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.

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Q 1 Attempt any FIVE of the following	**20**
a) Give two applications of the following and justify their use: i) Two stroke S.I. Engine ii) Four Stroke C.I. Engine	4
Answer: i) Two stroke S.I. Engine : Motorcycle and mopeds Justification: Two stroke S.I. engines are compact, light weight, cheap and have adequate power output. ii) Four Stroke C.I. Engine: Cars, Trucks, buses, Tractors, Generators Justification: low specific fuel consumption of both full load and part load conditions (lower running cost), Utilizes less expensive fuels, reduced fire hazard, long operating life, better suited for turbo-charging.	2 2
b) What are the fuel additives? Give two examples.	4
Answer: Fuel additives are stable chemical compounds soluble in fuel and are used to improve the combustion, performance of fuel. Examples: Oxidation inhibitor- alkyl amines Octane Improver -Tetra ethyl lead Cetane Improver- alkyl nitrates Detergent- Polyglycols Smoke Suppressants—over based Barium compounds	2 2
c) What is detonation in S.I. Engine? Describe the phenomenon of detonation.	4
Answer: 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. Phenomenon of Detonation: In detonation, the end charge auto-ignites before the flame front reaches it. In order to auto-ignite, the last unburnt charge must reach above a critical temperature and remain at this temperature for a certain length of time called 'ignition delay'. During Ignition delay, the chemical reactions take place, which prepare the charge for 'auto-ignition'. As the flame front moves through the combustion chamber, it progressively ignites the mixture ahead of it. It creates increase in pressure and raised temperature of the remaining unburnt mixture. This unburnt mixture is now closer to its ignition point and should therefore ignite more easily when contacted by the flame front. If the flame front reaches it, normal combustion takes place. If the flame front does not reach the unburnt mixture before ignition delay, it results in sudden combustion of unburnt charge and sets up very high rate of pressure rise and high maximum pressure.	2 2
d) State four properties of C.I. engine fuel.	4
Answer: (a) *Flash point* (b) *Fire point (c) Viscosity* (d) *Cloud point* (e) *Pour point (f)Volatility (g)Ignition Quality (h) Cetane Number*	1 each
e) What is ECM? State four control functions of ECM.	4
Answer: The ECM is Electronic control module. It evaluates the sensor inputs using data tables and calculations to determine the output of the actuating devices. The ECM processes signals from the ignition (engine speed), temperature sensor (coolant temperature), throttle potentiometer (intake air flow), throttle switch (idle and overrun WOT- wide open throttle), starter switch, Lambda (O_2) sensor, pressure sensor (manifold pressure) and other	2

sensors. Control functions of ECM are: 1. Injection volume control, 2 Injection timing control, 3. Ignition timing control, 4. Evaporative emission control, 5.Turbocharger boost pressure control (diesel), 6. Engine / vehicle speed control, 7. EGR control, 8. Glow Plug Control (diesel)	2
f) Give any four sensors used in MPFI system	4
Answer: 1. Throttle Position Sensor, 2. Crank shaft Position Sensor, 3. Cam Shaft Position Sensor, 4. Vehicle Speed Sensor, 5. Coolant Temperature sensor, 6. Engine Speed Sensor, 7. Manifold Absolute Pressure Sensor, 8. Mass air flow sensor.	1 each
g) What are the Euro norms? What equipments are used for checking exhaust emission of diesel vehicle?	4
Answer: The Euro norms i. e. European emission standards for vehicular pollution are followed by most of the countries, including India. Euro-I norms (Bharat stage -I) are those applicable for certain category of vehicles being registered with effect from year 2000. Similarly, Euro-II norms (Bharat stage -II) are those applicable from year 2005 and BS III Norms with effect from 1st April '05 in 11 Cities in our country. The emission norms specify the acceptable quantity of certain pollutants being emitted. For example- HC, NO_x, CO, Particulate matter etc. Equipments used for checking exhaust emission of diesel vehicle are 1. Exhaust gas analyzer. 2. Diesel Smoke meter.	2 2
Q 2. Attempt any TWO of the following	**16**
a) Describe the stages of combustion in S.I. engine with the help of P-θ diagram.	8
Answer: 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 $10,000^0$ 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 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.	2 2 1 3

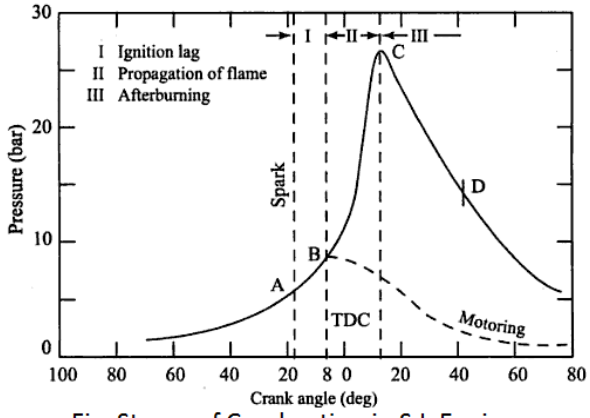
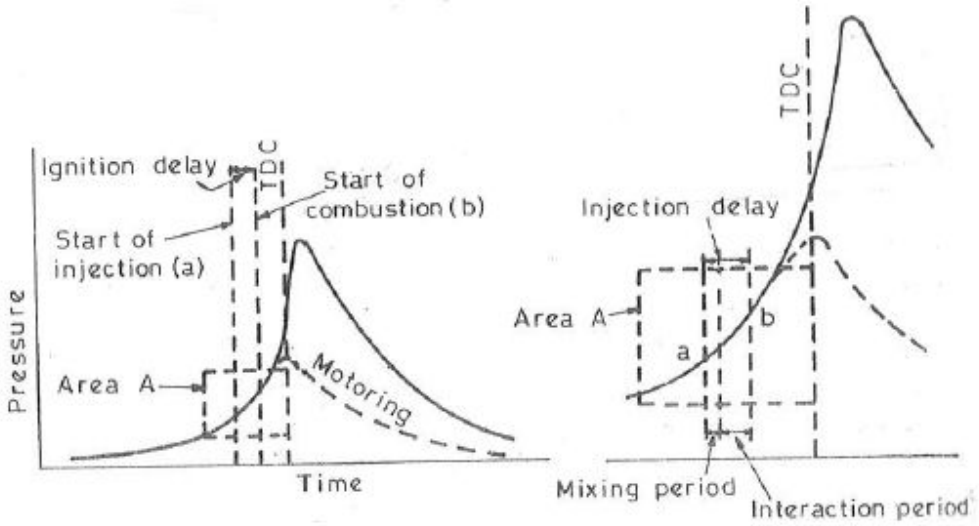


Fig: Stages of Combustion in S.I. Engine

b) What is delay period in C.I. engine combustion? Describe with pressure –time diagram, state variables affecting delay period. — 8

Answer: **Ignition Delay** 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 — 2

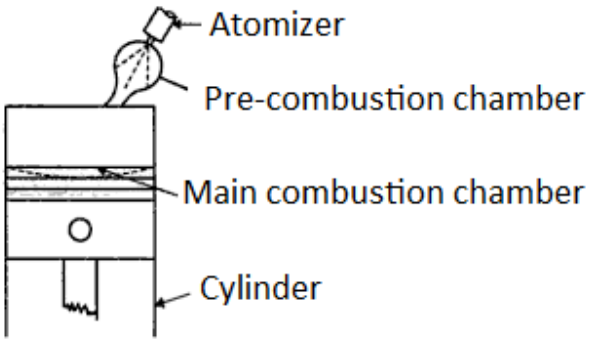


Pressure- time diagram illustrating Delay period — 2

Variables affecting delay period. (4 points)

1. Self ignition temperature of fuel.
2. Intake temperature
3. Intake pressure or supercharging
4. Compression ratio
5. Jacket water temperature.
6. The injection pressure or size of droplet.
7. Injection advance angle
8. The turbulence of air which promotes mixing.

— 4

c) What are alternative fuels for automobile engines? Explain the use of alcohol as C.I. engine fuel with its advantages and disadvantages.	8
Answer: Alternative fuels for automobile engines are as follows. 1. LPG, 2. CNG, 3. Ethanol, 4. Hydrogen Alcohol is not a suitable fuel for C.I. engines for the following reasons. 1. The Cetane number of alcohol fuels is very low (0 to 8), which prevents their ignition by compression 2. Alcohol fuels have low lubricating qualities – causing trouble in the ignition pumps and nozzles. 3. There are material problems caused by harsh reaction of methanol towards various plastics and metals. Because of very low ignition quality (Cetane number), alcohols cannot be used alone as fuels for the diesel engines without some in- cylinder assistance like, -- Spark plug, glow plug or other heated surface. To increase the Cetane number (ignition quality) of alcohol, chemical ignition accelerators (usually organic nitrates) may be added to alcohol. 5 % to 20 % additives are required for knock free operation. But Additives are expensive. The additives contain nitrogen, so they increase NO_x-emissions. Another method of using alcohol in diesel engines is by dual injection. The alcohol can be injected into the cylinder by a second high pressure system or into the inlet manifold by a low pressure system; in either case the charge of diesel fuel is used to initiate the combustion process. Advantages of alcohol as a fuel 1. It stretches the available fuel/ Petroleum gets conserved. Lesser import of petroleum. 2. Cost of fuel gets reduced. Disadvantages: 1. It attacks rubber and plastic parts. 2. High self ignition temperature.	2 2 2 2 2
Q 3 Attempt any TWO of the following	**16**
a) Draw and describe 'Turbulent combustion chamber using combustion induced swirl' type of C.I. engine combustion chambers.	8
Answer:  Fig. Pre- Combustion Chamber Turbulent combustion chamber using combustion induced swirl: A typical pre-combustion chamber is shown in the diagram. It consists of pre-combustion chamber. It	4 4

contains 20 to 30 % of clearance volume. The fuel is injected into the pre-chamber such that bulk of it reaches close to the orifice separating the two chambers. The combustion starts in pre-chamber and resulting pressure rise forces the burning droplets with air to rush out at high velocity through small holes.
It creates strong secondary turbulence and distributes them throughout the air in the main combustion chamber where major combustion takes place.
It uses single hole Pintle nozzle. The initial shock of combustion is limited to pre-combustion chamber only. Low ignition quality fuel may be used. It has multi-fuel capability.
High heat losses occur due to high velocity of gases. Small size valves due to central location of pre-chamber.

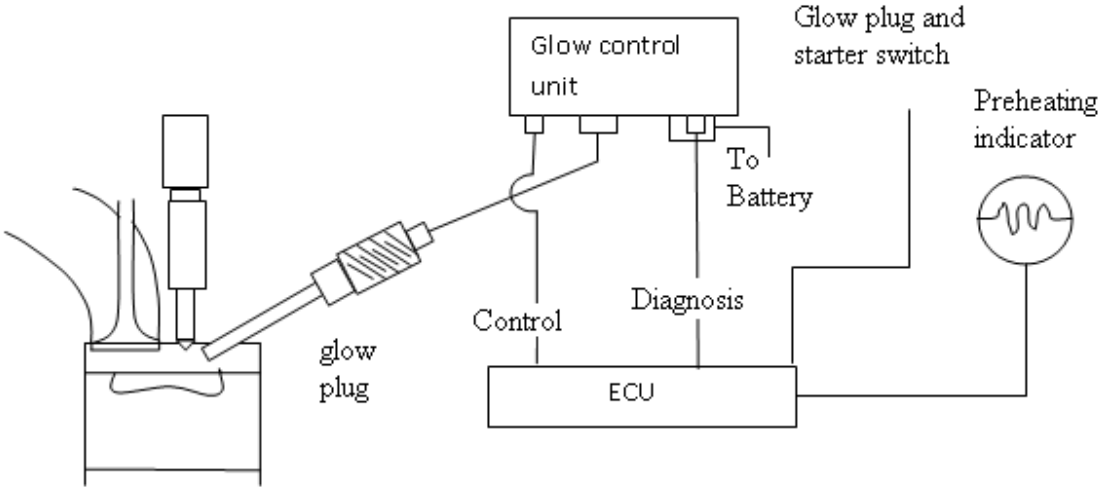
b) What is glow plug in diesel engine? Sketch and describe the working of glow plug circuit. 8

Answer:

The colder the diesel engine, the more difficult it is to start. So, as a starting aid, glow plug is used in diesel engine. In many of the latest vehicles, self-temp controlling type glow plugs are used. The glow plug has a spiral filament sitting in a glow tube of heat resistant steel, bedded and electrically insulated in a fine magnesium powder, thus protected against vibrations. The filament consists of 3 coils as follows. 2

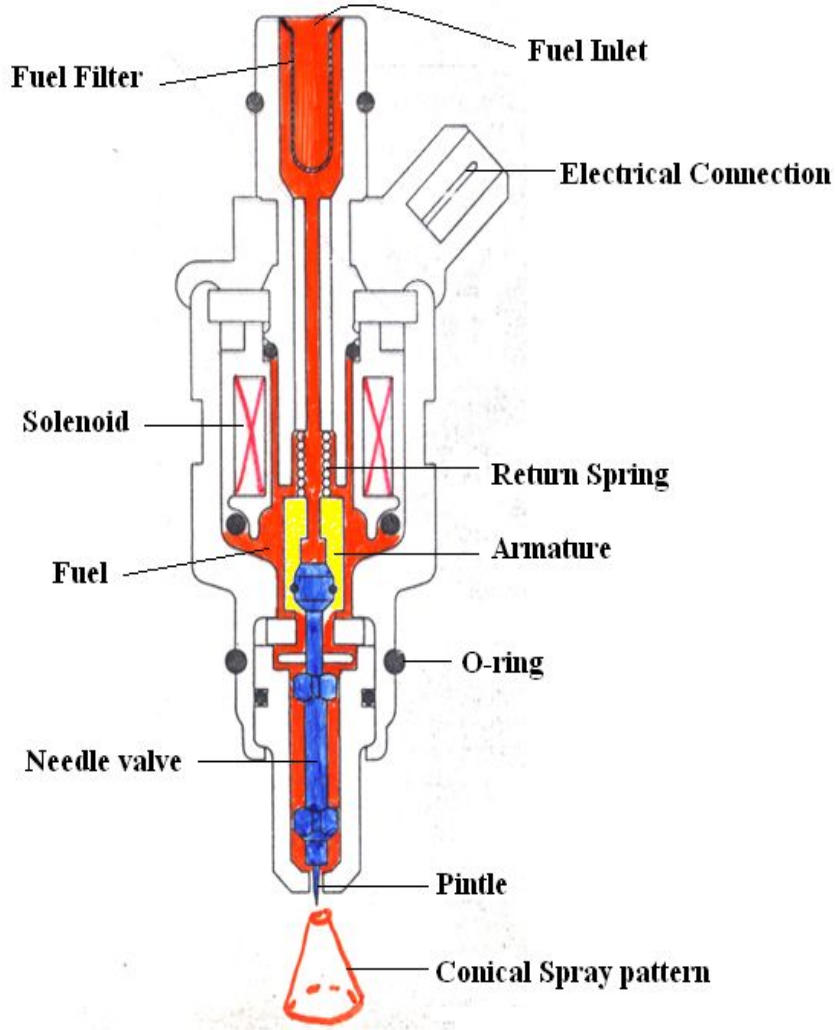
a) brake coil b) balance coil c) rush coil. These coils are connected in series.

Glow plug circuit: The glow plug must heat to starting temperature (approx. 850^0 c) as rapidly as possible. The preheating phase begins when the ignition switch is turned to 'Ignition on'. A temperature sensor in the glow control unit controls preheating period, so that the glow plug can reach the temperature necessary for efficient starting. At the end of glow period, the preheating indicator (glow plug) lamp goes out to signal that the engine can be started. The glow process continues as long as the starter remains in operation, or until the safety over ride comes into effect. 3



ECU Controlled Glow Plug System on D.I. Engine 3

c) Draw a sketch of injector used in MPFI system and describe its working. 8

`Answer: In MPFI system, Top feed fuel Injector is used. These injectors are solenoid-operated valves that are opened and closed by means of electric pulses from the ECU. The injectors are mounted in the intake manifold and spray onto the back of the intake valves. In general, one injector is used for each cylinder. The injected fuel mass is determined by the injector opening time (for a given pressure drop across the injector). In MPFI systems, each engine cylinder is assigned an electromagnetic fuel injector, which is activated individually for each cylinder. In this way, both the fuel mass appropriate to each cylinder and the correct start of injection are calculated by the control unit (ECU). The amount of fuel sprayed from the injectors is controlled by cycling the injectors open and close. More fuel will be sprayed out when the injector pulse is longer. In order to operate properly, the fuel must spray as a liquid throughout the injection. Injection pressure is approximately 2 bar to 3.5 bar. Pressure helps to keep the fuel as a liquid throughout the system. When the solenoid coil is energized, the Pintle is pulled up. System pressure then forces fuel between the Pintle and discharge opening to form a fine spray pattern that has a cone shape.	4
 TOP FEED FUEL INJECTOR	4
Q 4 Attempt any FOUR of the following.	**1**

a) List four major components of CRDI system and write their functions.	4
• Answer: HIghpressure fuel pump- • High pressure accumulator • Fuel injector • EDC Functions of Major components of CRDI system 1. High pressure Fuel Pump: To receive fuel from the fuel feed pump and supply high pressure fuel to the accumulator. 2. High pressure accumulator-The function of high pressure accumulator is to accumulate fuel supplied by the high prssure fuel pump and supply it through the high pressure lines to the individual injectors. 3. Fuel injector-After getting the signal from EDC Electronic fuel injector opens the nozzle to spray fuel from common rail to the combustion chamber under high pressure. 4. EDC: Electronic Diesel control unit controls the injection timing and volume of fuel. It controls the fuel supply as per the requirement. It receives data from various sensors such as accelerator pedal position sensor, fuel rail pressure, fuel temperature and engine load. It uses the data from the look-up table to decide and control the outputs such as fuel volume, injection timing using actuators.	2 2
b) Give any four sensors used in CRDI system and state their functions.	4
1. **Coolant Temperature Sensor**- Senses the temperature of the engine coolant and from this data the computer adjust the mixture strength to rich side for cold starting. 2. **Mass air flow sensor**: senses the volume of air flowing into the intake manifold and sends signal to EDC for calculation of air fuel ratio, and decide the quantity of fuel to be injected. 3. **Inlet air temperature sensor**- senses the temperature of the air entering the engine manifold, sends signal to EDC to calculate the mass of air entering the engine per unit time. 4. **Accelerator Pedal position sensor**- it is linked to the accelerator pedal for sensing load on the engine and sends signal to EDC to calculate the fuel to be injected in the combustion chamber. 5. **Camshaft position –**senses the rotation of engine camshaft/crankshaft foe speed and timing of injection. 6. **Boost pressure sensor**- senses the pressure in the intake manifold and sends signal to the EDC for processing the data for fuel injection control	1*4
c) Compare MPFI system with TBI system.	4
Answer:	1*4

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

d) Draw a layout of hybrid vehicle and describe it. 4

Answer: Answer: 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,** 2

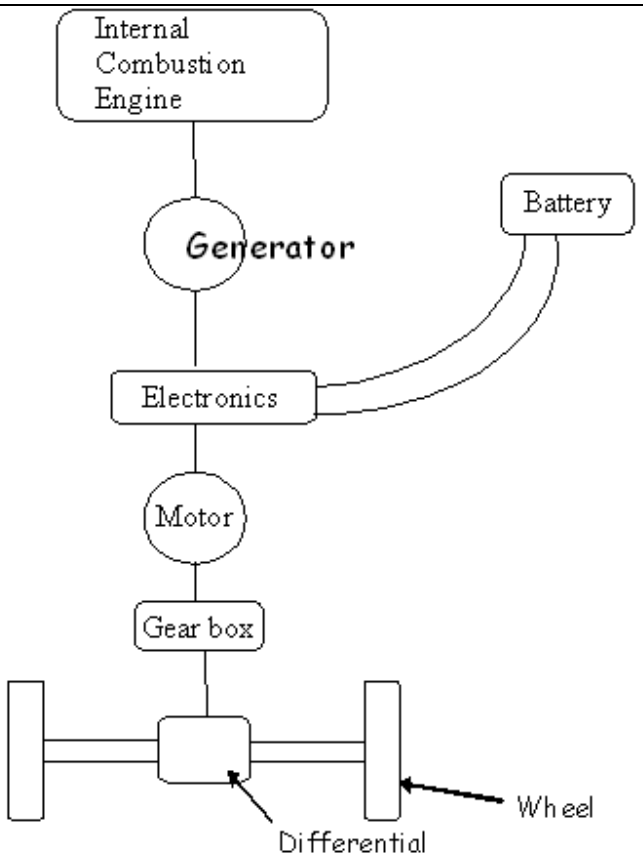
It causes low exhaust emissions. The vehicle is controlled electronically.

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.

Series Hybrid Vehicle



2

e) Describe four output control functions of electronic control module. 4

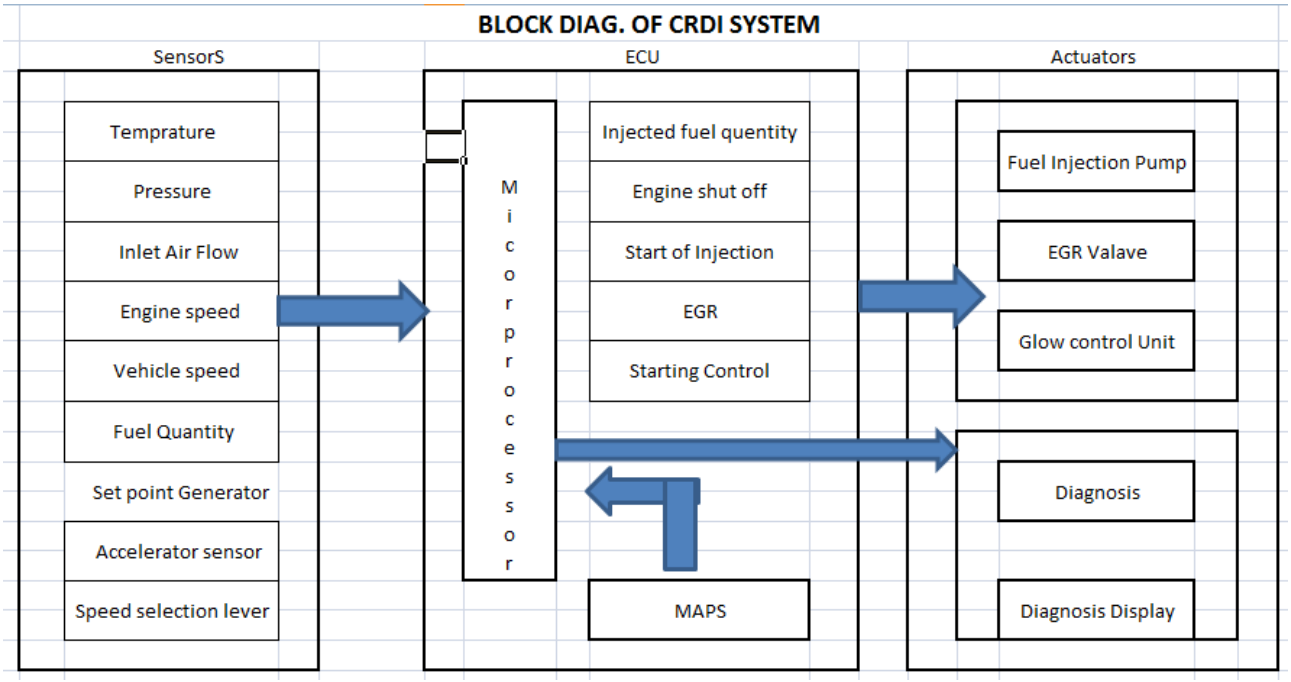
Answer: IGNITION SPARK ADVANCE CONTROL: - The logic module determines the precise spark advance requirements by interpreting data from the distributor rpm signal, MAP sensor, and coolant temperature sensor. When the engine is cold, the logic module will increase the spark advance for improved engine performance. The logic module commands the power module to open the primary ignition circuit at the right instant to provide the precise spark advance required by the engine. 1

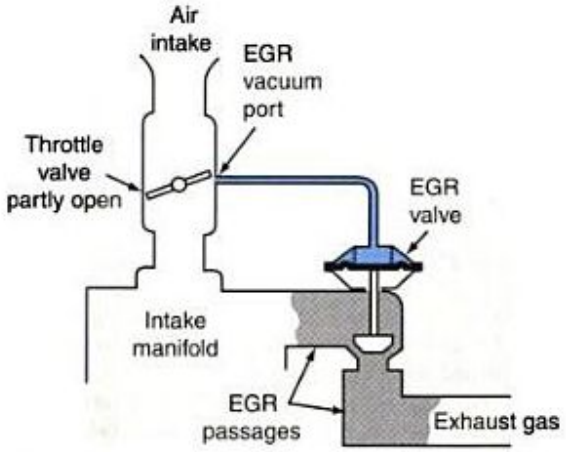
IDLE SPEED CONTROL: - While the engine is being started, the logic module will position the **automatic idle speed (AIS)** motor to provide the easy starting without the operator having to touch the accelerator pedal. When the engine is cold, the logic module will position the AIS motor to provide the correct cold fast idle speed. The AIS 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.

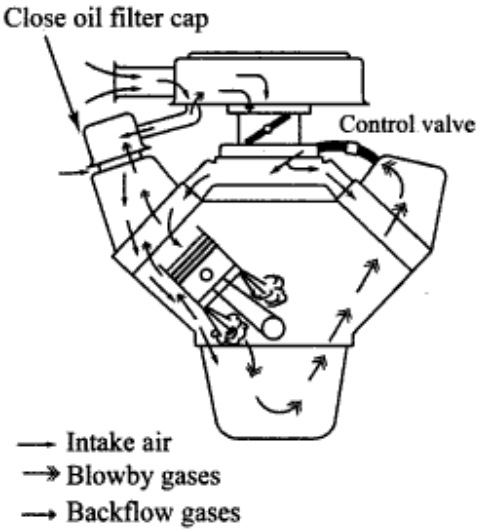
The AIS motor will provide the correct idle speed when the air conditioner is on and the correct throttle opening when the engine is decelerating.

EXHAUST GAS RECIRCULATION (EGR) CONTROL: - The logic module energizes a vacuum solenoid in the EGR vacuum system. When the solenoid is energized, it shuts off vacuum to the EGR valve, when the solenoid is de-energized, it allows vacuum to pass through it into the EGR system. The solenoid will be energized at speeds below 1200 rpm during wide open throttle operation or when the coolant temperature is below 21° C. During all other engine operating conditions, the solenoid is de-energized and vacuum is supplied through it to the pack-pressure transducer.

CANISTER PURGE CONTROL: - The logic module operates a solenoid connected in the vacuum hose to the canister purge valve. When the engine temperature is below 82° C the logic module energizes the solenoid, shutting off vacuum to the canister purge valve. Above this coolant temperature, the solenoid is de-energized, and the vacuum is supplied through it to the purge control valve. Under this condition the canister is purged through a port in the throttle body. The canister purge solenoid and the EGR solenoid are located with the diagnostic connector under a cover on the fender well. AIR CONDITIONING CONTROL: - When the throttle approaches the wide-open position, and the throttle position sensor voltage is above a specified value, the logic module will de-energize the air conditioning (A/C), wide open throttle (WOT) cutout relay, and the relay contacts will close, supplying voltage to the A/C compressor clutch. If the engine speed drops below 500rpm, the logic module will de-energize the A/C, WOT, cutout relay and open the circuit to the compressor clutch, preventing the engine from stalling under unusual conditions.	
f) State advantages and disadvantages of LPG as a S. I. engine fuel.	4
Answer: Advantages of LPG 1. It is cheaper than petrol 2. It is highly detonation resistant and does not pre-ignite easily. 3. It gives better manifold distribution and mixes easily with air. 4. Crankcase oil dilution is less/ nil, resulting in increased engine life. 5. Residue and oil contamination is small as it burns cleanly – implies- longer lubricating oil change period. 6. LPG is lead free – implies- less exhaust emission. 7. Life of spark plug is increased. disadvantages of LPG 1. It reduces volumetric efficiency due to its high heat of vaporization. 2. Handling has to be done under pressure of about 18 bars. 3. It characteristic odour is faint. An odourant (usually Mercaptan) is usually added so that the people will be aware of the leaks. 4. Much of its advantages can be realized (obtained) in engines of higher compression ratio. 5. Response to blending is very poor. 6. LPG produces 10 % less power for a given engine, at full throttle. 7. The vehicle weight is increased due to the use of heavy pressure cylinders for storing LPG	1*2 1*2
Q5 Attempt any Two of the following:	**16**
a) Draw a block diagram of CRDI system and describe its working. State advantages of CRDI	8

system.	
Answer: CRDI System  **Working:** • 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. • Microprocessor receives the sensor signals, converts the signal in required format and then processes the signals. eg. 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. • The signal to the actuators is given in the required form like analog signals. • 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. **Advantages:** 1. Separation of pressure generation and injection allowing flexibility in controlling both the injection rates and timing of CRDI 2. In CRDI system, Fuel pressure does not depend on the engine speed and load conditions 3. In CRDI, High injection pressures (about 1500 bar) and good spray preparations are possible even at low engine speeds and loads. 4. CRDI engines have capability to deliver stable, small pilot injections can be used for decreased NO_x emissions and noise.	4 2 2

5. In CRDI system, Fuel pump operates with low drive torque.	
b) What is EGR? Describe with sketch EGR.	8
Answer: EGR is Exhaust Gas recirculation. 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. Exhaust gas consists mainly of CO_2 and H_2O which are inert gases and do not react with oxygen; the EGR system recirculates these CO_2 & H_2O 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.  Fig: The EGR valve controls the amount of Exhaust flowing back into the intake manifold.	2 3 3
c) What is Positive Crankcase Ventilation? Describe with sketch PCV system.	8
Answer: The positive crankcase ventilation system is designed to control the emission from the crankcase. it is used to keep the crankcase clean of blow-by gases. It prevents the contamination of lubricating oil in the oil sump by fuel and products of combustion. It keeps the crankcase well	2

ventilated.  Positive Crankcase Ventilation It has a calibrated passage connected between oil filler tube and the air cleaner. It allows air to enter the crankcase only when the throttle valve is less than half open. At full throttle, the two hoses connected to air cleaner and manifold convey fumes to the induction system for burning in the engine. For correct operation of the engine, the crankcase is sealed during the operation of the engine. Components such as oil dip stick and oil filler cap is effectively sealed to prevent escape of the crankcase fumes.	3 3
Q6 Attempt any FOUR of the following	1
a) State and explain pollutants from S.I. engine emission.	4
Answer: The pollutants from gasoline engine are unburnt hydrocarbons from fuel tank and / or carburetor, unburnt hydrocarbons from crankcase, NOx, HC, CO, CO_2 and aldehydes are the pollutants from the tailpipe of engine. 1. Carburettor losses: occur due to air vent at float chamber. It also occurs due to **hot soak losses** which occur after the engine has been stopped, as a result of evaporation of petrol stored in the (float chamber) bowl, loss being through vent pipe or through air cleaner. 2. Crankcase blow-by: the blow-by is a phenomenon of leakage past the piston and piston rings from the cylinder to the crankcase. The blow-by HC emissions are about 20 % of the total HC emission from the engine. This is increased to about 30 % if the rings are worn. 3. Engine exhaust emission: complete combustion results carbon dioxide and water vapours. But due to incomplete combustion, the exhaust gas also contains carbon monoxide, a deadly poisonous gas, unburnt hydrocarbons (UBHC) and oxides of nitrogen (NO_x). at lower temperature the nitrogen is inert but at temperatures higher than 1100°C, nitrogen reacts with oxygen. Some of the oxides of nitrogen are very toxic and harmful. In addition there is large number of organic compounds formed.	1 1 1 1

b) Compare S. I. and C.I. engine on the basis of : 4
I) Thermodynamic cycle used ii) Compression ratio
iii) Power output per unit weight iv) Fuel economy

Answer: 1*4

Sr. No	S.I. ENGINE	C.I. ENGINE
a)	THERMODYNAMIC CYCLE	
	Otto cycle	Diesel cycle
b)	COMPRESSION RATIO	
	Compression ratio is low, about 10:1, limited by detonation	compression ratio is Higher, about 16:1 to 22:1
c)	POWER OUTPUT PER UNIT WEIGHT	
	S.I. engine may weigh about 2.7 kg/kW.	C.I. engine may be 2 to 3 times heavier than comparable S.I. engine. Roughly C.I. engine may weigh about 6.5 kg/kW
d)	FUEL ECONOMY	
	The η of the SI engine reduce rapidly at part throttle & idling-due to throttling of mixture.	CI engines give better fuel economy than SI engine .because of higher CR, η Bth (brake thermal efficiency) is higher implies lower BSFC.

c) State any four methods to improve fuel economy of an automobile. 4

Answer: **Methods of improving fuel economy.** 1*4

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)

d) Give types of injection system in MPFI and describe any one 4

Answer: The types of MPFI systems are D- MPFI and L- MPFI. 1

L- MPFI SYSTEM

- The L-MPFI system is a port fuel injection system.
- In this type, the fuel metering is regulated by the engine speed and the amount of air that actually enters the engine.
- The Air Flow Sensor measures the amount of air and sends information to the ECU.
- speed sensor sends information about the speed of the engine to the ECU.
- ECU processes the information and sends commands to the injector, in order to regulate the amount of petrol supply for injection.
- When injection takes place, the petrol mixes with the air and the mixture enters the cylinder.

3

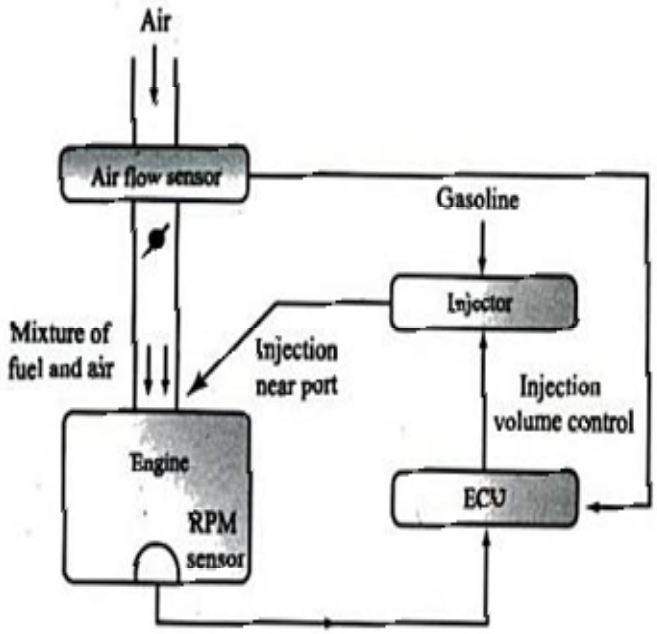
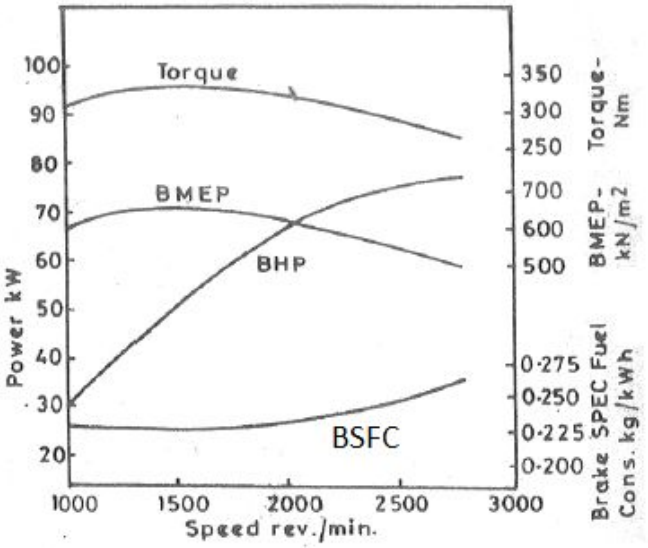


Fig. L-MPFI Gasoline Injection System

e) Draw performance characteristics curves of a diesel engine. 4

Answer



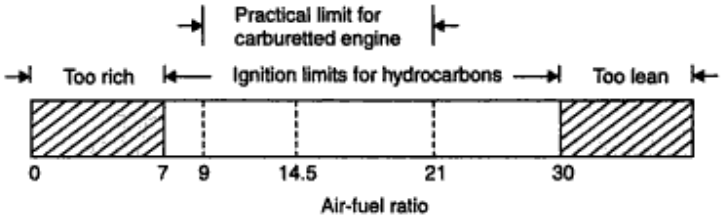
Performance curves of a diesel engine

4

f) What is ignition limit? Describe ignition limits for hydrocarbon fuels. 4

Answer: 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 neighbouring UN burnt mixture. The flame will propagate only if the temperature of the burnt gases exceeds approximately 1250^0 C in the case of hydrocarbon-air mixture. 2

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.

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

2