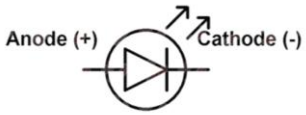
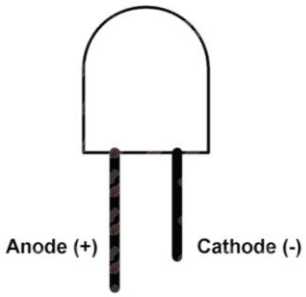
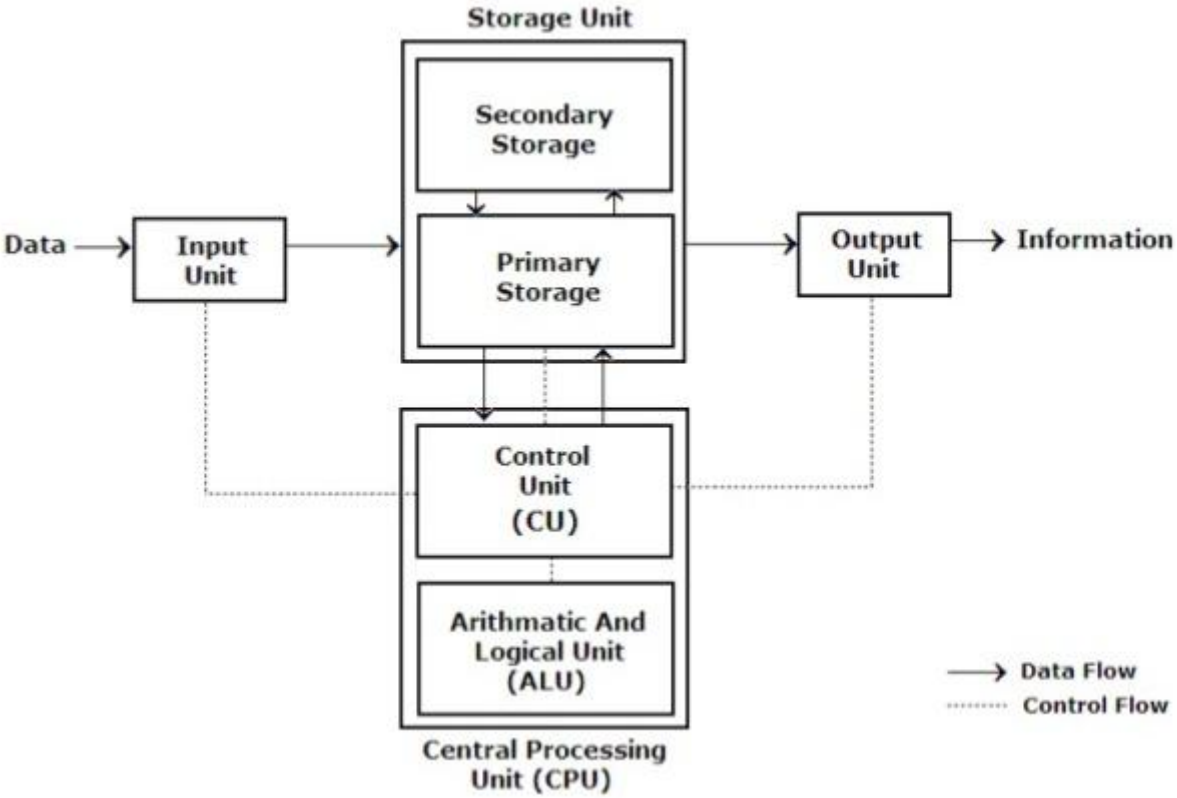
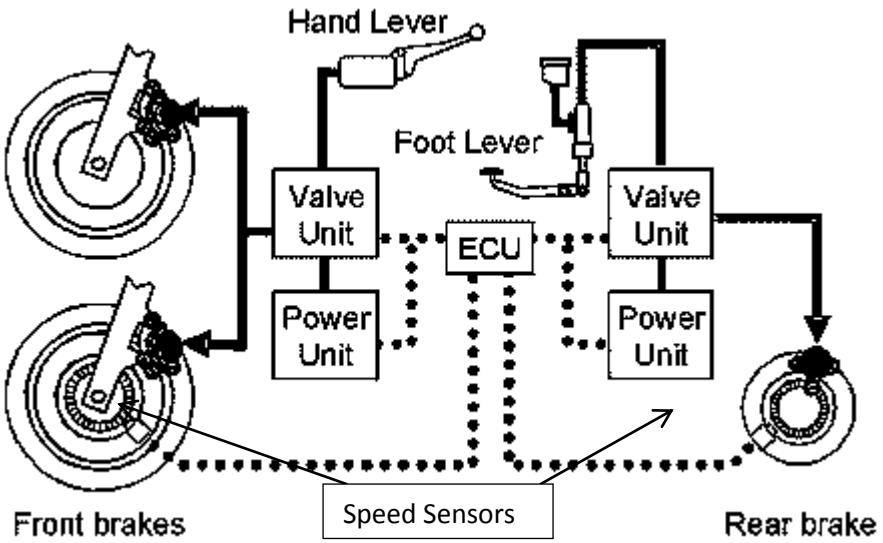
Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreimportance.(Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by 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.

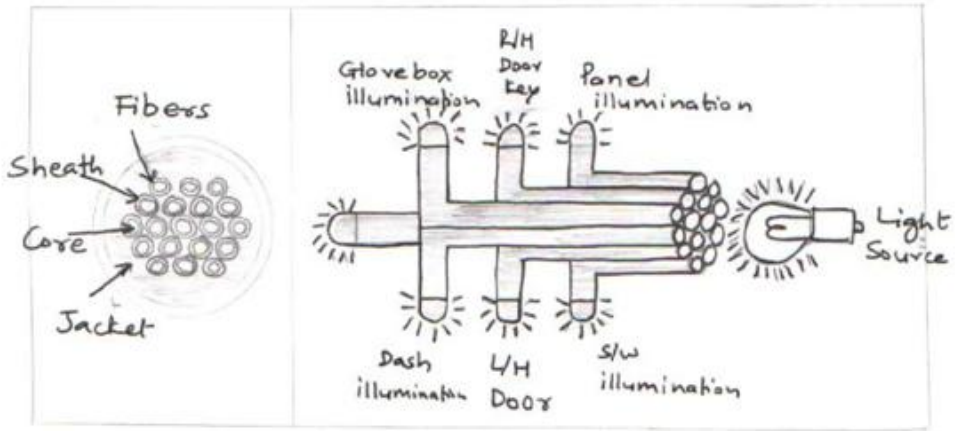
……

	Marks
1. a) Attempt any THREE of the following-	12
i) Explain LED. Enlist it's applications in automobiles.	04
Answer : *(Note: Explanation-2 marks, Credit should be given to sketch)* **Light Emitting Diode (LED):**A light emitting diode (LED) is similar in operation to the diode, except the LED emits light when it is forward biased. It has a small lens built into it so light can be seen when current flows through the diode. When the LED is forward biased, the holes and electrons combine and current is allowed to flow through it. The energy is generated is released in the form of light.Normally LED requires 1.5 to 2.2 volts to light.   Fig. symbol of LED **Applications:- (Any Two – 1 mark each)** i. It is used in head lamps and tail lamps system of vehicles. ii. It is used in light control panel. iii. It is used in interior light system of the car. iv. It is used in indicator lights of a car.	02 02

ii) State the need of safety systems used in vehicles.	04
Answer: ***(Note: Equivalent Explanation of need of safety systems - 4 marks)*** **Need of safety systems used in vehicles:** As vehicles improved with technological advancements, faster speeds were attained and annoying little bumps as well as more serious accidents were a byproduct of our use. Automobile manufacturers became more concerned with improving car safety and preventing injuries and deaths. It cannot be overstated how much car safety has improved over the years. But with that said, accidents can and do continue to occur. It is all of our responsibilities as motorists and passengers to strive for car safety. Not every accident can be prevented completely, but we as consumers can make good choices by selecting a safe vehicle for ourselves and our families, and use the restraint system. Some of the safety systems required for automobile vehicles for guidance to driver when he park the car in parking zone to avoid any small damage to our vehicles. Also some systems used to prevent the entry of thief in the car compartment.	04
iii) Draw the block diagram of basic computer.	04
Answer: ***(Note: Equivalent labeled block diagram - 4 marks)*** **Block Diagram of Basic Computer:**  	04

iv) State the purpose of OBD of MPFI system.	04
Answer: ***(Note: Credit should be given to Equivalent answer)*** **Purposes of OBD of MPFI system: (Any Four – 1 mark each)** • OBD provides an On Board Diagnostic System Capable of Identifying faults in the computer controlled system and to notify the driver by means of malfunctioning indicator light if the fault exists. • OBD is to have continuous monitoring & check functionality of a component within the fuel metering system, EGR system, and additional emission related components. • The requirements for diesel-engine vehicles vary and glow plug equipmentmay be monitored instead of the catalytic converter. • A sequence of diagnostic checks must be initiated at each engine start andcompleted at least once provided that the correct test conditions are met. • OBD used for measure, senses or responds tooperating variables (e.g. vehicle speed, engine speed, gear used, temperature,intake pressure or any other parameter) for the purpose of detecting malfunctionsand of minimizing the risk of indicating false malfunction. These devices are notdefeat devices. • OBD system required for the inspection, diagnosis, servicingor repair of the engine must be unrestricted and standardized. • The clean air Act of 1990 directed the Environmental Protection Agency (EPA) to develop new regulations for on-board diagnostics. The Environmental Protection Agency has been charged with reducing "mobile emissions" from cars and trucks and given the power to require manufacturers to build cars which meet increasingly stiff emissions standards. The manufacturers must further maintain the emission standards of the cars for the useful life of the vehicle. OBD-II provides a universal inspection and diagnosis method to be sure the car is performing to OEM standards. While there is argument as to the exact standards and methodology employed, the fact is there is a need to reduce vehicle emitted pollution levels in our cities, and we have to live with these requirements.	04
b) Attempt any ONE of the following:	06
i) Explain the concept and working of ABS with neat sketch.	06
Answer: ***(Note: Concept- 1 mark, Working -3 marks and equivalent sketch - 2 marks)*** **Concept of Antilock Braking System (ABS):** A skidding wheel(where the tire contact patch is sliding relative to the road) has less traction than a non-skidding wheel. If you have been stuck on ice, you know that if your wheels are spinning you have no traction. This is because the contact patch is sliding relative to the ice. By keeping the wheels from skidding while you slow down, anti-lock brakes benefit you in two ways: You'll stop faster, and you'll be able to steer while you stop. **Working:** There are four main components to an ABS system: i. Speed Sensors:The anti-lock braking system needs some way of knowing when a wheel is about to lock up. The speed sensors, which are located at each wheel, or in some cases in the differential, provide this information. ii. Valves:There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions. iii. Pump: Since the valve is able to release pressure from the brakes, there has to be some way	01

to put that pressure back. That is what the pump does; when a valve reduces the pressure in a line, the pump is there to get the pressure back up. iv. Controller: The controller is a computer in the car. It watches the speed sensors and controls the valves. The controller monitors the speed sensors at all times. It is looking for decelerations in the wheel that are out of the ordinary. Right before wheel locks up, it will experience a rapid deceleration. If left unchecked, the wheel would stop much more quickly than any car could. It might take a car five seconds to stop from 60 mph (96.6 kph) under ideal conditions, but a wheel that locks up could stop spinning in less than a second. The ABS controller knows that such a rapid deceleration is impossible, so it reduces the pressure to that brake until it sees acceleration, then it increases the pressure until it sees the deceleration again. It can do this very quickly, before the tire can actually significantly change speed. The result is that the tire slows down at the same rate as the car, with the brakes keeping the tires very near the point at which they will start to lock up. This gives the system maximum braking power.	03
 Fig. ABS system	02
ii)Enlist the different types of communication systems used in automobiles and describe fiber optics.	06
Answer: ***(Note: Enlist any four types of communication systems- 2 marks, explanation of fiberoptics - 2 marks, figure -2 marks)*** **Types of communication system in automobiles: (Any Four – ½ Mark Each)** 1. Bluetooth 2.Wi-Fi 3. CAN Bus 4. LIN Bus 5.GSM Network 6. Optic Fibers 7. Ethernet **Fiber Optic:-** • The invention of fiber optics material has provided a means of illuminating several objects with a single light source. • Plastic fiber optic strands made from a special plastic (**polymethylmethacrylate plastic)**are used to transmit light from the source to the object to be illuminated.	02 02

• This plastic helps to keep the light rays parallel even in the presence of extreme bends in the plastic. • The strands of plastic are sheathed by a polymer that insulates the light rays as they travel within the strands. • The light rays travel through the strands by means of internal reflections.  Fig. Optic Fibers	02
2. Attempt any FOUR of the following	16
a) Enlist any four automotive sensors along with their location. State its functions.	04
Answer: ***(Note:- Any four sensors-1 Marks each)*** **Following are the automotive sensors: (Credit should be given to equivalent answer)** **1. Oxygen Sensor:-** **Function:** Used to monitor the amount of oxygen in the exhaust. **Location:** Located in exhaust manifold. **2. Manifold Absolute Pressure Sensor:-** **Function:** The Manifold Absolute Pressure Sensor (MAP) supplies engine load information to the engine control module. **Location:** Located in Intake manifold. **3. Crankshaft Position Sensor:-** **Function:**The crankshaft position is used by the control module to calculate engine speed and cylinder position. **Location:** Near the toothed wheel of crank shaft. **4. Coolant Temperature Sensor:-** **Function:** Used to measure the engine temperature or coolant temperature. **Location:** The ECT sensor is screwed into the side of the engine where it is exposed to the engines coolant. **5. Inlet Air temperature sensor:-** **Function:** The intake air temperature sensor is a thermistor that is used to input air temperature information to the control module. **Location:** In Intake manifold.	04

6. Camshaft position sensor:-

Function: The camshaft position sensor is used by the control module to determine the position of the number one cylinder.

Location: Sensors can be mounted in the distributor or in the timing cover, facing the camshaft gear.

7. Detonation sensor:-

Function: The knock sensor is used by the control module to monitor engine detonation or spark knock.

Location: The knock sensor can be found at various locations on the engine block or cylinder head.

8. Throttle position sensor:-

Function: Used to monitor the position of the throttle in an internal combustion engine.

Location: In throttle body.

9. Mass Air Flow Sensor:-

Function: Used to tell the ECU the mass of air entering the engine.

Location: The mass air flow sensor is located between the air cleaner and the throttle body.

b)Explain the working of air bag with neat sketch. 04

Answer: ***(Note: Working -2mark& Equivalent Sketch – 2 mark)***

Working of Air bags:

The goal of an air bag is to slow the passenger's forward motion as evenly as possible in a fraction of a second. There are three parts to an airbag that help to accomplish this feat:-

1. The bag itself is made of a **thin nylon fabric**, which is folded into the steering wheel or dash board or, more recently the seat or door.
2. The sensor is the device that tells the bag to inflate. Inflation happens when there is collision force equal to running into a brick wall at **10 to 15 miles per hour (16 to 24 Km per hour).** A mechanical switch is flipped when there is a mass shift that closes an electrical contact, telling the sensor that a crash has occurred. The sensors receive information from an accelerometer built into a microchip.
3. The airbag's inflation system reacts **sodium azide (NaN3) with potassium nitrate (KNO3) to produce nitrogen gas.** Hot blasts of the nitrogen inflate the airbag.

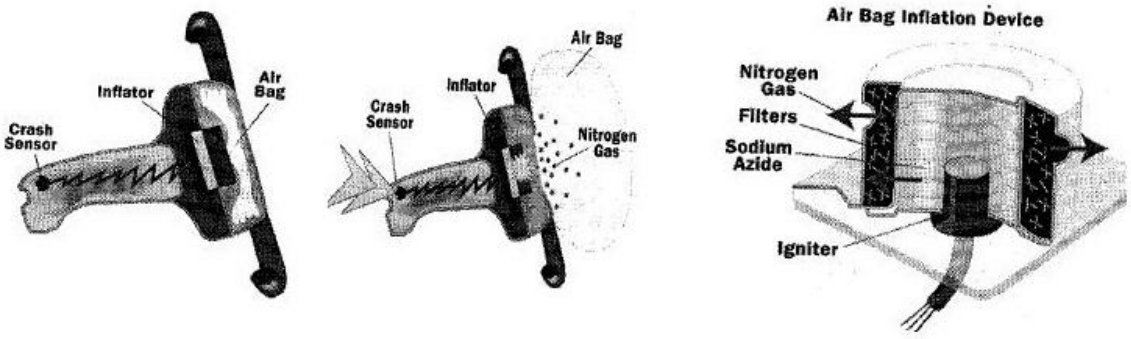


Fig. Air Bag

02

c) Compare between analog and digital visual display. 04

Answer: ***(Note: Any four points- 1 mark each)***

Comparison between analog and digital visual display: (Any Four) 04

Analog visual display	Digital visual display
An analog signal is any continuous signal for which the time varying feature of a signal is a representation of some other time varying quantity.	A digital signal is a physical signal that is a representation of a sequence of discrete values.
The reading is not precise.	The reading is precise.
Recording of the reading is not easy.	Recording of the reading is easy.
Convex errors may be present.	No convex/errors are present.
Extension of the reading is not possible.	Extension of the reading is possible.
Simple in design.	Complex in design.
Low cost.	High cost.

d)Explain electronic control system used in MPFI. 04

Answer:*(Note: Explanation - 4 marks, Credit should be given to equivalent Sketch)* 04

Electronic Control System used in MPFI:

Anelectronic engine control system is an assembly of electronic and electromechanical components that continuously varies the fuel and spark setting in order to satisfy government exhaust emission and fuel economy regulations.

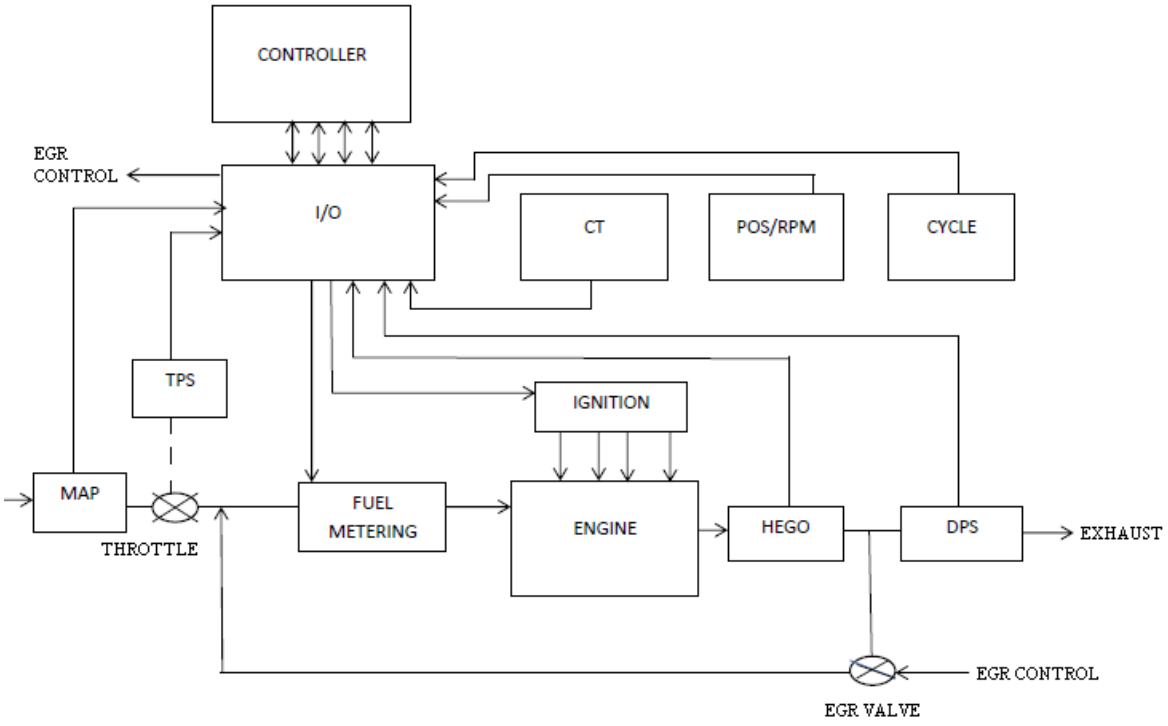


Fig. Electronic control system used in MPFI

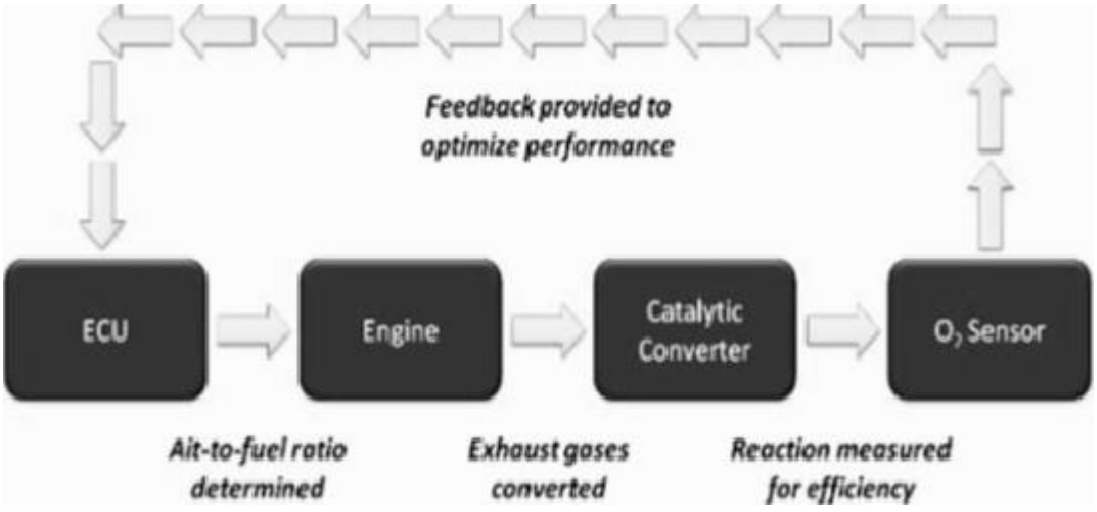
MAF: Mass air flow sensor
CT: Coolant temperature sensor
HEGO: Heated exhaust gas O_2 sensor
POS/RPM: Crank shaft angle position and RPM sensor cycle

TPS: Throttle position sensor
DPS: Differential pressure sensor for EGR control
EGR: Exhaust gas recirculation
I/O: Input/ Output
The electronic engine control system receives input electrical signals from the various sensors that measure the state of the engine. From this signals, the controller generates output electrical signals that determine the engine calibrations (i.e. correct fuel delivery and spark timing).
In modern engine control system, the controller is a special purpose digital computer built around a microprocessor. The controller includes ROM containing the main program as well as RAM for temporary storage of data during computation. The sensor signals are connected to the controller via an input / output sub system. Similarly the input /output sub system provides the output signals to the drive the fuel injectors as well as to trigger pulses to the ignition system.
In addition this solid state control system includes hardware for sampling and analog to digital conversion. Such that all sensors measurement is in a format suitable for reading by the microprocessor. The control system selects and operating modes based on the instantaneous operating condition as determine from the sensor measurements.
Within any given operating mode the desired air fuel ratio is selected. The controller then determines the quantity of fuel to be injected in to each cylinder during each engine cycle. This quantity of fuel depends on the particulars engine operating conditions as well as the controller mode operations.

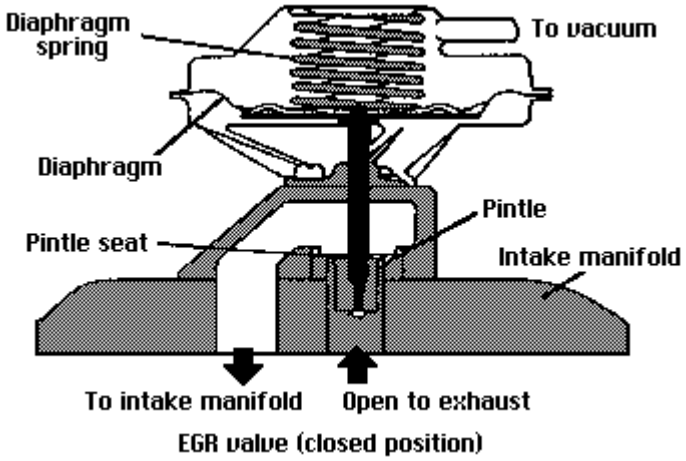
e) Explain with block diagram closed loop control system. — 04

Answer: ***(Note: Explanation -2 mark, Equivalent Block diagram -2 mark.)***

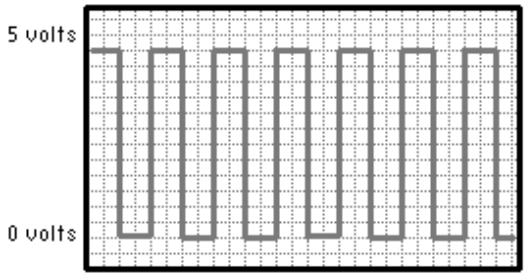
Closed loop Control system:
Control system in which the output has an effect on the input quantity in such a manner that the input quantity will adjust itself based on the output generated is called **closed loop control system**. Open loop control system can be converted in to closed loop control system by providing a feedback. — 02
This feedback automatically makes the suitable changes in the output due to external disturbance. In this way closed loop control system is called automatic control system. Figure below shows the block diagram of closed loop control system in which feedback is taken from output and fed in to input.



02

f) State the applications of lux meter and oscilloscope**.**	04
Answer: ***(Note: Any Two Applications of each instrument -2 marks.)*** **Applications of Lux Meter:- (Any Two – 1 mark Each)** 1. Used to measure light intensity. 2. It is used in photographyand video filming, 3. Check intensity of headlights in the automatic ON/OFF headlight system. **Applicationsof Oscilloscope:-(Any Two – 1 mark Each)** 1. Power analysis, 2. Serial data analysis, 3. Jitter analysis, 4. Data storage 5. device testing, 6. Time domain, 7. Reflectometry, 8. Engine vibrations, 9. Rise time measurement, 10. Phase measurement, 11. Bandwidth measurement etc.	02 02
3. Attempt any FOUR of the following	16
a)Explain with neat sketch working of EGR valve.	04
Answer: ***(Note: Explanation -2 mark, Equivalent diagram -2 mark)***  Fig. Vacuum operated EGR valve **Working of EGR valve**: Most early EGR valves were vacuum-operated. A vacuum diaphragm opened and closed a valve, allowing and cutting off exhaust flow. An early refinement was a temperature-controlled shut-off in the vacuum source. This kept the EGR valve from opening when the engine was too cool. The cool engine did not require EGR and cutting it off made the engine run smoother. EGR flow is also undesirable at other times, for instance at idle. At very low speed, combustion temperature is naturally lower. Adding exhaust gas at low speed can cause rough idle. The positive back-pressure EGR valve helped solve this problem. Similar to a	02

standard vacuum model, the positive back-pressure design has a hollow valve stem. This allows exhaust gas pressure to push against a spring loaded vacuum valve. When back pressure rises, such as on acceleration, exhaust pressure closes the spring-valve and seals the vacuum opening. This allows an engine vacuum to open the EGR valve.When back pressure is low, such as at an idle, the spring opens the vacuum port. Engine-vacuum is bled off and the EGR valve closes. The design change has caused many good EGR valves to be replaced needlessly.	02
b)State the use of semi-conductor diode and photo diode in Automobile.	04
Answer: ***(Note: Any Two uses of each instrument - 2 marks.)*** **1. Uses of Semi-conductor diode**: **-(Any Two – 1 mark Each)** a. Used in Voltage regulator in charging system, b. Rectifier bridge in chargingsystem, c. Automatic headlight dimming system. **2. Uses of Photo diode: -(Any Two – 1 mark Each)** a. Used in automobile headlight system, b. Ignition system, c. display system.	02 02
c) Explain the procedure for standalone diagnosis of actuators.	04
Answer: ***Note: (Description - 2 mark each – Credit should be given to sketch)*** **Testing of actuators: Testing of electronic injector-** **1.Sound Test:** a. The injector sound test is a method of quickly checking the operation of the pintle on engine where the injectors are accessible. b. A port injector that is not functioning may cause a cylinder misfire at low engine speed. c. With the engine idling a stethoscope pickup may be placed on the side of the injector body. d. Each injector does not produce any clicking noise the injector connecting wires or PCM may be defective. f. When the injector clicking noise is erratic the injector plunger may be sticking. g. If there is no injector clicking noise, proceed with the injector ohms test to locate the cause of the problem. **2. Ohmmeter Test:** a. An ohmmeter may be connected across the injector terminals to check the injector winding after the injector wire are disconnected. b. If the ohmmeter reading is infinite the injector winding is open. c. An ohmmeter reading below the specified valve indicates that the injector winding is shorted d. A satisfied injector winding should have result between 0.3 to 0.4 ohms. e. Replace the injector if the results do not have the specified resistance.	02 02

d) Explain working of crankshaft position sensor with neat sketch.	04
Answer: ***(Note: working - 3 marks and output voltage signal-1 marks)*** **Working of Crankshaft position sensor:** The principle elements of the sensor are: • An iron rotor with lobes on it • A permanent magnet • A metallic path (the pole piece) for carrying the magnetic flux • A coil, wound around the metallic path, in which a voltage is induced. It consists of a permanent magnet with a coil surrounding it. A metal tab passing close to the magnet fluxes the magnetic field across the coil, which in turn causes a change in the reluctance of the coil. A current being sent through the coil would change. The momentary change in the current is the output signal of the sensor. The output voltage is shown below: It should be in the range of 0V to 5V.  Amplitude remains constant but frequency increases with engine rpm	03 01
e) State any four types of computer memory.	04
Answer: ***Note: (Any four - 1 mark each)*** **Types of computer memory: (Any Four Listing – 1 mark)** 1.ROM: Read only Memory 2. PROM: Programmable Read only Memory 3. EPROM: Erasable Programmable read only memory 4. EEPROM: Electrically Erasable Programmable read only memory 5. RAM: Random access memory 6.KAM:Keep Alive memory **Explanation of Types of computer memory:(Any Four– 3 mark)** 1. **Read only memory (ROM)** contains a fixed pattern of 1s and 0s that represent permanent stored information. ROM contains the basic operating parameters for the vehicle. This information is used to instruct the computer on what to do in response to input data. The CPU reads the information contained in the ROM, but it cannot write to it or change it. ROM memory is not lost when power to the computer is lost. 2. **PROM: (Programmable Read only Memory)** the information in PROM is used to define or adjust the operating parameters held in ROM. It contains specific data that pertains to the exact vehicle in which the computer is installed. 3. **EPROM: Erasable Programmable read only memory** is similar to the PROM except its contents can be erased to allow new data to be installed. 4. **EEPROM: Electrically Erasable Programmable read only memory** allows changing the information electrically one bit at a time. 5. **RAM: Random access memory (RAM).** The RAM will store temporary information that can be read from or written to by the CPU.	01 03

6. Keep Alive memory (KAM) is a variation of RAM. KAM is connected directly to the battery through circuit protection devices. For example, the microprocessor can read and write information to and from the KAM, and erase KAM information. However, the KAM retains information when the ignition switch is turned off. KAM will lost when the battery is disconnected, if the battery drains too, or if the circuit opens.

4.a) Attempt any THREE of the following: 16

i) Explain how analog signals are converted into digital signals. 04

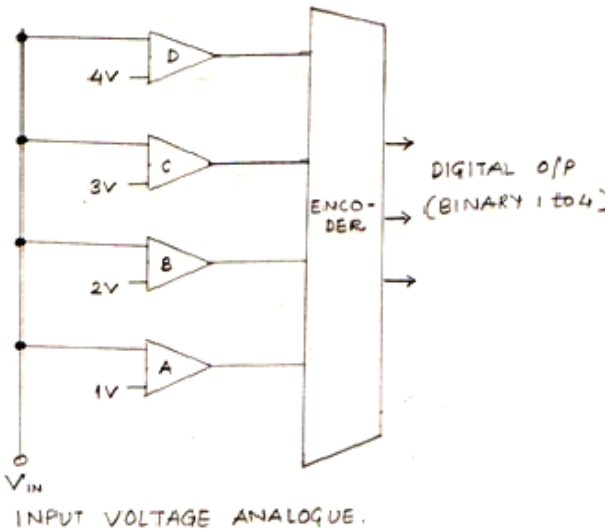
Answer: ***(Note: Description-02 Mark; Equivalent sketch- 02 mark)***

Analog to Digital Conversion:

Analog to digital conversion is necessary because many sensor signals are of analog (varying voltage) form. In order for the control computer (ECU) to function these analog signals must be converted to binary codes (digital signals). Conversion from an analog voltage to a digital code can be done in a number of ways. Figure shows one type of A/D converter that is known as a 'flash' converter.

The flash converter consists of four comparators and an encoder circuit which takes the comparator outputs and converts them into a binary code. An electronic comparator is a circuit which continuously compares two signals. One of the inputs, at each comparator is a reference voltage. When the input voltage matches the reference voltage the comparator outputs logic 1. The reference voltages shown in the figure are 1V up to 4 V. Table shows the input/output performance of the converter. 02

FLASH TYPE ANALOGUE TO DIGITAL CONVERTER.



INPUT VOLTAGE ANALOGUE. 02

A/D converter input Voltage range	Comparator outputs A B C D	Encoder outputs
0-1V	0 0 0 0	0 0 0
1-2V	1 0 0 0	0 0 1
2-3V	1 1 0 0	0 1 0
3-4V	1 1 1 0	0 1 1
4-5V	1 1 1 1	1 0 0

ii) Explain in brief global positioning system (GPS).	04
Answer:*(Note: Explanation-4 marks and Credit should be given to Equivalent sketch)*	04

Global positioning system (GPS): The Global Positioning System (GPS) is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

GPS systems are made up of 3 segments:-

- Space Segment (SS)
- Control Segment (CS)
- User Segment (US)

1. Space Segment:

   GPS satellites fly in circular orbits at an altitude of 20,200 km and with a period of 12 hours. Powered by solar cells, the satellites continuously orient themselves to point their solar panels toward the sun and their antenna toward the earth. Orbital planes are centered on the Earth. Each plane has about 55° tilt relative to Earth's equator in order to cover the polar regions. Each satellite makes two complete orbits each sidereal day. Sidereal - Time it takes for the Earth to turn 360 degrees in its rotation. It passes over the same location on Earth once each day.

2. Control Segment: The CS consists of 3 entities:
   i. Master Control Station:-The master control station, located at Falcon Air Force Base in Colorado Springs, Colorado, is responsible for overall management of the remote monitoring and transmission sites.
   ii. Monitor station: - Each of the monitor stations checks the exact altitude, position, speed, and overall health of the orbiting satellites. The control segment uses measurements collected by the monitor stations to predict the behavior of each satellite's orbit and clock. The prediction data is up-linked, or transmitted, to the satellites for transmission back to the users.
   iii. Ground Antennas: - Ground antennas monitor and track the satellites. They also transmit correction information to individual satellites.

3. User Segment:The user's GPS receiver is the US of the GPS system. GPS receivers are generally composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly-stable clock, commonly a crystal oscillator. They can also include a display for showing location and speed information to the user.

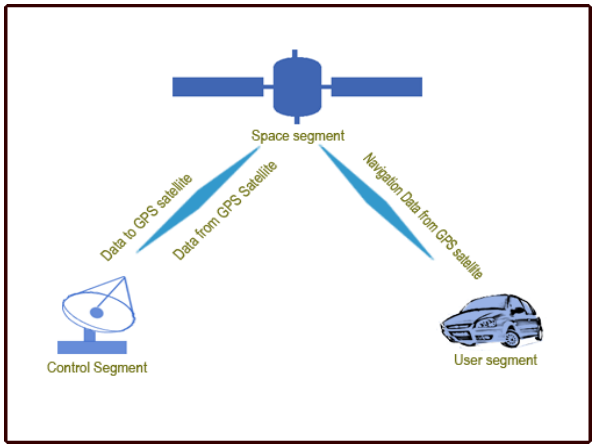


Fig. Global Positioning System

iii)Explain binary number system with suitable example. 04

Answer: ***(Note: Credit should be given to equivalent example &Explanation-4 marks)***

Binary number system:

Most modern computer systems operate on the binary logic. A binary number system use only two digits namely 0 and 1. It uses a base 2 system.

The binary digits (0 and 1) are also called as bits. Thus the binary system is a two bit system. The left most bit in a given binary number with the highest weight is called as the most significant bit(MSB) whereas the rightmost bit in a given number with the lowest weight is called as the least significant bit (LSB). It is represented as (0, 1)

In the binary system, whole numbers are grouped from right to left. Because the system usesonly two digits. The first portion must equal a 1 or a 0. To write the value of 2, the second positionmust be used. In binary, the value of 2 would be represented by 10 (one two and zero ones). To continue, a 3 would be represented by 11(one two and one one). Figure illustrates the conversion ofbinary numbers to digital base ten numbers. For example, if a thermistor is sensing 150 degrees, thebinary code would be 10010110. If the temperature increases to 151 degrees, the binary codechanges to10010111

04

Decimal number	Binary number code 8 4 2 1	Binary to decimal conversion
0	0000	= 0 + 0 = 0
1	0001	= 0 + 1 = 1
2	0010	= 2 + 0 = 2
3	0011	= 2 + 1 = 3
4	0100	= 4 + 0 = 4
5	0101	= 4 + 1 = 5
6	0110	= 4 + 2 = 6
7	0111	= 4 + 2 + 1 = 7
8	1000	= 8 + 0 = 8

iv)Write the on board diagnosis procedure for CRDI system. 04

Answer:***(Note: Credit should be given to equivalent procedure – 4 mark)***

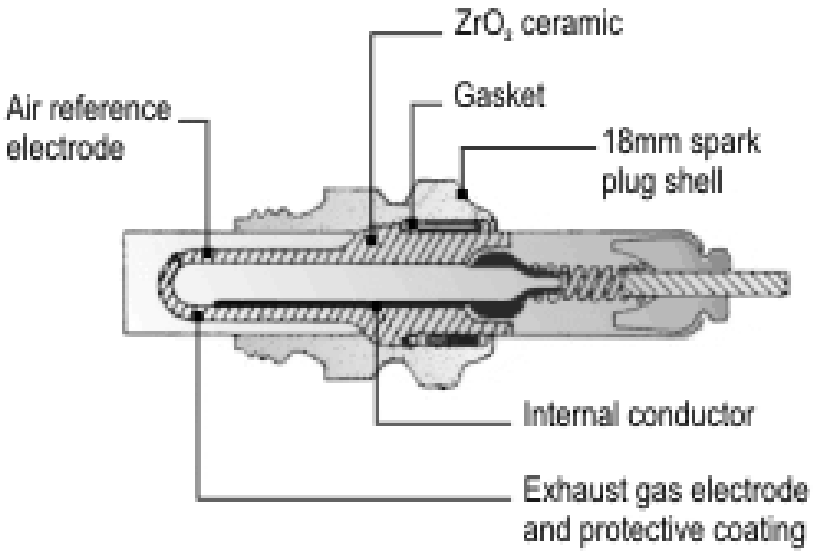
On board diagnosis procedure for CRDI system:

The On Board Diagnosis procedure can be carried out with the help of a diagnostic tool. There are a variety of tools used for diagnosis of a vehicle. We shall list out the procedure carried out with the help of a BOSCH KTS 180 SCANNER or equivalent tool.

The following procedural steps are carried out:

1. Connect the tool with the output of the ECM with the help of a data link connector.
2. Select the vehicle to diagnose from the menu list of the tool.
3. After that the tool is going to ask the operator to select the group i.e. Engine control, ABS, HVAC, or Central electronics system etc.
4. Suppose engine control group is selected the tool is now going to identify the code of the ECM used in the vehicle.

04

5. After identifying the ECM code the tool is going to ask for conducting the diagnosis of sensors and actuators. 6. While checking the sensors if there is any DTC present the tool is going to display the code on the screen. 7. Actuator tests can also be performed by the tool to check if the actuators are operating properly.	
b) Attempt any ONE of the following:	06
i) Explain the construction and working of oxygen sensor.	06
Answer: ***(Note: Construction – 2 mark and Working-2 mark and figure-2 mark)***	
Construction & working of Oxygen sensor:	
Construction:	
	02
Fig. cut section of oxygen sensor	02
The core of the sensor consists of a hollow ceramic bulb or tube like structure coated with a platinum film and a protective coating. Surrounding that is a metal shield with perforations to allow exhaust gases to come in contact with the bulb. The inside of the bulb is vented to the atmosphere.	
Working: The oxygen sensor operates on the basis of a difference between the oxygen partial pressure of atmospheric air and the partial pressure of oxygen in the exhaust gas. Figure shows that the sensor element is essentially a cell (battery). The plates are made from platinum which have a layer of ceramic zirconia between them which acts as an electrolyte. The platinum plates acts as a catalysts for the oxygen which makes contact with them, and they are also used to conduct electricity away from the sensor. The catalyzing action that takes place when oxygen contacts the platinum plates causes the transport of oxygen ions through the electrolyte and this creates the electric current that gives rise to the e.m.f. (voltage) of the sensor.	02

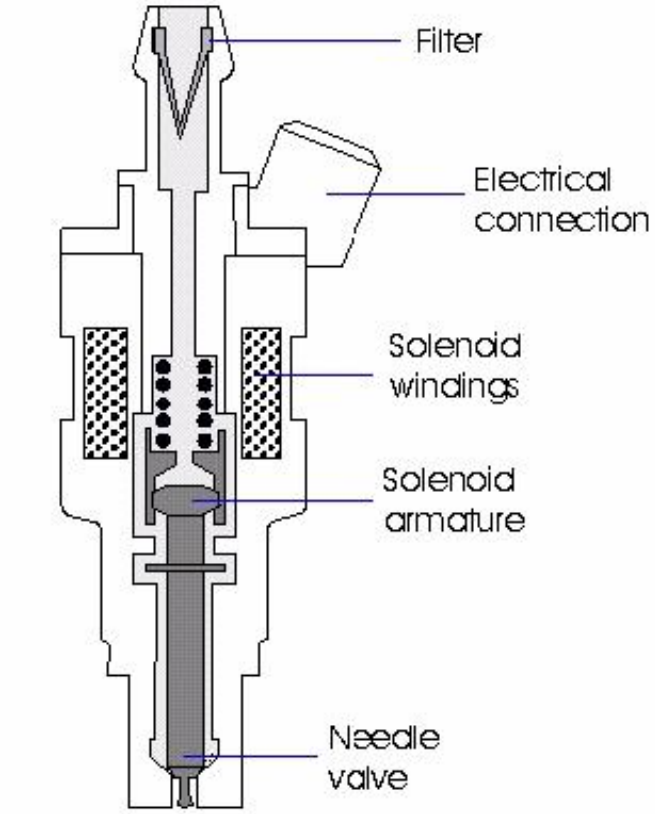
ii)Describe the working of unit injector as an actuators.	06
Answer: ***(Note: Working -4 marks, Equivalent diagram -2mark.)***	

Electronic Fuel Injector (Unit Injector):

A vacuum –powered fuel pressure regulator at the end of the fuel rail ensures that the fuel pressure in the rail remains constant relative to the intake pressure. For a gasoline engine, fuel pressure is usually on the order of 35-50 psi. Fuel injectors connect to the rail, but their valves remain closed until the ECU decides to send fuel into the cylinders. 04

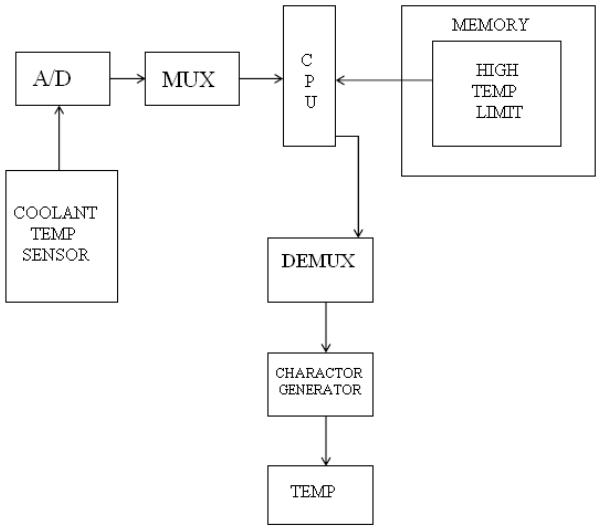
Usually, the injectors have two pins. One pin is connected to the battery through the ignition relay and the other pin goes to the ECU. The ECU sends a pulsing ground to the injector, which closes the circuit, providing the injectors solenoid with current. The magnet on top of the plunger is attracted to the solenoids magnetic field, opening the valve. Since there is a high pressure in the rail, opening the valve sends fuel at a high velocity through the injectors spray tip. The duration that the valve is open and consequently the amount of fuel sent into the cylinder depends on the pulse width (i.e. how long the ECU sends the ground signal to the injector).

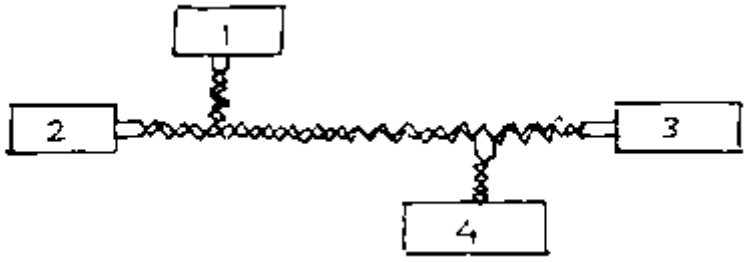
When the plunger rises, it opens a valve and the injector sends fuel through the spray tip and into either the intake manifold, just upstream of the intake valve, or directly into the cylinder.



02

Fig. Electronic Fuel Injector

5. Attempt any FOUR of the following:	16
a) State the different types of errors.	04
Answer: ***(Note- Any Two Types of errors - 04 marks.)***	
Types of error:- (Any Two) 1) Gross error 2) Systematic error 3) Random error **1. Gross error:** The class of errors covers human mistakes in reading instruments and recording and calculating measurement results. The responsibility of the mistakes normally lies with the experimenter. **2. Systematic error:** Systematic error result from known variation in instrument performance, for which corrections can be made if desired. There are many sources of systematic errors, including temperature variation in calibration, loading and dynamic response. **a. Systematic loading errors** - This error are due to energy extracted by the instruments when making measurements. Whenever the energy extracted from a system under measurement is not negligible, the extracted energy causes a change in the quantity being measured. Whenever possible, an instrument is designed to minimize such loading effects. **b. Dynamic Response**- This are the another source of Systematic error. Any instruments has limited response rate to very rapidly changing input. In many automotive instrumentation applications the bandwidth is purposely reduced to avoid rapid fluctuation in reading. **3. Random Error**: Random errors are essentially random fluctuations in indicated value for the measurement. Most random measurement error results from noise.	04
b) Explain the digital visual display.	04
Answer:*(Note: Description- 04 marks, credit should be given to block diagram)* **Digital visual display:** An example of digital visual display system is given below: Coolant temperature measurement  **Fig: Digital visual display for coolant temperature measurement**	04

The coolant temperature sensor used in most of the cars is a solid-state sensor called a thermistor. The resistance of this sensor decreases with increasing temperature. The sensor output voltage is converted to a binary number by the A/D converter and is sent to the CPU through the MULTIPLEXER (MUX). The computer compares this binary number to the one stored in memory that corresponds to the high temperature limit. If the coolant temperature exceeds the limit, an output signal is generated that activates the warning indicator. If the limit is not exceeded, the output signal is not generated and the warning message is not activated. A proportional display of the actual temperature is then displayed to the display via a DEMUX.	
c)Describe operation of camshaft position sensor.	04
Answer:*(Note: Credit should be given toEquivalent Description 04 marks)* **Camshaft Position Sensor Inductive type:** The Camshaft sensor can be an inductive type sensor (AC sine wave) or a Hall Effect producing square wave on/off signal and is exactly the same as the crankshaft senor. Each tooth produces a pulse signal, and as the camshaft speeds up more pulses are produced; the ECU determines the speed of the shaft by the number of pulses in one second. The signal is used for quicker cylinder 1 recognition. When the ECU receives a signal from the camshaft sender and the reference mark from the crankshaft simultaneously it knows that it is now on compression in cylinder number 1. It then counts the number of teeth on the crankshaft as each tooth represents a number of degrees of crankshaft rotation and from this information the ECU can calculate the position of each piston.	04
d) Explain CAN Bus communication system.	04
Answer:*(Note: Equivalent Description of CAN Bus system - 04 marks)* **CAN bus system:** CAN (Controller Area Network) is an example of an automotive digital data system. CAN is aserial synchronous communication protocol that connects electronic control modules sensors and actuators. A typical example of the CAN bas system used in Rover vehicle is described below.A Two wire CAN bus that can operate at high data transmission speeds of up to 500k band (500000bits/sec) is shown in the figure.  1. Automatic transmission control unit 2. Engine control module 3. ABS/ Traction control ECU 4. Instrument Pack.	04

The twisted pair of the CAN bus system minimizes electrically initiated interference and virtually eliminates the possibility of messages becoming corrupted. The major feature of the CAN bus system are: 1. Priority controlled message transmission. 2. Low cots through the use of a low cost twisted two wire cable and use of simple protocol with low power demand. 3. A data transfer rate up to 1MBPS for the high speed CAN (CAN-C) and up to 125KBPS for the low speed CAN (CAN-B) . 4. Of data transfer. In simple words CAN is a message based vehicle bus standard that allows ECU's to communicate with each other within a vehicle.	
e) State the applications of battery tester and frequency meter.	04
Answer:*(Note: AnyTwo applications of each)* ***1.* Battery Tester**: - ***(Any Two – 1 Mark each)*** a. Voltage measurement, b. Resistance measurement, c. CCA valueMeasurement, d. Battery condition, e. Battery load test etc. ***2.* Frequency meter**: - ***(Any Two – 1 Mark each)*** a. To check sensors such as throttle position, b. crankshaft position, cam-shaft position etc. c. To check radio frequency in cars, d. Electronic suspension system (to check vibrations of dampers)	02 02
f) Explain with neat sketch electronic power steering system.	04
Answer:*(Note: Description-2 marks and neat sketch-2 marks)* **Electronic power steering:-** An electronically control power steering system adjusts steering boosts adaptively to driving conditions using electronic control of power steering the available boost is reduced by controlling a pressure relief valve on the power steering pump. The system consists of following components: 1. Steering column that connects the steering pinion with steering wheel inside the vehicle. 2. Steering pinion that converts the rotating steering movement into linear movement of the rack. 3. Rack connected to the wheels via tie rods and links. 4. Sensors to record the information required to calculate the necessary supporting steering torque. 5. Servo unit consisting of an ECU and servo motor (electric motor) that generates the supporting steering torque.	02

Working:

When the driver moves the steering wheel a sensor registers the steering torque exerted and sends this information as an electric signal to ECU. This calculates the supporting torque and activates the servo motor on the basis of the calculated result. Generally the steering torque generated by these motors is 3-6 Nm. The direction of rotation of motors depends on the direction of motion of steering wheel.

The control electronics takes into account the different signals and parameters e.g. Driving speed, steering angle, steering torque and steering speed with the help of other sensors in the vehicle and due to networking of steering ECU with other ECUs in the vehicle framework. This steering system can be used to implement assistance function to enhance comfort and safety.

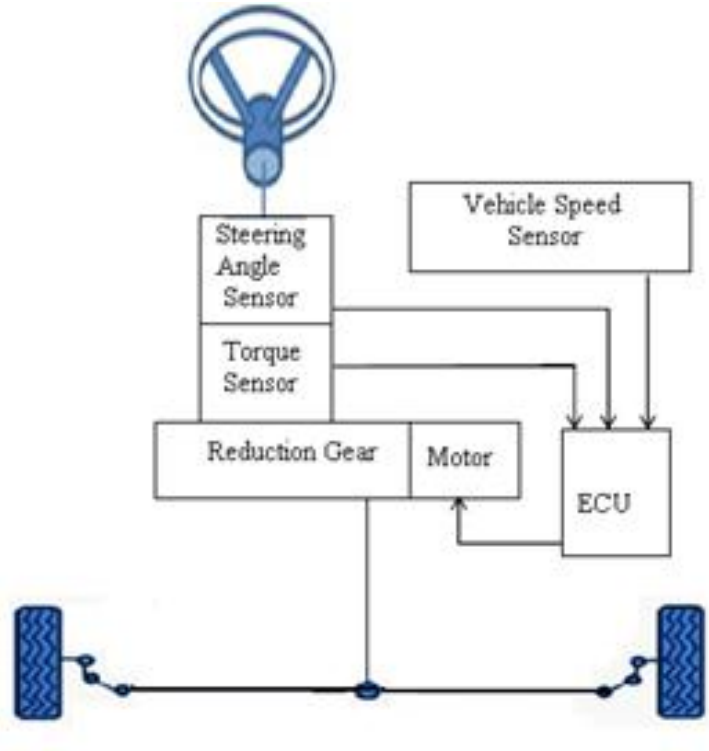
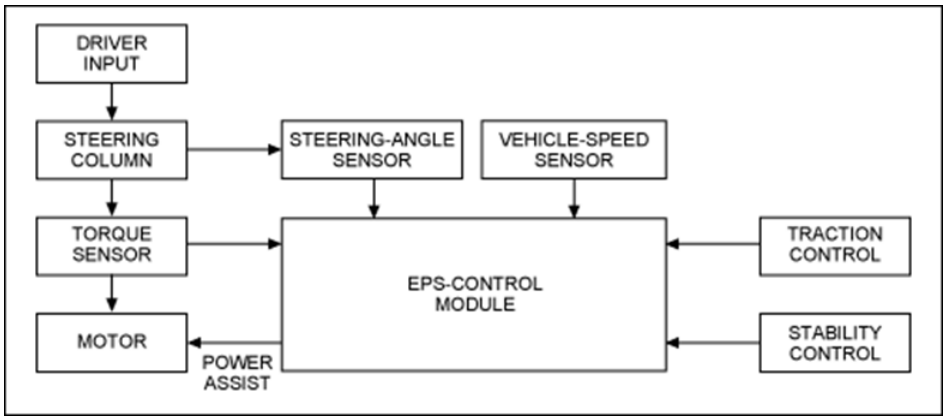
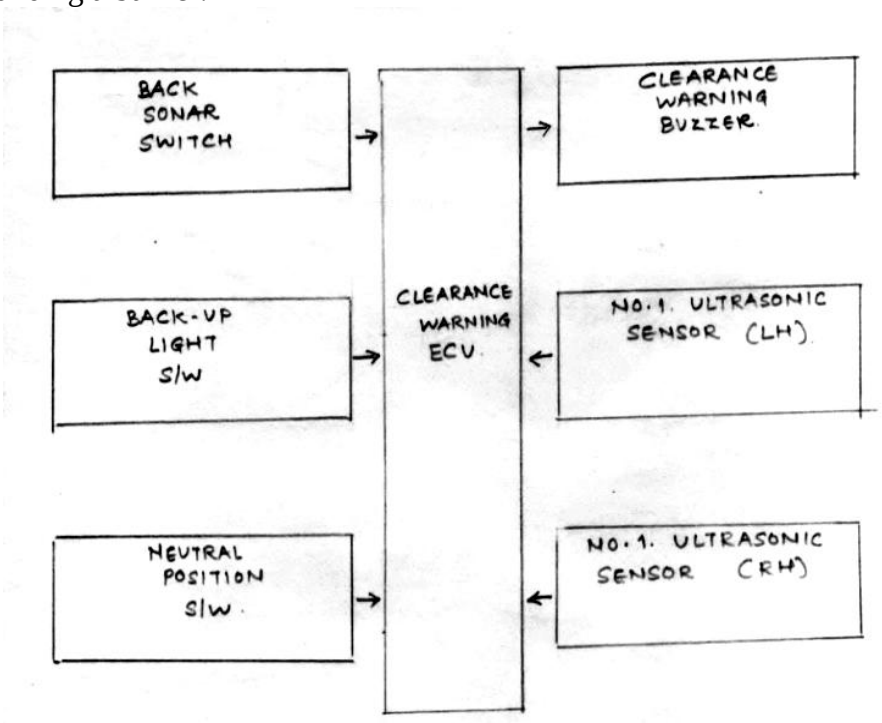


Fig. Electronic power steering

02

OR



6. Attempt any FOURof the following:	16
a) Explain Wi-Fi and Bluetooth communication system in automobile.	04
Answer: ***(Note: Description of Wi-Fi & Bluetooth systems - 02 mark each)*** **Wi-Fi (Wireless Fidelity):** In a car Wi-Fi is used to access the internet during a car side. Wi-Fi allows you to connect to a network through a wireless router or access point. Wireless networks utilize ratio waves to maintain communication channels between copmuters. **Advantages**: 1. Quick & easy intallaion. 2. No need of i/o sockets & path chords. 3. You are always on network anytime and anywhere. 4. Data access speed is always higher as compreared to ethernet. **Bluetooth:** Bluetooth is designed to support personal area network (PAN) to replace wired cable between nearby devices. Bluetooth is a used to pair mobile phones to vehicles. Such pairing enable hands free calling from the vehicle. It allows a vehicle embedded display unit to be used to control mobiles phones and allows a mobiles phone to use the vehicle embedded sound systems.It also enables making emergency calls during accidents, downloading digital contacts, travel information or software updates, and to access to internet.	02 02
b) Explain the park assist system with neat sketch.	04
Answer: ***(Note: Description - 02 marks, block diagram - 02 marks)*** **Park Assist System:** This system uses ultrasonic sensors to detect obstacles at the rear of the vehicle the system then informs the driver of the approximately distance between the sensors and the obstacles by sounding a buzzer.  Fig. Park assist system	02

Components	Function
Ultrasonic Sensor	Detects distance between vehicle and obstacle
Back Sonar Switch	Turns the clearance sonar system on and off.
Clearance Warning Buzzer	Emits an intermittent sound to inform the driver that the ECU has detected an obstacle within prescribed rages.
Clearance Warning ECU	Judges approximate distance between vehicle and obstacle.
Park/ Neutral Position Switch (A/T)	Sends a signal that activate the clearance sonar system when the shift lever is moved to the R position
Back up light Switch	Transmits reverse shift position signal to clearance warning ECU.

OPERATION:

a) The clearance warning ECU determines whether the clearance sonar system should operate or not based on the back sonar switch on / off status and the shift lever position.

b) When the system operates the clearance warning ECU. Based on this information the clearance warning ECU sends signal to the clearance warning buzzer. The approximate distance between the vehicle and the obstacle is then communicated through different types of buzzers sounds.

02

c) Define : i) Sensor
ii) Actuator

04

Answer:*(Note : Credit should be given to equivalent definition)*

1. **Sensor**: A sensor is an object whose purpose is to detect events or changes in its environment, and then provide a corresponding output. A sensor is a type of transducer; sensors may provide various types of output, but typically use electrical or optical signals. For example, a thermocouple generates a known voltage (the output) in response to its temperature (the environment).

02

2. **Actuator**: An actuator is a type of motor that is responsible for moving or controlling a mechanism or system.It is operated by a source of energy, typically electric current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion. 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 (e.g. a printer driver, robot control system), a human, or any other input.

02

d) State the six step approach for component testing.

04

Answer:*(Note: Six Step Approach for Component testing - 04 marks)*

List of steps in Six step approach for components testing:- (1 mark)

1. Collect evidence.
2. Analyze evidence.
3. Locate the fault.
4. Find the cause of the fault and remedy it.
5. Rectify the fault (if different from 4).
6. Test the system to verify that repair is correct.

01

Six step approach for components testing:- (3 mark) **1. Collect Evidence-**Collecting evidence means looking for all the symptoms that relate to the fault and not jumping to conclusions, e.g. because the system is controlled by an ECU it must be the ECU that is at fault. In order to collect the evidence it is necessary to know which components on the vehicle actually form the part of the faulty system. This is where sound basic skills come in. If an engine control system is malfunctioning because one cylinder has poor compression it is important to discover this at an early stage of the diagnostic process. **2. Analyze Evidence-**In the case of poor compression on one cylinder, given above as an example, the analysis would take the form of tests to determine the cause of low compression, E.g. burnt valve, blown head gasket etc. The analysis of evidence that is performed will vary according to the system under investigation. But these steps are obviously important. **3. Locate the fault -**The Procedure for doing this on an electronics system varies according to the type of test equipment available. It may be the case that the system has some self-diagnostics which will read you to the area of the system which is defective Let us assume that this is the case and the self- diagnostics report that an engine coolant temperature sensor is defective. How do you know whether it is the sensor, or the wiring between it and the remainder of the system? Again this is where a good basic knowledge of the make-up of the system is invaluable. **4. Find the cause of the fault and remedy it-**With electronic system repair it is often the case that a replacement unit must be fitted. However, this may not be the end of the matter. If the unit has failed because of some fault external to it, it is important that this cause of failure is found and remedied before fitting the new unit. It is often not just a matter of fitting a new unit. **5. Give the system a thorough test -**Testing after repair is an important aspect of vehicle work and especially so where electronically controlled systems are concerned. In the case of intermittent faults, such testing's may need to be extended because the fault may only occur when the engine is hot and the vehicle is being used in a particular way. **6. Test the system to verify that repair is correct.-**It is mandatory to test the system so that it will verify that the steps followed during the testing are correct. However we can come across any fault then we have to follow the stepwise procedure of testing.	03
e) Write the output signals of camshaft position and speed sensors.	04
Answer: ***(Note: Description with waveform - 02 marks each)*** **1. Camshaft position sensor:** Magnetic sensors can be checked by unplugging the electrical connector and checking resistance between the appropriate terminals. For example, the sensor should read between 500 and 900 ohms. Always refer to the vehicle manufacturers test specifications when testing these sensors. Obviously, if you see a zero resistance reading (shorted) or an infinite (open) reading, the sensor has failed and needs to be replaced. If viewed on an oscilloscope, a magnetic crank sensor will produce a waveform similar to that below:	02

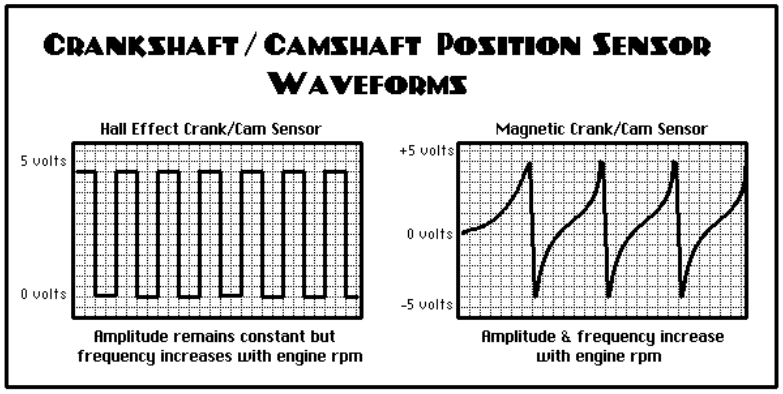


Fig: Output signals of crank shaft position and speed sensors

2. Checking the speed sensor output signal:

Connect an oscilloscope to the two output wires. While taking a scope readings spin the tyre (at least once per second) and look for a uniform sine wave. Typical VR and Hall Effect sensor waveforms are shown below. The VR sensor generates a sine wave signal with amplitude proportional to RPM. It does not require an external power source. Minimum signal requirement to trigger the ECM is 1 volt peak-peak with a 2.7K Ohm load on the sensor output. Hall Effect sensors always require an external power supply and pull-up resistor. Hall Effect sensors are capable of zero-speed sensing and the signal output is a square wave with amplitude independent of RPM.

02