SUMMER – 19 EXAMINATION

Subject Name: **Model Answer** Subject Co 17619

Important Instructions to examiners:

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

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	[A]	**Attempt any THREE of the Following:**	**12**
	(a)	**Enlist the four uses of diode in Automobile.**	**04**
	Ans.	***(Any Four 01 Mark Each)*** **Uses of Diode:** a. Used in automobile headlight system. b. Ignition system. c. Display system. d. Headlight Dimmer. e. Twilight Detectors. f. Climate Control - Sunlight Detector.	*Any Four 01 Mark Each*
	(b)	**State the importance of display devices used in automobile applications. List any two types of digital display devices.**	**04**
	Ans.	***(Importance 02 Marks Any Two Types 01 mark each)*** **Importance of Display Devices Used in Automotive Applications:** Function of any visual display is to communicate information to the desired level of accuracy. Most displays used in the vehicle must provide instant data but the accuracy is not always important. Analogue displays can provide almost instant feedback from one short glance. For example, if the needle of the temperature gauge is about in the middle then the driver can assume that the engine temperature is within suitable limits. A digital read-out of temperature such as 98 ° C would not be as easy to interpret. This is a good example as to why even when digital processing and display techniques are used, the actual read-out will still be in analogue form. Numerical and other forms of display are, however, used for many applications. **The Different Types of Digital Display Devices are:** 1. Fuel quantity level measurement 2. Coolant temperature measurement	*Importance 02 Marks Any Two Types 01 mark each*

		3. Vehicle speed measurement 4. Oil pressure measurement	
	(c)	**Draw a neat block diagram of a basic computer used in automobile. Describe the function of any two components.**	**04**
	Ans.	***(Block Diagram 02 Marks and Function of Any Two 01 Mark Each)*** **1. Input Unit**: Data and instructions must enter the computer system before any computation can be performed on the supplied data. The input unit that links the external environment with the computer system performs this task. Data and instructions enter input units in forms that depend upon the particular device used. It accepts (or reads) the list of instructions and data from the outside world. It converts these instructions and data in computer acceptable format. It supplies the converted instructions and data to the computer system for further processing. **2. Output Unit**: The job of an output unit is just the reverse of that of an input unit. It supplied information and results of computation to the outside world. Thus it links the computer with the external environment. It accepts the results produced by the computer which are in coded form and hence cannot be easily understood by us. It converts these coded results to human acceptable (readable) form. It supplied the converted results to the outside world. **3. Storage Unit:** The data and instructions that are entered into the computer system through input units have to be stored inside the computer before the actual processing starts. The Storage Unit or the primary / main storage of a computer system is designed to do all these things. It provides space for storing data and instructions, space for intermediate results and also space for the final results. All the data to be processed and the instruction required for processing. Intermediate results of processing. Final results of processing before these results are released to an output device. **4. Central Processing Unit:** The main unit inside the computer is the CPU. This unit is responsible for all events inside the computer. It controls all internal and external devices, performs "Arithmetic and Logical operations". The operations a Microprocessor performs are called "instruction set" of this processor. The control Unit and the Arithmetic and Logic unit of a computer system are jointly known as the Central Processing Unit (CPU). The CPU is the brain of any computer system. in a computer system, all major calculations and comparisons are made inside the CPU and the CPU is also responsible for activating and controlling the operations of other units of a computer system. **5. Arithmetic and Logic Unit (ALU):** The arithmetic and logic unit (ALU) of a computer system is the place where the actual execution of the instructions takes place during the processing operations. All calculations are performed and all comparisons (decisions) are made in the ALU. The arithmetic and logic unit (ALU) is the part where actual computations take place. It consists of circuits that perform arithmetic operations (e.g. addition, subtraction, multiplication, division over data received from memory and capable to compare numbers (less than, equal to, or greater than).	*Block Diagram 02 Marks and Function of Any Two 01 Mark Each*

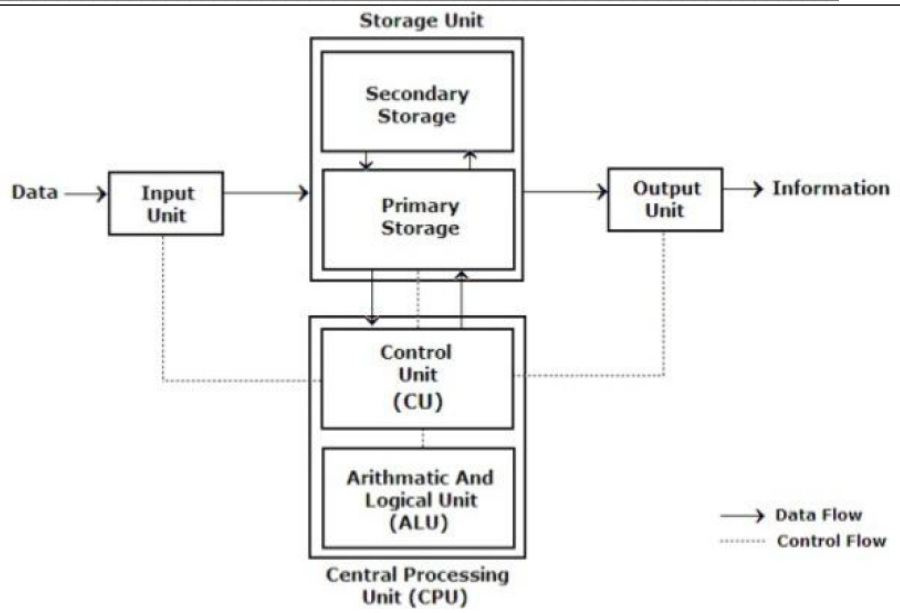


Figure: Block Diagram of a Basic Computer Used in Automobile

OR

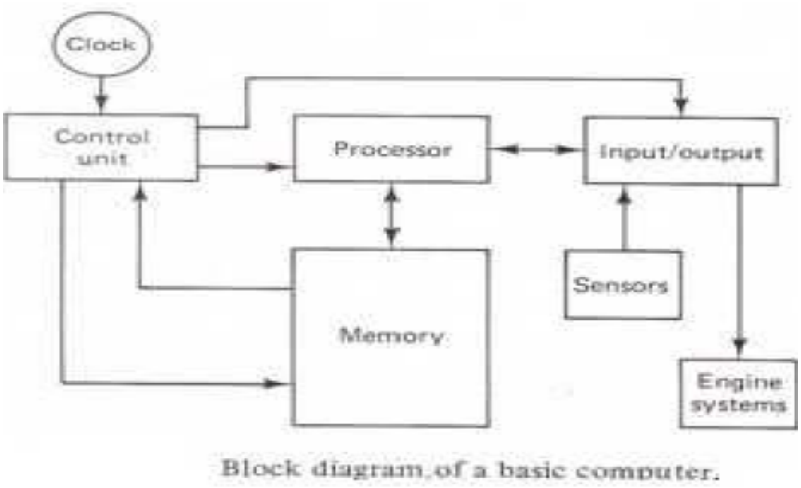


Figure: Block Diagram of a Basic Computer Used in Automobile

	(d)	**Explain with neat sketch the working of idle speed actuator.**	
	Ans.	***(Sketch 02 Marks and Working 02 Marks)*** **Working of idle speed actuator:** In throttle body and port fuel injection systems, engine idle speed is controlled by passing a certain amount of air flow past the throttle valve in the throttle body housing. The IAC system consists of an electrically controlled stepper motor or actuator operated by the ECM. The ECM controls the idle speed by opening and closing the air passage into the intake. The ECM/PCM calculates the amount of air required for smooth idling based on input data such as coolant temperature, engine load, and engine speed and battery voltage. The ECM/PCM the signals the IAC motor to extend or retract the idle air control valve in the air bypass channel.	*Sketch 02 Marks and Working 02 Marks*

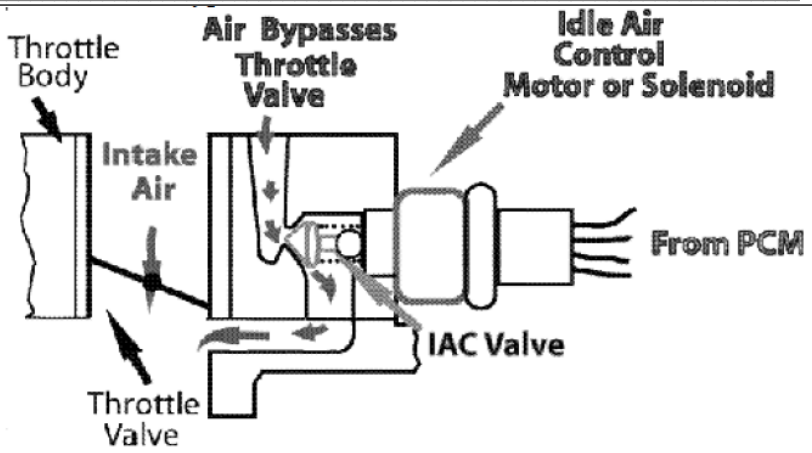


Figure: Idle Speed Actuator

1	[B]	**Attempt any ONE of the Following:**	**06**
	(a)	**Explain the use of semiconductor diode in voltage regulation of charging system with the help of a schematic diagram.**	**06**
	Ans.	*(Uses 04 Marks and Sketch 02 Marks)*	

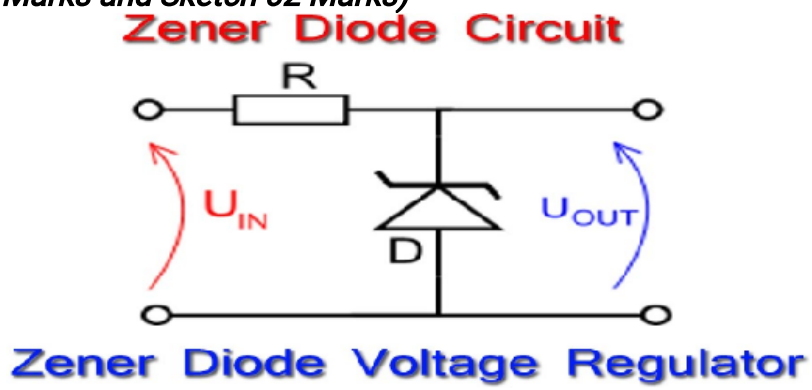


Figure: Zener Diode Voltage Regulator

Use of Semiconductor Diode in Voltage Regulation:

To prevent the vehicle battery from being overcharged the regulated system voltage should be kept below the gassing voltage of the lead-acid battery.

Accurate voltage control is vital with the ever-increasing use of electronic systems. Voltage regulation is a difficult task on a vehicle alternator because of the constantly changing engine speed and loads on the alternator.

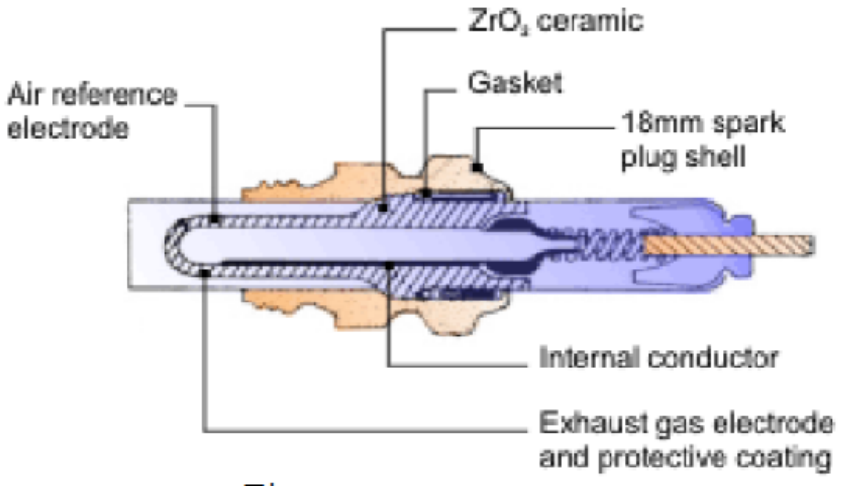
The output of an alternator without regulation would rise linearly in proportion with engine speed.

Zener diode is used as the sensing element in an electronic regulator. A Zener diode is designed to operate in the break-down region. At the point that Zener voltage is reached, a large current flows in reverse bias. This prevents voltage from climbing any higher. This makes the Zener diode an excellent component for regulating voltage.

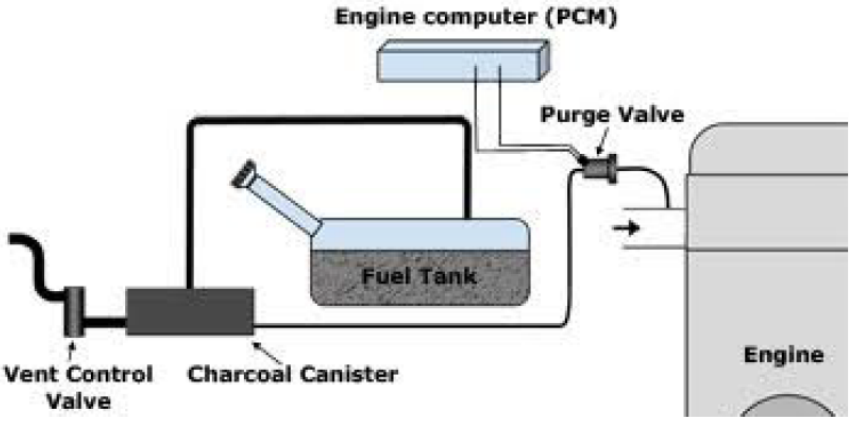
If the Zener diode is rated at 15 volts, it will not conduct in the reverse direction when the voltage is below 15 volts. At 15 volts it will conduct and the voltage will not increase over 15 volts. If a semi-conductor diode is reverse-biased it will not conduct current. However, if the reverse voltage is increased, a voltage level will be reached at which the diode will conduct in the reverse direction. This voltage is called Zener voltage.

Reverse current can destroy a simple PN-type diode, but the diode can be

Uses 04 Marks and Sketch 02 Marks

		dropped with materials that will withstand reverse current.	
	(b)	**With a neat sketch explain the construction and working of oxygen sensor**	**06**
	Ans.	***(Sketch 02 Marks, Construction 02 Marks and Working 02 Marks)*** **Construction and Working of Oxygen Sensor:** 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  **Figure: Oxygen Sensor**	*Sketch 02 Marks, Construction 02 Marks and Working 02 Marks*
2		**Attempt any FOUR of the Following:**	**16**
	(a)	**State the different types of computer memories. Describe the function of ROM.**	**04**
	Ans.	***(Types of computer memory 02 Marks and Function of ROM 02 Marks)*** **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	*Types of computer memory 02 Marks and Function of ROM 02 Marks*

		information that can be read from or written to by the CPU. **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 lose when the battery is disconnected, if the battery drains too, or if the circuit opens. **Function of Read only memory (ROM):** **i.** It contains a fixed pattern of 1s and 0s that represent permanent stored information. **ii.** 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. **iii.** ROM memory is not lost when power to the computer is lost.	
	(b)	**Explain open –loop control system with a neat block diagram.**	**04**
	Ans.	***(Explanation 02 Mark, Equivalent Diagram 02 Mark)***  If in a physical system there is no automatic correction of the variation in its output, it is called an open loop control system. That is, in this type of system, sensing of the actual output and comparing of this output (through feedback) with the desired input does not take place. The system on its own is not in a position to give the desired output and it cannot take into account the disturbances. In these systems, the changes in output can be corrected only by changing the input manually. These systems are simple in construction, stable and cost cheap. But these systems are inaccurate and unreliable. Moreover these systems do not take account of external disturbances that affect the output and they do not initiate corrective actions automatically. Any non-feedback control system can be considered as a feedback control system if it is under the supervision of someone. Although open loop control systems have economical components and are simple in design, they largely depend on human judgment. As an example, let us consider a home furnace control system. This system must control the temperature in a room, keeping it constant. An open loop system usually has a timer which instructs the system to switch on the furnace for some time and then switch it off. Accuracy cannot be achieved as the system does not switch on/off based on the room temperature but it does as per the pre-set value of time.	*Explanation 02 Mark, Equivalent Diagram 02 Mark*
	(c)	**Draw a neat block diagram to indicate canister purge control circuit.**	**04**
	Ans.	***(Neat Labelled Diagram 04 Marks)***	*Neat Labelled Diagram 04 Marks*



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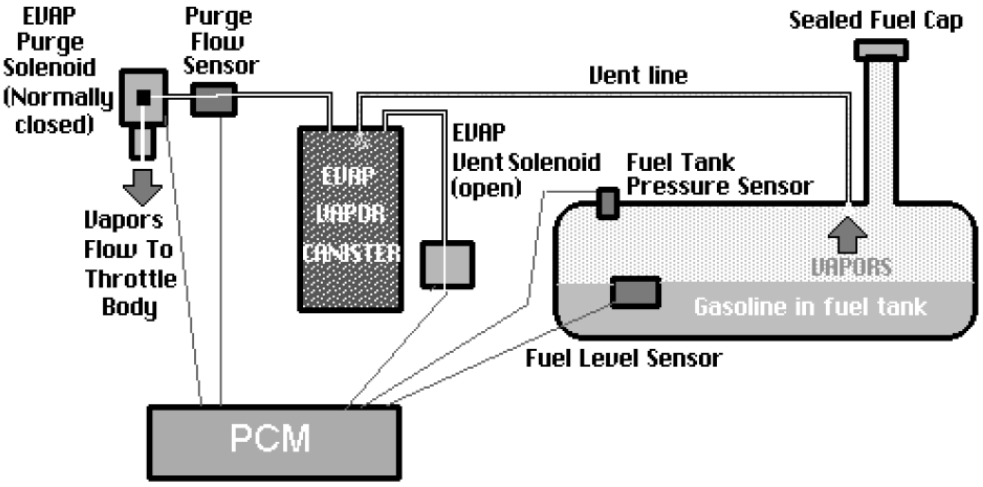
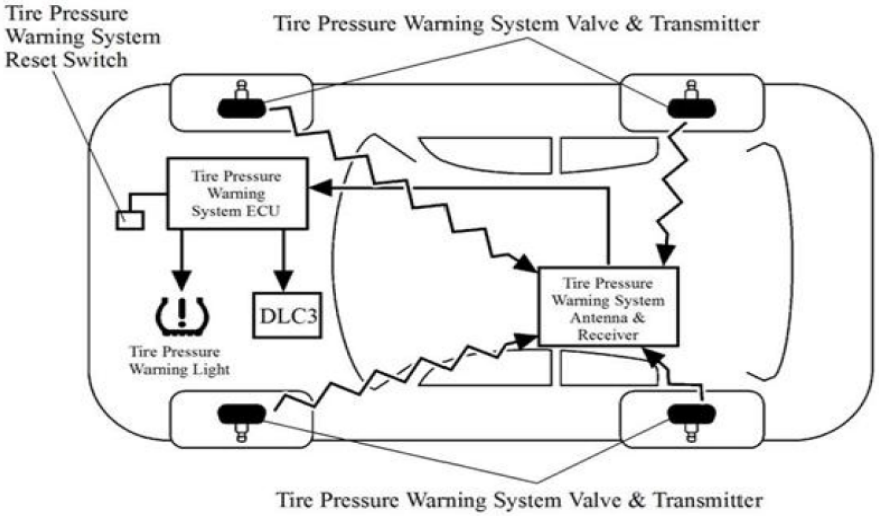


	(d)	**Enlist any four automotive sensors along with their location. State its function**	**04**
	Ans.	***(Name, Location and function of each sensor 01 Mark each)*** ***[NOTE: Credit should be given to equivalent answer]*** **1. Oxygen Sensor:-** **Function:** Used to monitor the amount of oxygen in 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	*Name, Location and function of each sensor 01 Mark each*

		input air temperature information to the control module. **Location:** In Intake manifold. **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.	
	(e)	**Explain Low Pressure Warning System.**	**04**
	Ans.	***(Sketch 02 Marks and Explanation 02 Mark)*** Low pressure warning system: This system directly senses the air pressure of each tire through tire pressure warning system valve & transmitter that are attached to each wheel and illuminate the tire pressure warning light to inform the driver of the low air pressure. After tire replacement, firstly register tire pressure warning system valve & transmitter IDs into the tire pressure warning system ECU, and then store the appropriate tire pressure in the ECU using the tire pressure warning system reset switch. 1. Combination Meter: Transmits the vehicle speed signal to the tire pressure warning system ECU for vehicle speed correction. 2. **Tire Pressure Warning Light:** Turns ON or blinks to warn the driver in accordance with the signal from the tire pressure warning system ECU, Displays the 2-digit DTC (Diagnostic Trouble Code). 3. **Tire Pressure Warning System Reset Switch:** The appropriate air pressures of the tires currently mounted on the vehicle are stored in the tire pressure warning system ECU by operating the tire pressure warning system reset switch. 4. **Tire Pressure Warning System Valve & Transmitter:** Detects the inflation pressure and internal temperature of the tire and transmits the measured value and the ID number to the tire pressure warning antenna & receiver. 5. **Tire Pressure Warning System Antenna & Receiver:** Receives the tire pressure warning system valve & transmitter signal and transmits this data to the tire pressure warning system ECU. 6. **Tire Pressure Warning System ECU:** Receives the data from the tire pressure warning system antenna & receiver and monitors the tire inflation pressure. When the tire pressure warning system ECU detects a drop in the tire inflation pressure or a system malfunction, it outputs the respective signal to the combination meter.	*Sketch 02 Marks and Explanation 02 Mark*

		 **Figure: Low Pressure Warning System**	
	(f)	**Explain Electronic Control of Suspension.**	**04**
	Ans.	***(Explanation 02 Marks and Sketch 02 Marks)*** Electronic control of suspension: It consists of springs shock absorbers and various linkages to connect the wheel assembly to car frame. The purpose the suspension system is to isolate the car body motion as much as possible from wheel motion due to rough road input. The performance of suspension system is strongly influenced by the damping of shock absorber The control system for a typical active suspension system is shown in the block diagram. It is in the form of a micro controller or microprocessor base digital controller the inputs for each sensor are sampled converted to digital format and stored in the memory the sampling is typically at about 500 Hz. In this control configuration the relative position and motion of the wheel of the wheel body (sprung mass) acceleration, the relative position and motion of the wheel body. (Unsprung or sprung mass) the steering wheel input and vehicle speed. The body acceleration measurement can be used to evaluate ride quality. The controller dies this by computing weighted average of spectrum of the acceleration the relative body or wheel motion can be used to estimate tire force.	*Explanation 02 Marks and Sketch 02 Marks*

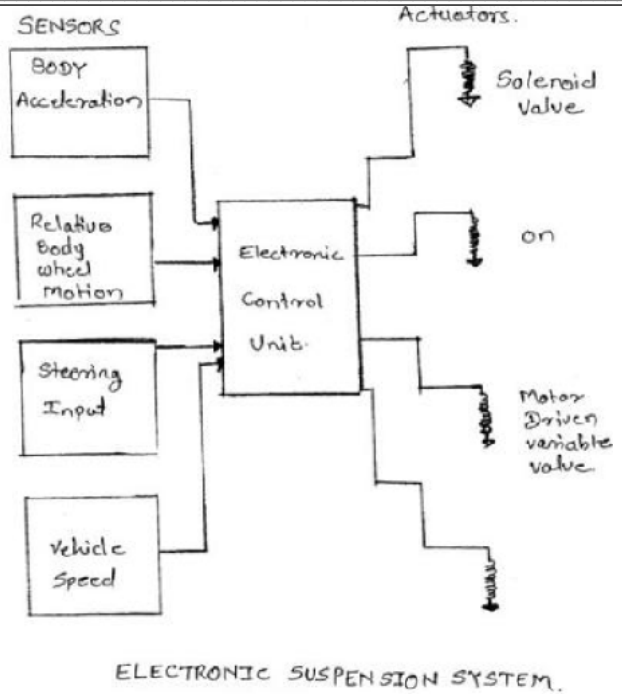
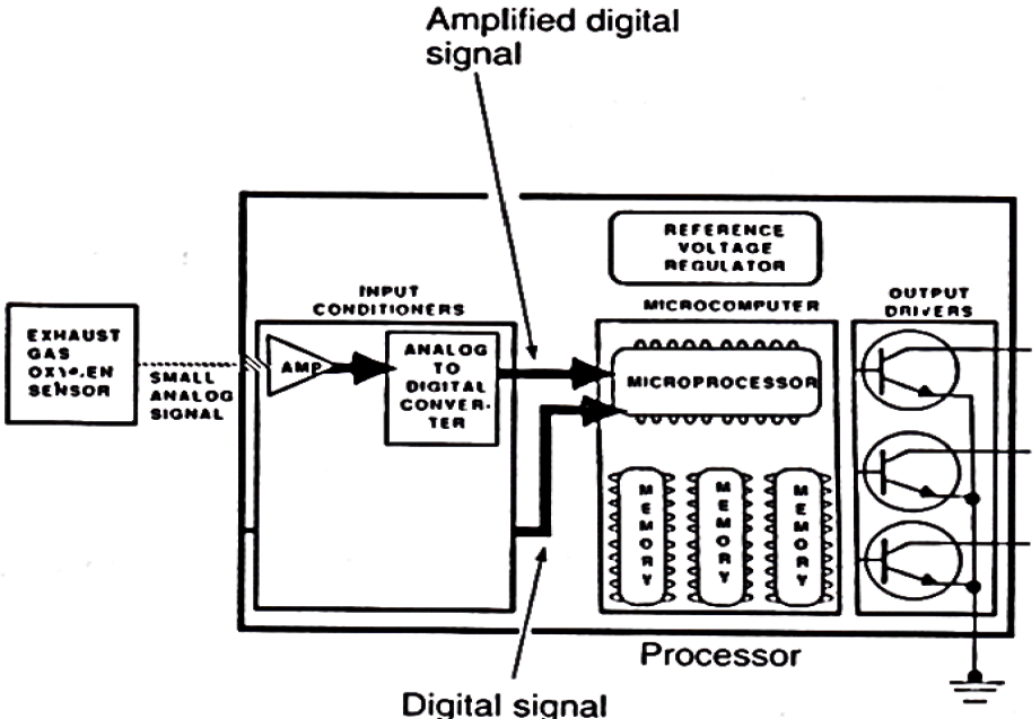
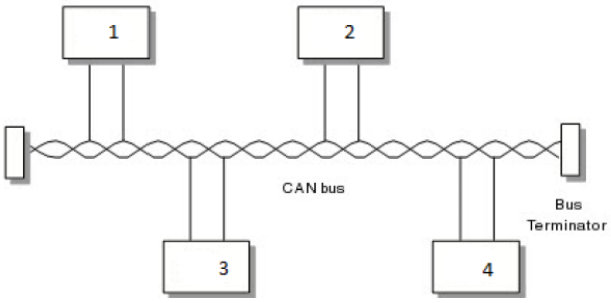


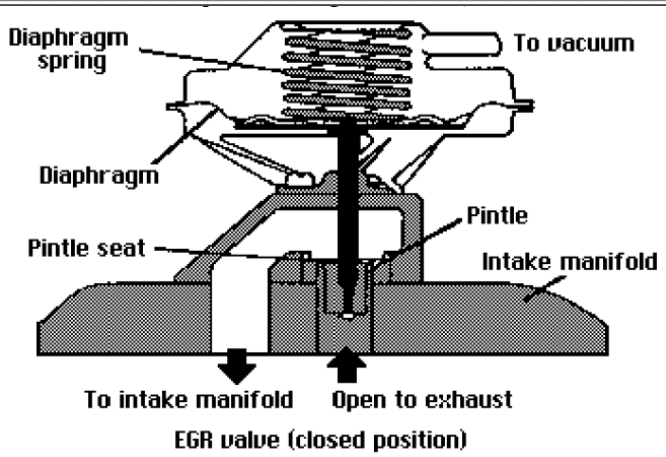
Figure: Electronic Suspension System

3		**Attempt any FOUR of the Following:**	**16**
	(a)	**Convert $(624)_{10}$ into equivalent binary number and write the steps involved.**	**04**
	Ans.	***(Correct equivalent Answer 01 Marks and Steps 03 Marks)*** **$(624)_{10} = 0\ 0\ 0\ 0\ 1\ 1\ 1\ 0\ 0\ 1$** **$(624)_{10}$**	*Correct Equivalent Answer 01 Marks and Steps 03 Marks*
	(b)	**Explain the concept of signal conditioning.**	**04**
	Ans.	***(Explanation 02 Marks and Sketch 02 Marks)***	*Explanati*

2	**624**	**0**
2	**312**	**0**
2	**156**	**0**
2	**78**	**0**
2	**39**	**1**
2	**19**	**1**
2	**9**	**1**
2	**4**	**0**
2	**2**	**0**
2	**1**	**1**

		Signal Conditioning: The input and/or output signals may require conditioning in order to be used. This conditioning may include amplification and/or signal conversion. Some input sensors, such as the oxygen (O2) sensor, produce a very low voltage signal of less than 1V. This signal also has an extremely low current flow. Therefore, this type of signal must be amplified, or increased, before it is sent to the microprocessor. This amplification is accomplished by the amplification circuit in the input conditioning chip inside the computer. For the computer to receive information from the sensor, and to give commands to actuators, it requires an interface. The computer will have two interface circuits: input and output, The digital computer cannot accept analog signals from the sensors and requires an input interface to convert the analog signal to digital. The analog to digital (A/D) converter continually scans the analog input signals at regular intervals, For example, if the A/D convertor assigns a numeric value to signal at 5V the A/D converter assigns a numeric value this specific voltage. The A/D converter then changes this numeric value to binary code. Also, some of the controlled actuators may require an analog signal. In this instance, an output digital to analog (D/A) converter is used.  **Figure: Signal Conditioning**	*on 02 Marks and Sketch 02 Marks*
	(c)	**Explain CAN bus system with neat block diagram.**	**04**
	Ans.	***(Explanation 02 Marks and Sketch 02 Marks)*** **CAN bus system:** CAN (Controller Area Network) is an example of an automotive digital data system. It was developed by the Robert Bosch Company in Germany. CAN is a serial synchronous communication protocol that connects electronic control modules, sensors and actuators. 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: i. Priority controlled message transmission. ii. Low cots through the use of a low cost twisted two wire cable and	*Explanation 02 Marks and Sketch 02 Marks*

		use of simple protocol with low power demand. iii. 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) iv. High reliability of data transfer Block Diagram of CAN Bus System: 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 below figure. 1. Automatic transmission control unit 2. Engine control module 3. ABS/ Traction control ECU 4. Instrument Pack.  **Figure: CAN Bus System**	
	(d)	**Explain with neat sketch working of EGR valve.**	**04**
	Ans.	***(Explanation 02 Marks and Sketch 02 Marks)*** 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 backpressure EGR valve helped solve this problem. Similar to a 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.	*Explanation 02 Marks and Sketch 02 Marks*

		 Figure: EGR Valve Closed	
	(e)	**Describe the procedure used to indicate the TDC reference mark of cylinder No. 1 to the ECM.**	**04**
	Ans.	*(Detailed Procedure 01 Mark for each step)* **Procedure used to indicate the TDC reference mark of cylinder No.1 to the ECM:** • The camshaft and crankshaft position sensors are collectively used to determine the exact position of the number 1 cylinder in respect to top dead center on the compression stroke. • These two sensors are either a Hall Effect or magnetic reluctant controlled devices. The Hall Effect-type sensor makes use of a notched ring and an electromagnetic sensor. The sensor is stationary while the notched ring, called an interrupter, passes through it. • Passing the notches on the wheel through the sensor produces a signal, which is then sent to the Power train Control Module (PCM) representing the position of the crankshaft or camshaft relative to top dead center on the number 1 cylinder. • The magnetic reluctant sensor uses a rare earth magnet and a winding of wire. As the trigger wheel passes near the sensor it generates an AC voltage signal, which is sent to the PCM. • The introduction of the crank and cam sensors helped to eliminate the variances in ignition timing signals so prevalent in a distributor controlled ignition engine.	*Detailed Procedure 01 Mark for each step*
4	**[A]**	**Attempt any THREE of the Following:**	**12**
	(a)	**Draw a neat block diagram indicating electronic control system used in CRDI.**	**04**
	Ans.	*(Description 02 Marks Block Diagram 02 Marks)* **Electronic control system used in CRDI** In a CRDI system, the microprocessor works with input from multiple sensors. Based on the input from these sensors, the microprocessor can calculate the precise amount of the diesel and the timing when the diesel should be injected inside the cylinder. Using these calculations, the CRDI control system delivers the right amount of diesel at the right time to allow best possible output with least emissions and least possible wastage of fuel. The input sensors include Accelerator Pedal Position (APP) sensor, crank position sensor, pressure sensor, lambda sensor etc. The use of	*Description 02 Marks Block Diagram 02 Marks*

sensors and microprocessor to control the engine makes most efficient use of the fuel and also improved the power, fuel-economy and performance of the engine by managing it in a much better way.

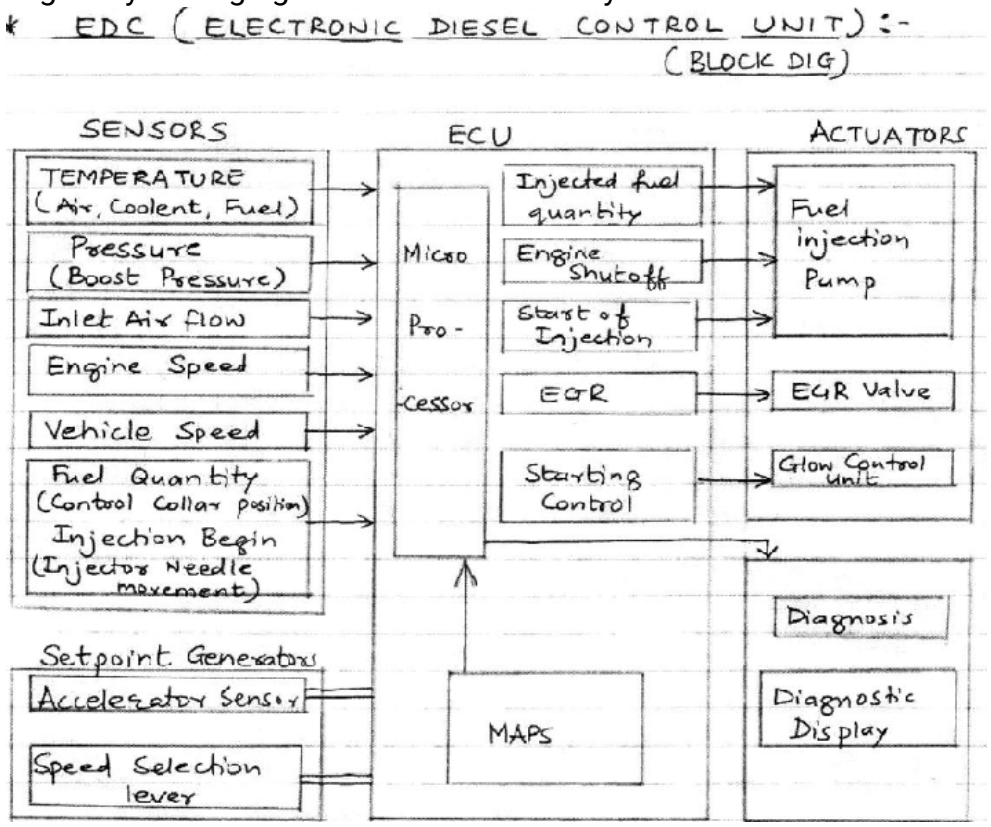
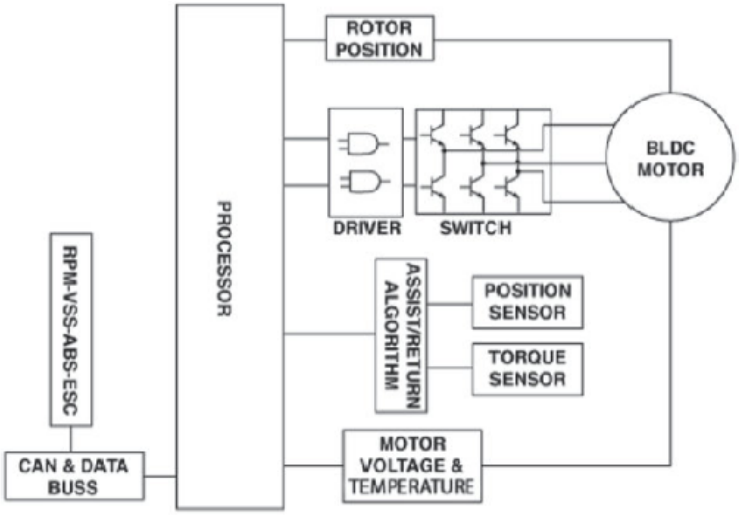


Figure: Block Diagram of Electronic Diesel Control Unit

	(b)	**Explain the working of Electronic Power Steering System.**	**04**
	Ans.	(***Description 02 Marks Block Diagram 02 Marks***) An Electronic Power Steering (EPS) system's advantage over a hydraulic system is if the engine stalls, you will still have steering assist. This advantage can also be a disadvantage if the system should shut down while the engine is running you lose steering assist. Electronic power steering systems eliminate the need for a pump, hoses and a drive belt connected to the engine using variable amounts of power. The configuration of an EPS system can allow the entire power assist system to be packaged on the rack and pinion steering gear or in the steering column. The system does not drag on the engine from either a power steering pump or alternator because it will not provide assist until required by driver input. Also, there is no hydraulic fluid. The rotor direction is determined by the sequence in which voltage is applied to coil A, B or C and returned to ground through an attached pair. The sequence for clockwise is ABC and for counterclockwise it is CBA (shown in figure). The primary purpose of the EPS controller is to provide motor control. The processor is the heart of the controller for input and output. Processor output drives the three pairs of transistors that control the rotation of the motor. Primary input to the processor comes from the torque sensor and hand wheel speed and position sensor. The processor also is an integral part of the controlled area network (CAN) and vehicle data buss for chassis and powertrain communications. This data buss supplies vehicle speed, engine	*Description 02 Marks Block Diagram 02 Marks*

		speed, ABS and ESC information. The controller has adaptive memory and diagnostics.  **Figure: Block Diagram of Electronic Power Steering Unit**	
	(c)	**List the six steps followed during component testing. Explain any one step in detail.**	**04**
	Ans.	***(List of the Six Steps 02 Marks and Explanation of any one 02 Marks)*** **Six step approach for components testing:-** 1. Collect evidence. 2. Analyse 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. Six step approach for components testing:- (each One- 1 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 here a good basic knowledge of the make-up of the system is invaluable.	*List of the Six Steps 02 Marks and Explanation of any one 02 Marks*

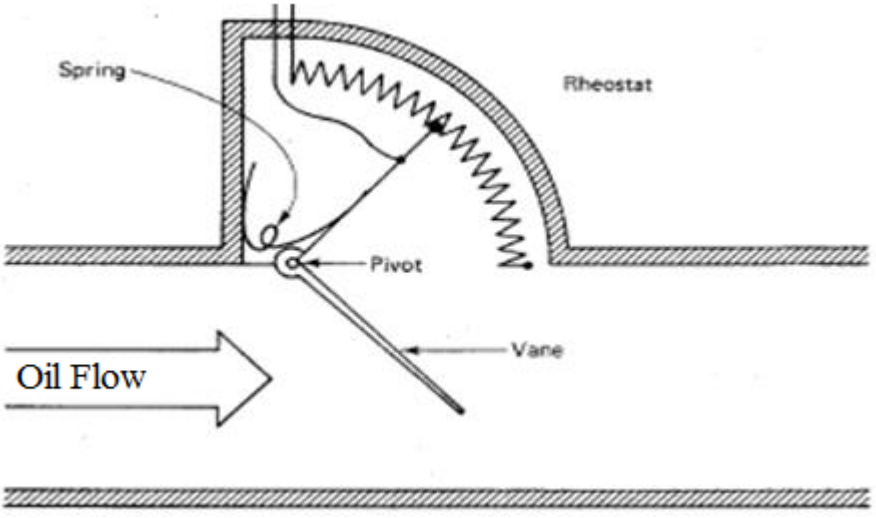
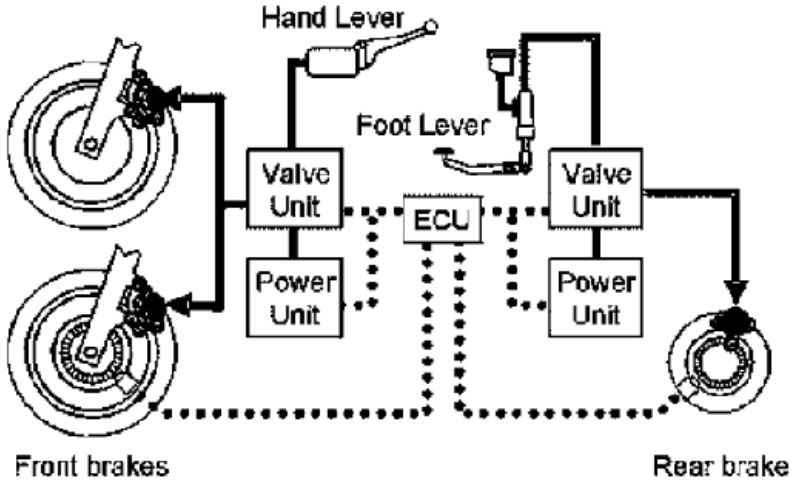
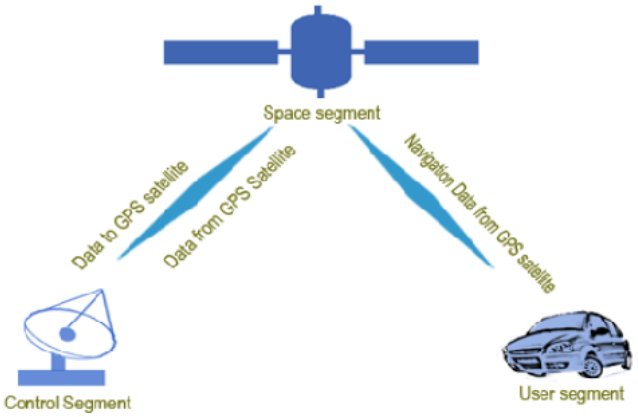
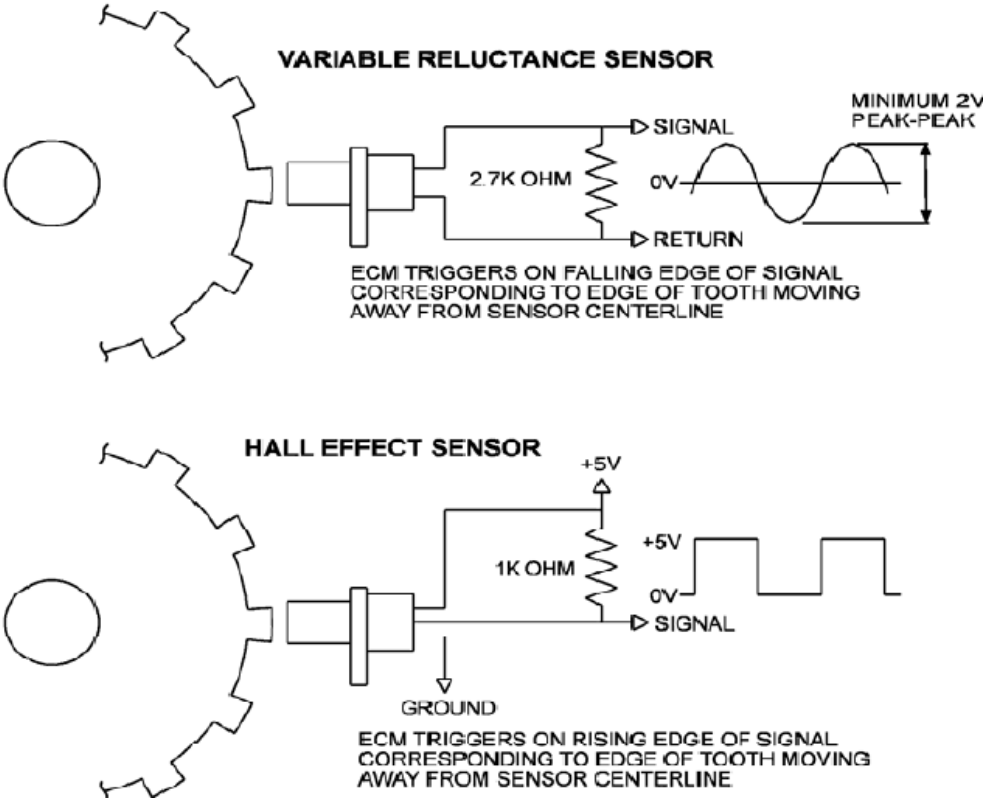
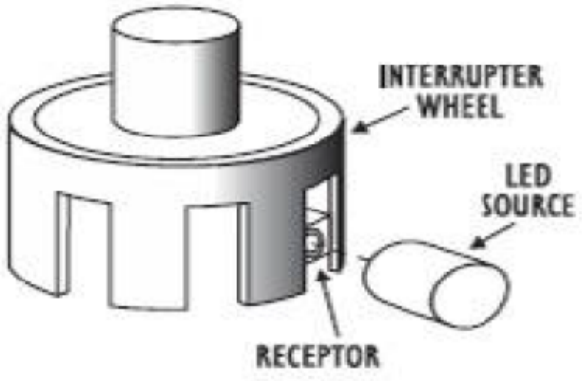
		4. Find the cause of the fault and remedy it- With electronic system repair it is often the case that a replacement unit must be fitted. However, this may not be the end of the matter. If the unit has failed because of some fault external to it, it is important that this cause of failure is found and 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.	
	(d)	**Explain the use of battery tester in testing of an automotive battery.**	**04**
	Ans.	***(Any Four Uses 01 Mark Each)*** **Battery testers used for testing the various parameters & conditions of the battery:** a. Voltage measurement. b. Resistance measurement. c. CCA value Measurement. d. Battery condition. e. Battery load test etc	*Any Four Uses 01 Mark Each*
4	**[B]**	**Attempt any ONE of the Following:**	**06**
	(a)	**Explain with neat sketch, construction and working of oil flow measurement sensor.**	**06**
	Ans.	***(Construction 02 Marks, Working 02 Marks and Sketch 02 Marks)***  **Figure : Oil Flow Sensor** **Construction of Oil Flow Measurement Sensor:** The vane type oil flow measurement consists of lightly spring loaded valve that moves aside as oil flow increases. The valve is tied to a rheostat, a type of variable resistor. **Operation of Oil Flow Sensor:-** The change in current in the resistor circuit is the sensor signal. Also used is a carbon film resistor with variable area connected to the oil flow meter	*Construction 02 Marks, Working 02 Marks and Sketch 02 Marks*

		plate. It gives a signal that varies air/ fuel ratio with demand.	
	(b)	**Explain the working of ABS system with neat sketch. State four advantages of ABS.**	**06**
	Ans.	***(Explanation 02 Marks, Sketch 02 Marks and Any four advantages ½ Mark Each)*** **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 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  **Figure: ABS System** **Advantages of ABS System:**	*Explanation 02 Marks, Sketch 02 Marks and Any four advantages ½ Mark Each*

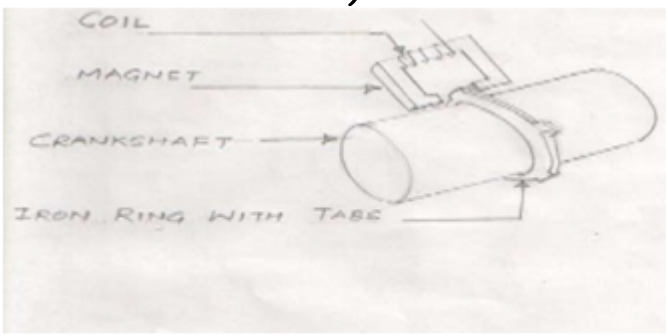
		1. Anti-lock braking system (ABS) guarantees stable braking characteristics on all road surfaces, hence avoids overturning of the vehicle. 2. ABS reduces friction on wheels and road, thus increases the efficiency of tires (up to 30%). 3. The Vehicle with ABS can be stopped at a lesser distance than a non ABS vehicle. 4. Steering control is effective, i.e., the vehicle can be steered smoothly while braking. Thus minimizes the accidents. 5. A driver without experience can drive ABS vehicle effectively, then an experienced driver on the non-ABS vehicle	
5		**Attempt any FOUR of the Following:**	**16**
	(a)	**State the types of errors and explain error compensation.**	**04**
	Ans.	***(Any Two Types of Error 01 Mark each and Explanation of Error Compensation 02 Mark)*** **Types of error:- (Any Two)** 1) Gross error 2) Systematic error 3) Random error **Error Compensation:** error in computation or in recording of accounting data, that is neutralized (counter balanced) by an equal and opposite error .since compensating errors do not show up in the total , they are difficult to locate through statistical methods	*Any Two Types of Error 01 Mark each and Explanation of Error Compensation 02 Mark*
	(b)	**Describe the applications of Global Positioning System used as a navigation system in car.**	**04**
	Ans.	***(Correct Description 04 Marks)*** ***[NOTE: Credit should be given to sketch also]*** **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:-** **1. Space Segment (SS)** **2. Control Segment (CS)** **3. 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,	*Correct Description 04 Marks*

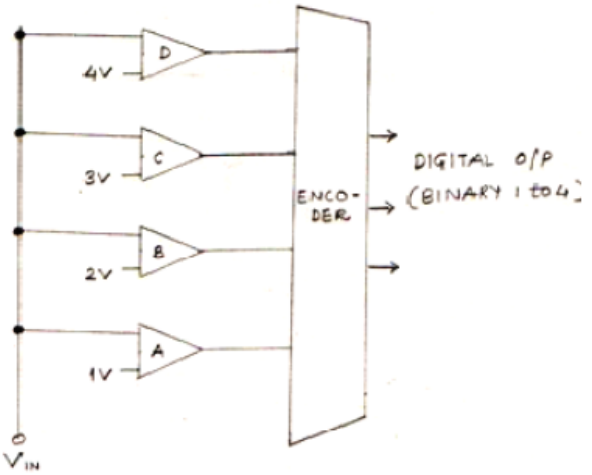
		position, speed, and overall health of the orbiting satellites. The control segment uses measurements collected by the monitor stations to predict the behavior of each satellite's orbit and clock. The prediction data is up-linked, or transmitted, to the satellites for transmission back to the users. **(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.  **Figure: GPS System**	
	(c)	**Write the procedure for checking an oxygen sensor with a digital multimeter.**	**04**
	Ans.	***(Any Four Steps 01 Mark Each)*** **Testing of Oxygen Sensor with a Digital Multimeter**: - Following procedure is followed to diagnose an oxygen sensor. 1. Disconnect the connector of the oxygen sensor. 2. Start the engine and warm-up for 2 minutes at 3000 rpm under no load conditions. 3. Raise the engine speed to 4000 rpm and release the throttle suddenly for at least 5 times. 4. Within one minute after the engine has been warmed up, measure the voltage between the connector terminal and body ground. 5. The voltage should be below 0.4 Volts. 6. Replace the oxygen sensor if the voltages are out of the above range.	*Any Four Steps 01 Mark Each*
	(d)	**Describe the procedure of diagnosing MPFI system.**	**04**
	Ans.	***(Any Four Steps 01 Mark Each)*** **Following procedure shall be followed for diagnosing MPFI system:** 1) Connect the Bosch KTS 180 scanner with the pin connector of ECM. 2) Start diagnostic procedure as per recommended procedure. 3) Check the actual value of sensor for desired voltage resistance. 4) Go in the error memory to check for errors or the DTCs. 5) The SAE J 2012 standards are used for finding a particular DTC (diagnostic Trouble Codes).	*Any Four Steps 01 Mark Each*
	(e)	**Describe application of oscilloscope while checking alternator output signal.**	**04**
	Ans.	***(Correct Description 02 Marks and Sketch 02 Marks)*** **Checking the speed sensor output signal using oscilloscope:** Connect an oscilloscope to the two output wires. While taking a scope	*Correct Description 04*

		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 have 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.  **Figure: Oscilloscope while Checking Alternator Output Signal**	*Marks & Sketch 02 Marks*
	(f)	**Draw a sketch of LED and photodiode arrangement used in ignition system. Describe its operation.**	**04**
	Ans.	***(Description 02 Marks and Sketch 02 Marks)***  **Figure: LED and Photodiode Arrangement** **Operation:** An optical triggering mechanism consist of a light emitting diode (LED) and light sensitive photo transistor (photocell) and also a slotted disc	*Description 02 Marks and Sketch 02 Marks*

		called a light beam interrupter . The slotted disc is attached to the distributor shaft. The LED and photocell are situated over and under the slotted disc opposite of each other. As the slotted disc rotates between the LED and the photocell, light from LED shines through the slots. The intermittent flashes of the LED are translated into voltage pulses by the photocell. Where the voltage signal occurs, the control unit turns ON the primary circuit. When the disc interrupts the light and the voltage signal is not given the control system turns the primary circuit OFF causing the magnetic field in the primary coil to collapse and sending a high voltage current to spark plug through secondary winding.	
6		**Attempt any FOUR of the Following:**	**16**
	(a)	**State the instruments used for measuring following parameters:** **(i) Speed** **(ii) Level** **(iii) Distance** **(iv) Temperature**	**04**
	Ans.	***(Correct Ans 01 Mark Each)*** (i) **Speed:** Tachometer, Speedometer, Incremental encoder, Tacho-generator, Pyroelectric sensors (ii) **Level:** Floats, Differential Pressure (iii) **Distance:** Scale, Tape, Potentiometer, Strain-gauged element, Capacitive element, Differential transformers, Eddy current proximity sensors, Inductive proximity switch, Optical encoders, Pneumatic sensors, Proximity switches (magnetic), Hall effect sensors (iv) **Temperature:** Thermocouple, Thermometer, Thermistors, Bimetallic strips, Resistance temperature detectors, Thermistors, Thermo-diodes and transistors, Thermocouples, Light sensors, Photo diodes, Photo resistors, Photo transistor	*Correct Ans 01 Mark Each*
	(b)	**Describe the testing procedure to conduct a test on any one automotive actuator.**	**04**
	Ans.	***(Testing Procedure to Conduct a Test on any one Automotive Actuator 04 Marks)*** **1. Testing of Oxygen Actuator: -** Following procedure is followed to diagnose an Oxygen sensor. • Disconnect the connector of the oxygen sensor. • Start the engine and warm-up for 2 minutes at 3000 rpm under no load conditions. • Raise the engine speed to 4000 rpm and release the throttle suddenly for at least 5 times. • Within one minute after the engine has been warmed up, measure the voltage between the connector terminal and body ground. • The voltage should be below 0.4 Volts. • Replace the oxygen sensor if the voltages are out of the above range. **2. Testing of Intake air temperature (IAT)sensor and Engine coolant temperature (ECT) Actuator:** - Following procedure is followed to diagnose an IAT sensor. • Remove IAT sensor from the engine. • Place it in a container of water with thermometer.	*Testing Procedure to Conduct a Test on any one Automotive Actuator 04 Marks*

		• Make sure that more than half of the connector is submerged in the water. • Connect a pair of ohmmeter leads to the sensor terminals. • Heat the water in the container and measure the resistance at different temperatures. • The sensor should have the specified resistance 0.98 to 1.34KΩ at 40^0 C and 0.22 to 0.35KΩ at 80^0C. • Replace the sensor if the resistance values are outside the range. **3. Testing of Throttle position (TP) Actuator:-** Following procedure is followed to diagnose a TP sensor: • With the ignition switch in the RUN position, connect a voltmeter from the sensor signal wire to ground. • Slowly open the throttle and observe the voltmeter. • The voltmeter reading should increase smoothly and gradually. • Typical TPS voltage readings are 0.5V to 1V with the throttle in the idle positions, and 3.5V to 4.5V at wide open throttle Always refer to the vehicle manufacturer's specifications. • If the TPS does not have the specified voltage or if the voltage signals is erratic, replace the sensor. **4. Manifold absolute pressure (MAP) Actuator:** - Following procedure is followed to diagnose an ECT sensor. • Turn the ignition ON (engine OFF). • Measure the voltage (or frequency) of the sensor output. • Using a hand operated vacuum pump, apply vacuum to the sensor. • A good pressure should change voltage (or frequency) in relation to the applied vacuum. • If the signal does not change or the values are out of range according to the manufacturer's specifications, the sensor must be replaced.	
	(c)	**State the different types of communication system used in automobile. State function of Bluetooth Technology.**	**04**
	Ans.	***(Types 02 Marks and Function of Bluetooth 02 Marks)*** **Types of communication system used in automobile:(**Any Four-1/2 mark each) 1. Bluetooth 2. Wi-Fi 3. CAN Bus 4. LIN Bus 5. GSM Network 6. Optic fibers. 7. Ethernet **Function of Bluetooth Technology:** 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	*Types 02 Marks and Function of Bluetooth 02 Marks*

		access to internet.	
	(d)	**Explain the working of crankshaft position sensor.**	**04**
	Ans.	***(Working - 3 Marks And Sketch-1 Marks)***  Figure: Crank Shaft Positioning Sensor **Working of Crankshaft Position Sensor:** The principle elements of the sensor are: 1. An iron rotor with lobes on it 2. A permanent magnet 3. A metallic path (the pole piece) for carrying the magnetic flux 4. 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.	*Working 03 Marks And Sketch 01 Marks*
	(e)	**Explain the conversion of analog to digital signal with suitable sketch**	**04**
	Ans.	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.	



Flash Type Analog to Digital Converter

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