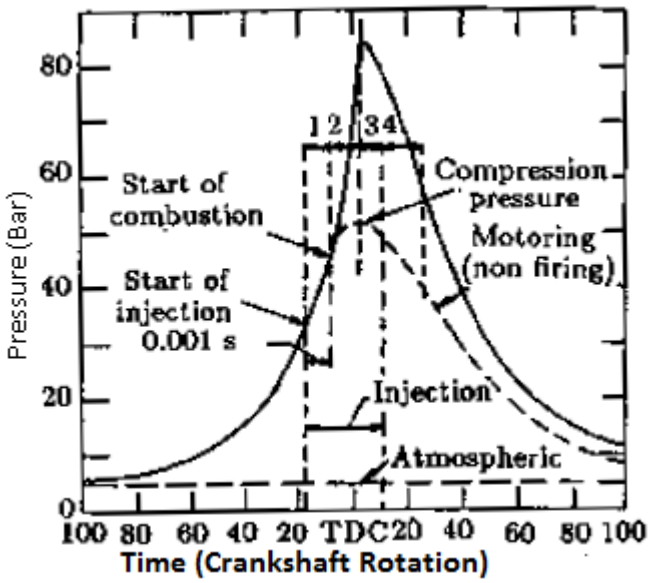


Figure: Pressure Crank Angle Diagram for CI Engine.

- **Ignition Delay period /Pre-flame combustion:**

The fuel does not ignite immediately upon injection into the combustion chamber. There to the combustion chamber. There is a definite period of inactivity between the time is a definite period of inactivity between the time of injection and of injection and of injection and the actual burning the actual burning the actual burning this period is known as the ignition delay period. is known as the ignition delay period.

- **Period of Rapid Combustion:**

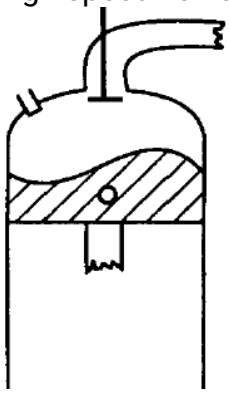
The period of rapid combustion also called the uncontrolled combustion, is that phase in which the pressure rise is rapid. During the delay period, a considerable amount of fuel is accumulated in combustion chamber, these accumulated fuel droplets burns very rapidly causing a steep rise in pressure. The period of rapid combustion is counted from end of delay period or the beginning of the combustion to the point of maximum pressure on the indicator diagram. The rate of heat-release is maximum during this period. This is also known as uncontrolled combustion phase, because it is difficult to control the amount of burning / injection during the process of burning. It may be noted that the pressure reached during the period of rapid combustion will depend on the duration of the delay period (the longer the delay the more rapid and higher is the pressure rise since more fuel would have been present in the cylinder before the rate of burning comes under control).

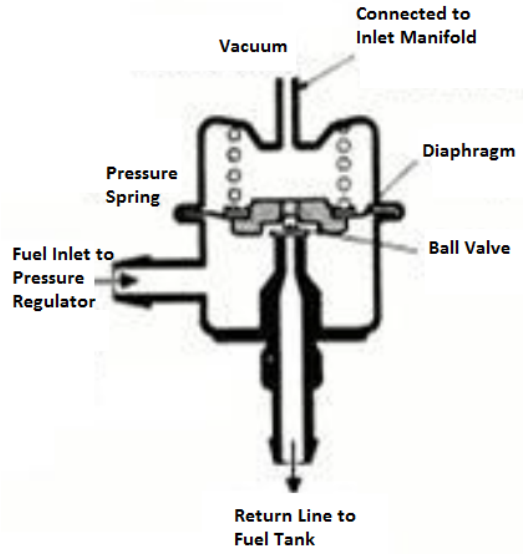
- **Period of Controlled Combustion**

The rapid combustion period is followed by the third stage, the controlled combustion. The temperature and pressure in the second stage are so high that fuel droplets injected burn almost as they enter and find the necessary oxygen and any further pressure rise can be controlled by injection rate. The period of controlled combustion is assumed to end at maximum cycle temperature.

- **Period of After-Burning**

Combustion does not stop with the completion of the injection process. The unburnt and partially burnt fuel particles left in the combustion chamber start burning as soon as they come into contact with the oxygen. This process

		continues for a certain duration called the after-burning period. This burning may continue in expansion stroke up to 70 to 80% of crank travel from TDC.	
	(b)	**Select the combustion chamber for racing car engine with justification.**	**04**
	Ans.	**(Name 01 Mark, Sketch 01 Mark and any two Justifications 02 Marks)** I-head combustion chambers have overhead valves. The engines with this type of combustion chamber are used in high speed vehicles and racing cars.  **Figure: I-Head Combustion Chamber** **I-Head Combustion Chamber:** This type of combustion chamber has both the inlet valve and the exhaust valve located in the cylinder head. An overhead engine is superior to side valve engine at high compression ratios. The overhead valve engine is superior to side valve or L-head engine at high compression ratios, for the following reasons: **Justifications:** • Lower pumping losses and higher volumetric efficiency from better breathing of the engine from larger valves or valve lifts and more direct passageways. • Less distance for the flame to travel and therefore greater freedom from knock, or in other words, lower octane requirements. • Less force on the head bolts and therefore less possibility of leakage (of compression gases or jacket water). The projected area of a side valve combustion chamber is inevitably greater than that of an overhead valve chamber. • Removal of the hot exhaust valve from the block to the head, thus confining heat failures to the head. Absence of exhaust valve from block also results in more uniform cooling of cylinder and piston. • Lower surface-volume ratio and, therefore, less heat loss and less air pollution. o Easier to cast and hence lower casting cost.	**Name 01 Mark, Sketch 01 Mark and any two Justification 02 Marks**
	(c)	**Explain working of fuel pressure regulator of multi port fuel injection engine with suitable sketch.**	**04**
	Ans.	**(Explanation 02 Marks and Sketch 02 Marks)** **Working of Fuel Pressure Regulator:** 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.	**Explanation 02 Marks and Sketch 02 Marks**

		 **Figure: Fuel Pressure Regulator**	
	(d)	**Describe the procedure for diagnosis fault in a sensor of Common Rail Direct Injection Engine.**	**04**
	Ans.	**(Correct Answer 04 Marks)** **Procedure for Diagnosis Fault in A Sensor of Common Rail Direct Injection Engine:** (1) Connect the voltmeter to the self-diagnostic connector, across the MPI diagnosis and ground terminals. (2) Turn the ignition switch *ON* . The ECU diagnostics memory will immediately start. (3) If the voltmeter displays a steady needle sweep, the system is normal and no codes are in the memory. (4) If the voltmeter displays a steady *HIGH* signal, the ECU is damaged. (5) If the ECU has detected a malfunction, the voltmeter will deflect, indicating the diagnostic code. (6) Record the codes displayed by the voltmeter needle deflections. (7)The ECU will continue to send any memorized trouble codes to the self-diagnostic for as long as the ignition is *ON* , or until the codes have been cleared from memory.	**Correct Answer 04 Marks**
3		**Attempt any THREE of the Following**	**12**
	(a)	**Explain with sketch the LPG fuel supply system.**	**04**
	Ans.	**(Explanation 02 Marks and Sketch 02 Marks)** **LPG Fuel Supply System:** 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. 4. LPG solenoid valve, Gasoline solenoid valve 5. Electronic control module which controls of the flow of LPG in fuel injection systems 6. LPG / Petrol switch, which enables the driver to choose which fuel he wishes to use	**Explanation 02 Marks and Sketch 02 Marks**

7. Pressure regulator Mixer / gas injection which flows the LPG into the combustion chamber

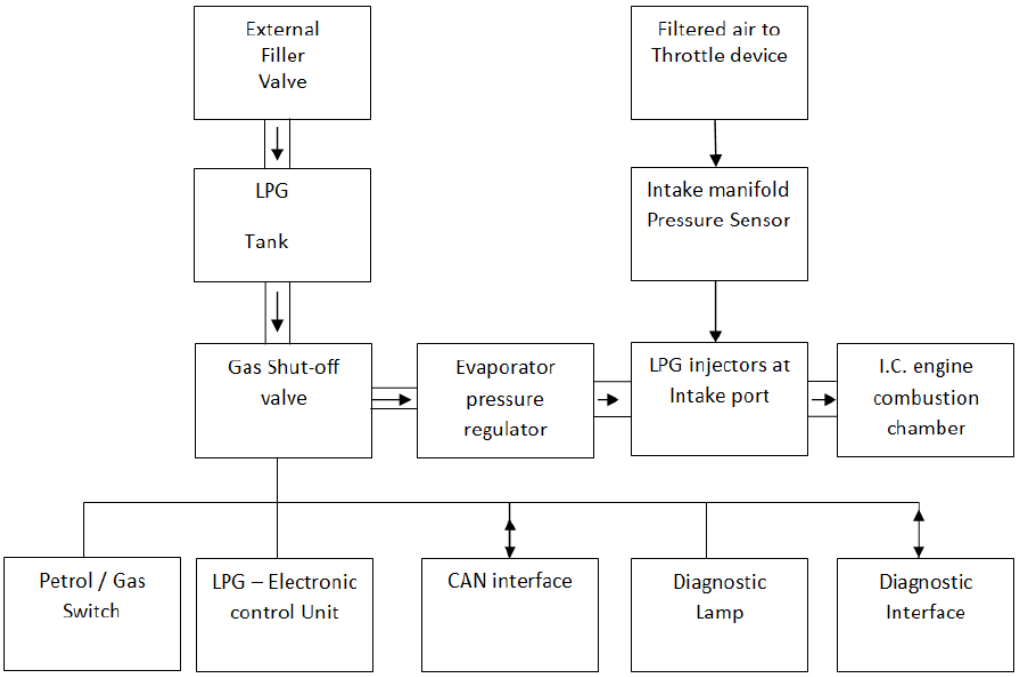
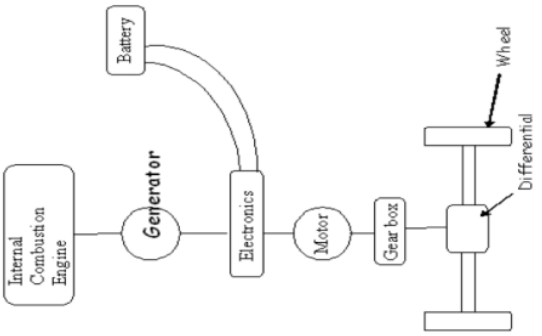


Figure: LPG Fuel Supply Layout

	(b)	**Select fuel for rickshaw engine to be used in metro city with justification.**	**04**
	Ans.	**(Name 01 Mark and Any Three Justifications 03 Mark)** **CNG** is used as fuel for rickshaw engine in metro city **Justifications:** **1.** CNG reduces the harmful emission **2.** Operating cost of the vehicle running on CNG is lower. **3.** Reduced vehicle maintenance. **4.** Fuel theft is not possible. Since NG cannot be siphoned off from a vehicle **5.** CNG contains less carbon than any other fossil fuel **6.** CNG vehicle is as safe as petrol vehicle **7.** CNG has a much higher Octane Number.—So, it is superior to petrol. And the anti- knock additives are not required. **8.** Being a gaseous fuel, CNG mixes with air easily and evenly. **9.** Almost any petrol / diesel vehicle can be converted to operate on CNG. **10.** CNG is non-toxic. **11.** CNG is lighter than air and so Dissipates into atmosphere implies less chance of fire Hazard.	**Name 01 Mark and Any Three Justificatio n 03 Mark**
	(c)	**Enlist the feature of GDI for a car engine.**	**04**
	Ans.	***(Any Four Features 01 Mark Each)*** **Feature of GDI for a Car Engine:** (1) Gasoline Direct Injection (GDI), also known as Petrol Direct Injection. (2) The gasoline is highly pressurized, and injected via a common rail fuel line directly into the combustion chamber of each cylinder, (3) Directly injecting fuel into the combustion chamber requires high pressure injection. (4) The GDI engines operate on full air intake; there is no air throttle plate. (5) Engine speed is controlled by the engine control unit. (6) In this only the combustion air flows through open intake valve on the	***Any Four Features 01 Mark Each***

		induction stroke. (7) The engine management system continually chooses among three combustion modes: ultra lean burn, stoichiometric, and full power output. (8) Each mode is characterized by the air-fuel ratio. (9) 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). (10) These mixtures are much leaner than in a conventional engine and reduce fuel consumption considerably.	
	(d)	**Describe relevant properties of four constituents in petrol engine exhaust gas.**	**04**
	Ans.	**(Each Correct Answer 01 Mark)** **Properties of HC:** The boiling points of alkanes directly correspond to the size of the molecule. Alkanes with higher molecular weight will have higher boiling points. **Properties NOx:** At higher temperatures it is a reddish-brown gas that has a characteristic sharp, biting odor. **Properties CO:** It is a highly poisonous, odorless, colorless, and tasteless gas. It is very flammable in air over a wide range of concentrations. **Properties CO_2:** It is colorless. At low concentrations the gas is odorless; however, at sufficiently-high concentrations, it has a sharp, acidic odor.	**Each Correct Answer 01 Mark**
4		**Attempt any THREE of the Following**	**12**
	(a)	**Explain diagnosis procedure of CRDI to diagnosis multi point fuel injection engine.**	**04**
	Ans.	***(Procedure 02 Marks and Sketch 02 Marks)*** **Diagnosis Procedure of CRDI to Diagnosis Multi Point Fuel Injection Engine:** (1) Connect the voltmeter to the self-diagnostic connector, across the MPI diagnosis and ground terminals. (2) Turn the ignition switch *ON* . The ECU diagnostics memory will immediately start. (3) If the voltmeter displays a steady needle sweep, the system is normal and no codes are in the memory. (4) If the voltmeter displays a steady *HIGH* signal, the ECU is damaged. (5) If the ECU has detected a malfunction, the voltmeter will deflect, indicating the diagnostic code. (6) Record the codes displayed by the voltmeter needle deflections. (7)The ECU will continue to send any memorized trouble codes to the self-diagnostic for as long as the ignition is *ON*, or until the codes have been cleared from memory.	***Procedure 02 Marks and Sketch 02 Marks***
	(b)	**Describe the procedure to locate leakage in liquefied petroleum gas fuel supply system of car. State the relevant precautions to be taken during leakage identification.**	**04**
	Ans.	**(Properties 02 Marks and Precautions 02 Marks)** **Procedure to locate Leakage in Liquefied Petroleum Gas Fuel Supply System of Car:** 1. The first indicator is the pungent acrid smell of LPG. 2. The second level of test you can do is to take a soap solution and apply the same in all possible areas of leak. 3. There is one more way. You can install a gas leak detector. They detect gas	**Properties 02 Marks and Precautions 02 Marks**

		leaks as soon as the LPG reaches 20% of the explosive limit. **Precautions to be taken During Leakage Identification** 1. When a gas **leak** is suspected, extinguish all flames, incense sticks, etc. 2. Close the **LPG** regulator and 3. Put the safety cap on the cylinder.	
	(c)	**Draw a block diagram of series type Hybrid car. State two advantages of Hybrid Car.**	**04**
	Ans.	**(Diagram 02 Marks And Any Two Advantages 01 Mark Each)**  **Figure: Block Diagram of Series type Hybrid Car** **Advantages:** 1) Environmentally friendly. 2) Financial Benefits. 3) Less dependence on Fossil Fuels 4) Regenerative braking system. 5) Built from light Materials.	**Diagram 02 Marks And Any Two Advantages 01 Mark Each**
	(d)	**Prepare a chart of Bharat Stage IV (BSIV) norms for petrol engine of Car.**	**04**
	Ans.	Note: ***Credit should be given to information in sentence format, mentioning Bharat Stage norms being equivalent to corresponding Euro norms. Two / three rows need to be appearing for BS emission norms containing permissible levels of pollutants***	

Standard	Reference	Date	Region
India 2000	Euro 1	2000	Nationwide
Bharat Stage II	Euro 2	2001	NCR*, Mumbai, Kolkata, Chennai
		2003.04	NCR*, 13 Cities†
		2005.04	Nationwide
Bharat Stage III	Euro 3	2005.04	NCR*, 13 Cities†
		2010.04	Nationwide
Bharat Stage IV	Euro 4	2010.04	NCR*, 13 Cities†
Bharat Stage V	Euro 5	2020 (proposed)	Entire country

* National Capital Region (Delhi)

† Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, Jamshedpur and Agra

The above standards apply to all new 4-wheel vehicles sold and registered in the respective regions.

	(e)	**Explain PCV System with suitable Sketch.**	**04**
	Ans.	**(Explanation 02 Marks and Sketch 02 Marks)**	**Explanation**

PCV System:

The purpose of PCV system is to remove the harmful gases from the crankcase before damage occurs and combine them with the engine's normal incoming air: fuel mixture. PCV system uses a variable flow PCV valve accurately matches ventilation flow with blow-by production characteristics. By accurately matching these two factors, crankcase ventilation performance is optimized, while engine performance and drivability remains unaffected.

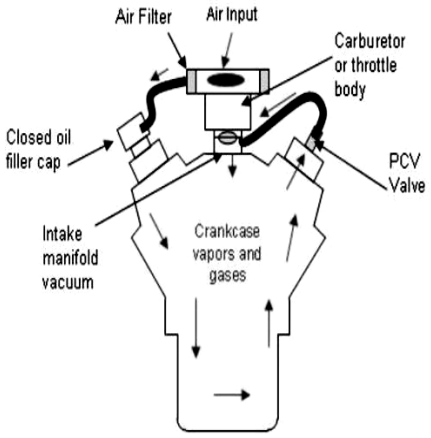


Figure: Positive Crankcase Ventilation (PCV) System

02 Marks and Sketch 02 Marks

5 **Attempt any THREE of the Following** **12**

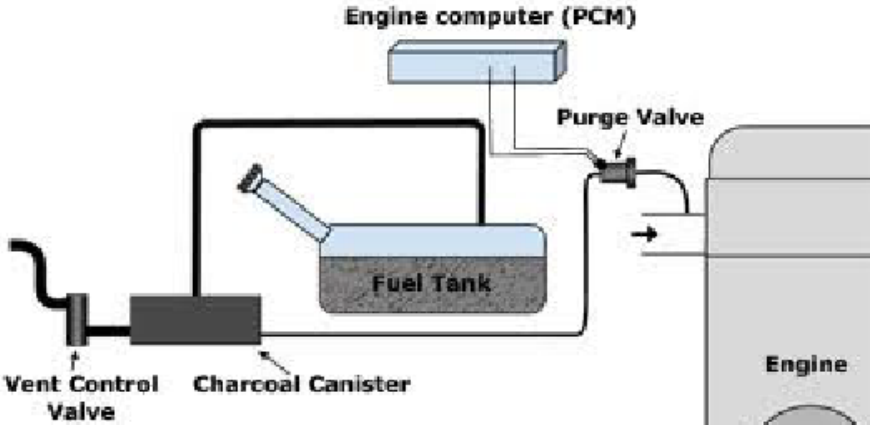
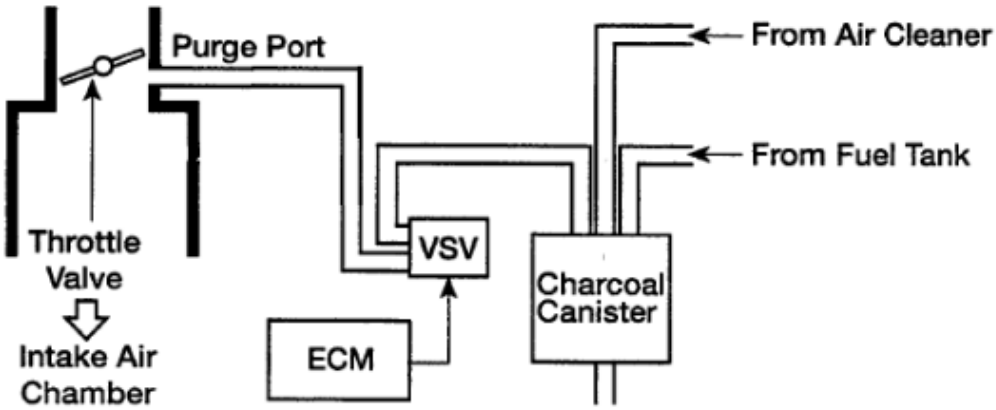
(a) **Compare SI and CI engine with justification for the following parameters;**
- **(i) Compressive Pressure.**
- **(ii) Power to weight Ratio.**
- **(iii) Distribution of fuel in the cylinder.**

06

Ans. **(Each Parameter Difference 01 Marks and its justification 01 Mark each)**

Parameters	SI Engine	CI Engine	Justification
Compressive Pressure.	**Less**	**More**	A CI engine delivers more torque on the wheels as compared to SI engines. SI engines uses carburetor for proper air-fuel mixture.
Power to weight Ratio.	**Less**	**More**	Since diesel engines are operated at higher compression ratio, mean effective pressure is *more* and more power. Therefore more fuel can be burned per unit time in *SI engines* of equal displaced volume at a given engine speed.
Distribution of Fuel in the Cylinder.	**Air and fuel Injected Separately**	**The pre-mixing was formerly done in a carburetor**	In the case of CI engines, ignition takes place by high pressure Compression. And in SI engine its takes place by using Spark Plug.

Each Parameter Difference 01 Marks and its justification 01 Mark each

	(b)	**Describe Canister Purge as output control function of multi-point fuel injection engine with the help of sketch.**	**06**
	Ans.	**(Explanation 03 Mark and sketch 03 Mark)** **Canister Purge Control:** The purge valve is the part of the vehicle Evaporative Emission Control (EVAP) system. The EVAP system prevents fuel vapors in the fuel tank from escaping into the atmosphere. The EVAP system traps fuel vapors from the fuel tank and temporarily stores them in the charcoal canister, see the diagram. When the engine is running under certain conditions, the fuel vapors are purged from the canister and burned inside the engine. The purge valve precisely controls the amount of fuel vapor that is purged from the charcoal canister. In modern cars, the purge valve is an electrically-operated solenoid that is controlled by the engine computer. When the engine is off, the purge valve is closed. When the engine is running and fully warmed up, the engine computer gradually opens the purge valve to allow some amount of fuel vapor to be moved from the charcoal canister to be burned in the engine. The purge flow is monitored by a number of sensors. If the purge flow is less or more than is expected under the conditions, the computer illuminates the "Check Engine" light.  **Figure: Canister Purge Control** **OR**  **Figure: Canister Purge Control**	**Explanation 03 Mark and sketch 03 Mark**
	©	**Explain working of CRDI System with the help of sketch.**	**06**
	Ans.	**(Working 03 Marks and Sketch 03 Marks)**	**Working**

Working of CRDI System:

(i) In the common rail direct injection system different sensors are used for operation. These sensors collect information about engine operating condition and send signal to the CRDI System.

(ii) Microprocessor receives the sensor signals, converts the signal in required format and then processes the signals. e.g. Analog signals are converted into digital signals. Digital signals are amplified. Then the data is compared with the look- up tables. In the Logic and power modules, the actuators are controlled for desired control of the system. The actuators include Fuel injectors, EGR valve, Glow control unit etc.

(iii) The signal to the actuators is given in the required form like analog signals.

iv. Information is also available in form of Diagnostic trouble codes at the dashboard. It can also be availed from the EDC using a scan tool.

03 Marks and Sketch 03 Marks

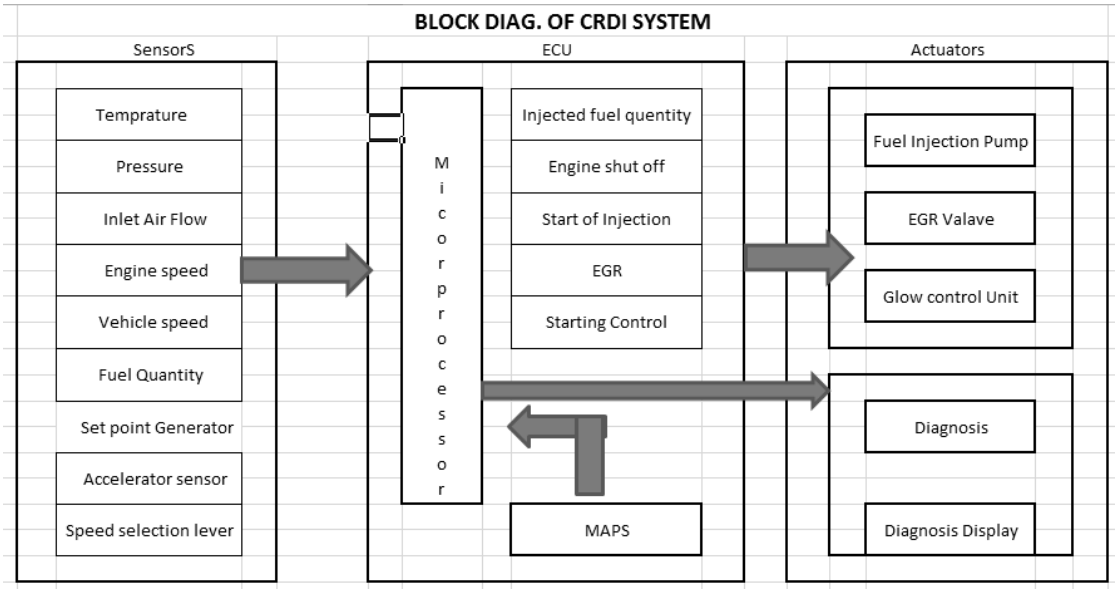
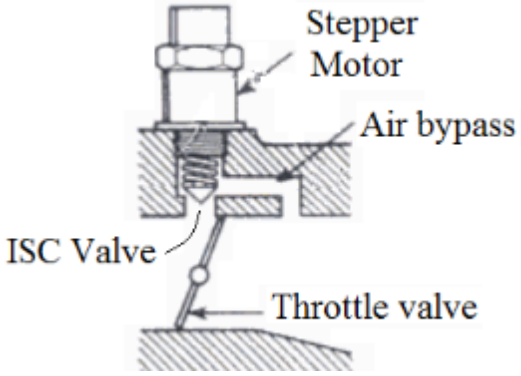
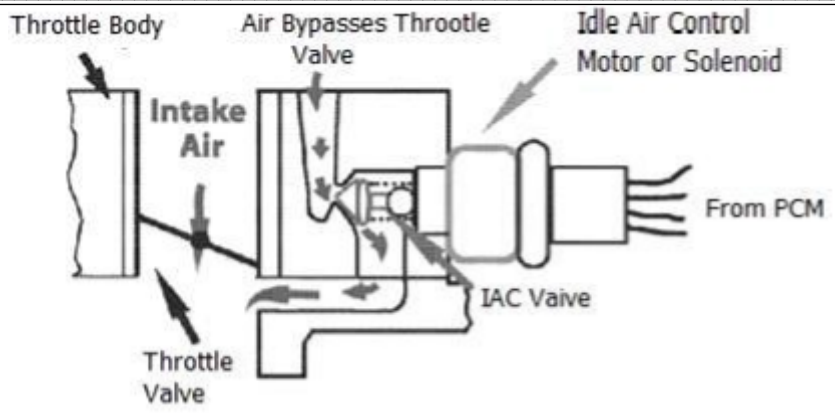


Figure: Block Diagram of CRDI

6		**Attempt any THREE of the Following**	**12**
	(a)	**Compare TBI and PFI system of the fuel supply with justification for the following parameters;** **(i) Number of Injectors and it's Location** **(ii) Knock** **(iii) Injector Pressure**	**06**
	Ans.	**(Difference 01 Mark each and Justification 01 Mark each)**	**Difference 01 Mark each and Justification 01 Mark each**

Parameters	TBI system	PFI System
Number of Injectors and it's Location	**Single or Pair Location:** injectors are located in a central throttle body that supplies fuel to the engine through the intake manifold	**In each cylinder. Location:** The injectors are mounted at each of the intake ports so fuel can be sprayed directly into the ports
Knock	Less atomization and vaporization will make the engine **more knock prone**.	Better atomization and vaporization will make the engine **less knock prone**.
Injector Pressure	**More** Fuel atomization depends	**Less** Atomization of fuel is

			upon velocity of air in the venturi.	independent of cranking speed therefore cranking is easier.
	(b)	**Describe Idle Speed control as an output function of multi – port fuel Injection with the help of sketch.**		**06**
	Ans.	**(Explanation 02 Marks and Sketch 02 Marks)** **Idle Speed Control as Output function of MPFI:** While the engine is being started, or operated, the logic module of Electronic Control Module (ECM) will signal the **Stepper motor of Idle Speed Control (ISC) valve** to provide the easy starting without the operator having to touch the accelerator pedal. 1. When the engine is cold, the logic module will position the AIS motor to provide the correct cold fast idle speed. The ISC valve motor allows more air to flow past the motor plunger into the intake manifold to increase the idle speed. This air flow bypasses the throttle. 2. The ISC valve motor will provide the correct idle speed when the air conditioner is on and required air: fuel mixture when the engine is decelerating. 3. The injection time is extended to provide additional fuel for cold start and during the post-start and warm up phases. The idle speed is controlled by a stepper motor, which is signaled by ECM as a function of engine speed, load and engine temperature. 4. The stepper motor controls the idle passage size to change the amount of air entering the intake manifold. Thus it controls the effective air: fuel ratio. 5. Stepper Motor: It rotates a valve shaft either in or out. This in turn increases or decreases the clearance between the ISC (Idle Speed Control) valve and its seat, thereby regulating the amount of air allowed to pass through. The Idle speed control valve stepper motor allows 125 possible valve opening positions.  **Figure: Idle Speed Control** **OR**	**Explanation 02 Marks and Sketch 02 Marks**

		 **Figure: Idle Speed Control**	
	(c)	**Explain causes of SI engine emission and state measures to control emission.**	**06**
	Ans.	**(Cause 02 Marks and Measures 02 Marks)** **Causes of SI Engine Emission:** The major pollutants emitted from the exhaust due to incomplete combustion are: CO, HC, NOx are the Pollutants from SI Engine. The main causes of emissions are non-stoichiometric combustion of nitrogen and impurities in fuel and air. **Measures to Control Emission:** **1. Air injection:** This system was used to inject air into the engine's exhaust ports to provide oxygen so unburned and partially burned hydrocarbons in the exhaust would finish burning. **2. Exhaust Gas Recirculation (EGR):** In EGR a certain portion of exhaust gases are directed back to the cylinder head, where they are combined with the fuel-air mixture and enter the combustion chamber. **3. Catalytic Converter:** The catalytic converter is a device placed in the exhaust pipe, which converts hydrocarbons, carbon monoxide, and NO_x into less harmful gases by using a combination of platinum, palladium and rhodium as catalysts.	**Cause 02 Marks and Measures 02 Marks**