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

Marks

1. **A) Attempt any THREE of the following:**	12
a) Enlist any two purpose of the following: i) Relay ii) Fuse iii) Solenoid iv) Ganged switch	4
Answer : (one mark for each component) 1. **Relay:** a) Purpose of relay is to control a load circuit with the use of small current carrying control circuit. b) It saves the size of wiring connected to the switch/es and reduces weight. 2. **Fuse**: a) It protects a circuit from carrying higher than rated current. b) A fuse also separates a number of circuits like starting circuit, ignition circuit, charging circuit etc. thus failure of a fuse doesn't affect the other circuit. 3. **Solenoid**: a) Purpose of a solenoid is to control a larger current carrying circuit with use of small current carrying circuit. b) It converts electrical energy into mechanical movement of core. 4. **Ganged switch:** a) Ease of operating various circuits using single switch. b) A number of circuits can be controlled simultaneously. Ganged switches are frequently used in application where the motion of switch is needed to control more than one circuit.	4
b) Enlist any four safety precautions in battery maintenance.	4
Answer: (*any four - 4 marks*) **Safety precautions in battery maintenance:** 1. Always keep the jewellery and metal tools far away from battery. 2. Follow the battery manufacturer's recommendations about replacing batteries.	4

3. Wear eye protection (safety goggles) when working around the batteries. 4. When disconnecting battery cables, always disconnect negative (ground) cable first. 5. When connecting battery cables, always connect negative cable last. 6. Avoid flame or spark that could ignite the hydrogen gas produced by the battery and cause an explosion. 7. Protective clothing, such as rubber apron, rubber gloves, and a face shield should be worn when working with batteries. 8. Always turn a battery charger off, before connecting or disconnecting the leads. 9. Check the electrolyte levels and specific gravity in each cell of non-sealed batteries. Use a rated flashlight that is intrinsically safe, while checking the electrolyte liquid levels of the batteries. 10. Tighten cable clamp nuts with the proper size wrench. Do not subject battery terminals to excessive twisting forces. 11. Use a battery carrier to lift a battery, or place hands at opposite corners. Practice safe lifting and carrying procedures to prevent back injuries. 12. Never squeeze the hydrometer rubber bulb so hard that the water splashes acid from the cell opening.	
c) State the need of starter motor drive and list any two types of starter motor drive.	4
Answer: (*Need- 2 marks, starter drive types- 2 marks*) **Need of starter motor drive: (Any Two)** • To transmit the turning force to the engine when the starting motor runs and to disconnect the starting motor from the engine immediately after the engine has started and • To provide a gear reduction ratio between the starting motor and the engine. • When the engine starts and is running under its own power, the ring gear attempts to drive the pinion gear faster than the starter motor. Thus to protects the starter motor from getting driven by the started engine, vehicle need starter drive. It is necessary to avoid damage of starter motor while engine is running, hence drives are used. • It ensures the starter motor engagement while cranking, and immediate disengagement upon engine starting. This prevents the engine from driving and damaging the starter. **The various drives are as follows:- (any two)** 1) Bendix drive 2) Folo-thru drive 3) Barrel type drive 4) Gear reduction drive 5) Overrunning clutch 6) Dyer drive 7) Friction clutch drive	2 2
d) State the functions of any two sensors used in Ignition system.	4
Answer: Functions of sensors used in Ignition system: (Any two - 2 marks each) **a) Detonation Sensor:** A large spark-advance is needed to obtain maximum power and economy from an engine. But when the spark is over-advanced, combustion knock will occur. To overcome this problem a detonation sensor is used. The detonation sensor detects the engine detonation and sends the voltage signal to the Engine control unit. The ECU uses the detonation sensor signal to control timing.	4

The detonation sensor signal is an input to the ECM which then retards the computed ignition timing signal already advanced by the igniter circuit. i.e. the ignition timing is retarded to make the engine work without detonation.

b) Cylinder Identification sensor / camshaft position sensor:

The function of cylinder identification sensor used in ignition system is to detect the position of the engine camshaft. Camshaft position is used to identify when first piston is 26° before top dead center (BTDC) of its compression stroke. The DIS module uses the CID signal to select the proper coil to fire. It uses a Hall-effect pickup.

c) Crankshaft position sensor:

The ECU uses the crankshaft position signal to determine engine RPM, crankshaft position and engine misfire. The ECU can determine from its programming the engine firing order. This signal is sent to the ignition control module or engine control module which then energizes the appropriate coil.

B) Attempt any ONE of the following: : 6

a) Describe with neat sketch working of engine oil pressure gauge. 6

Answer: ***Diagram 3 marks and Explanation 3 marks. Similar drawing and description should be considered.***

Engine Oil Pressure Gauge:

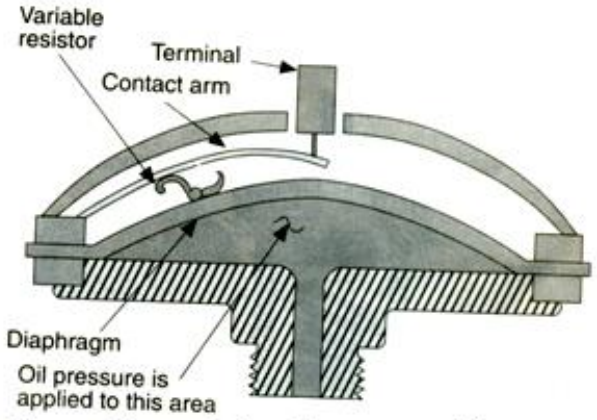


Figure: Piezoresistive Sensor used for measuring Engine oil pressure 3

Working:

A piezo-resistive sensor **(Fig.)** is threaded into the oil delivery passage of the engine. The pressure exerted by the oil causes the flexible diaphragm to move. This movement is transferred to a contact arm that slides down the resistor. The position of the sliding contact on the arm in relation to the resistance coil determines the resistance value and the amount of current flow through the gauge to ground.

The oil pressure typically should be between 45 and 70 psi (310 and 483 kPa) when the engine is running at a specified engine speed, with SAE 10W-30 oil, and at operating temperature. A lower pressure is normal at low idle speed. 3

The oil pressure determines whether or not current flows through the oil pressure gauge winding. With low oil pressure (or with the engine shut off), the oil pressure switch is open and no current flows through the gauge winding. The needle points to L. With oil pressure above a specific limit, the switch closes and current flows through the gauge winding to ground. A resistor limits current flow through the winding and ensures that the needle points to about mid-scale with normal oil pressure.

OR

Engine Oil Pressure Gauge:

Vehicles have an oil pressure gauge or a low oil-pressure indicator light. Oil pressure gauge shown in the diagram is electrically operated. It displays the actual oil pressure of the engine. The indicator light only warns the driver of low oil pressure.

Construction and working: Oil pressure sending unit is screwed into the oil gallery. As oil passes through an oil pressure sender, it moves a diaphragm, which is connected to a variable resistor. This resistor changes the amount of current passing through the circuit. The gauge then reacts to the current and moves a needle over a scale to indicate the oil pressure. This gauge is electromagnetically operated. 3

As oil pressure changes, the resistance in the oil pressure gauge circuit and the reading on the gauge change accordingly.

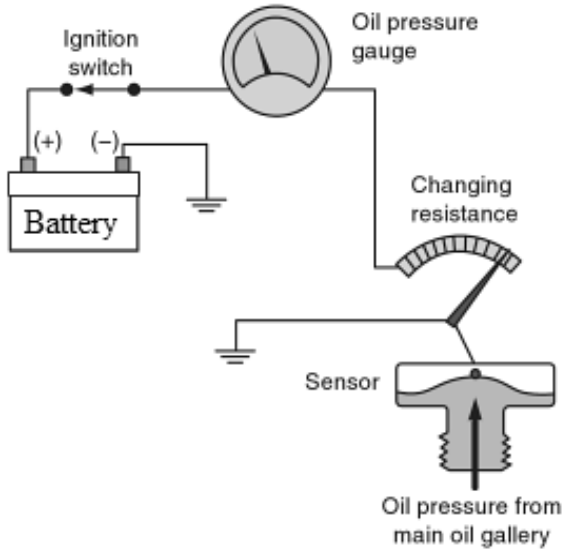


Figure: Electromagnetically operated engine oil pressure gauge 3

b) State any three reasons of battery failures. 6

Answer: Reasons of battery failures: ***(explanation of any three - 2 marks each.)***

1.Overcharging failure:

a. If a battery is subjected to prolonged period of charging to restore it to its full charge condition, excessive heat will be produced, which will cause the positive plates to expand & warp.

b. The swelling of positive plates takes place because the free oxygen continues to enter the positive plates even after complete conversion of lead sulphate into active material.

c. This free oxygen starts attacking the grid and gradually converts it into lead peroxide .Since lead peroxide needs more space than lead, the plates expands & push upwards, raising the cell covers, bulging of battery case.

d. Overcharging also affect the negative plates of battery. The negative plates become hard & dense.

2. Cycling failure:

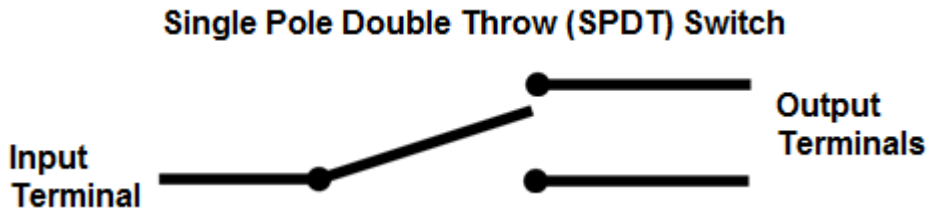
a. This type of failure is considered to be a normal type of failure because during the course of the normal life of a battery, it is being repeatedly charged and discharged.

b. The active material of the negative plates contracts and expands during the discharge –recharge cycle.

c. This makes it to loosen and then wash out the plates.

d. In case of cycling failure, the positive plate active material becomes soft, muddy and brown in colour. 6

e. It may become so soft that it will start shedding some of its material due to gassing. f. This material will fall at the bottom of the cell and will ultimately bridge over and produce a short circuit path between the positive and negative plates. **3. Sulphation failure:** a. During battery discharge, the active material in negative & positive plates gets converted into lead sulphate. b. If battery is recharged without allowing it to stand in this condition, the lead sulphate will get reconverted into active material without any difficulty. c. On the other hand, if the battery is allowed to stand in discharged condition for a longer period, the lead sulphate will become hard, which shall resist reconversion. Plates tend to expand and break the grid. d. During this process, the negative plate becomes grayish white whereas positive plate tends to become milky white. **4. Internal short circuit:** a. Internal short-circuits result from the bridging over of the material across the negative and positive plates which has been shed from them. b. Short-circuits may result because of the failure of a separator. c. Internal short-circuits can be detected by observing orange coloured spots on the plates or the separators. d. These orange coloured spots are due to the heat produced from short-circuits forming an orange colored lead compound. **5. Self-discharge:** a. Batteries tend to self-discharge over a period of time. Even if a battery is not utilized, it is found to discharge at a slower rate. b. The self-discharge tends to occur more quickly at higher temperatures. The changing crystal structure of the active chemicals can cause the electrodes to swell increasing the pressure on the separator and, as a consequence, increasing the self-discharge of the cell.	
2. Attempt any FOUR of the following:	16
a) Enlist any four types of automotive switches and describe SPDT switch with neat sketch.	4
Answer : (*List- 2 marks, Description and sketch of SPDT- 2 marks)* **Types of automotive switches: (*any four*)** 1. Single Pole Single Throw (SPST) 2. Single Pole Double Throw (SPDT) 3. Double Pole, Double Throw (DPDT) 4. Ganged Switch 5. Mercury switch **Single Pole Double Throw (SPDT) switch:** A Single Pole Double Throw (SPDT) switch has one input terminal and two output terminals. A **single-pole, double-throw** (abbreviated SPDT) switch can be on in both positions, switching on a separate device in each case.	2 2



b) State the test procedure of "Short to ground" circuit defect. 4

Answer: credit given to sketch. 4

Short circuit:

Stepwise procedure :

1. Use digital multimeter for measurement of voltage.
2. Check individual segment of circuit.
3. Measure the voltage across battery.
4. Measure the voltage across switch.
5. Measure the voltage across dimmer/connector.
6. Measure the voltage across load (lamp).
7. Note down the reading of voltage.

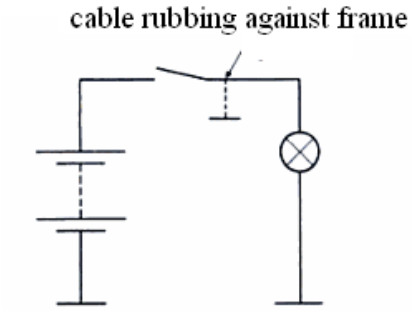


Fig. Short circuit

OR

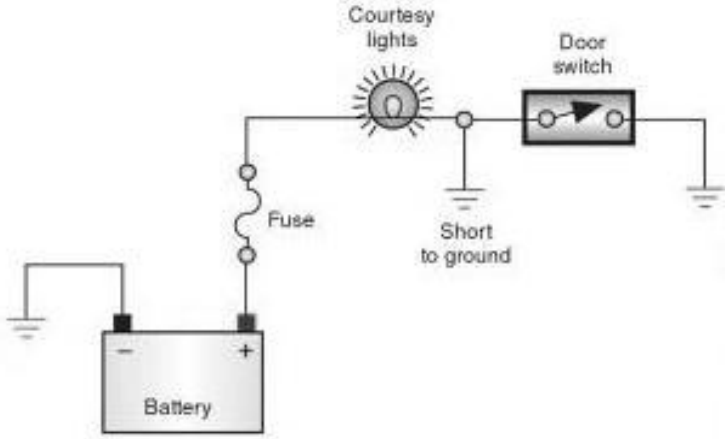


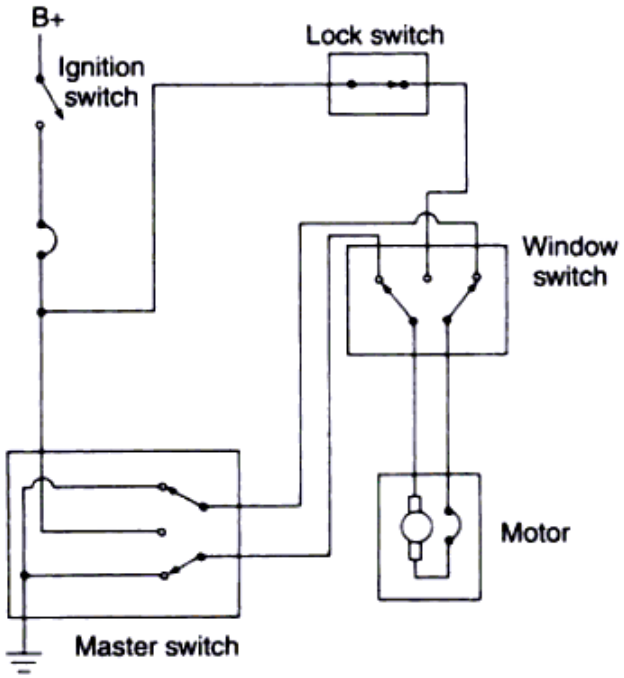
FIGURE A ground in this location will cause the lamp to remain on.

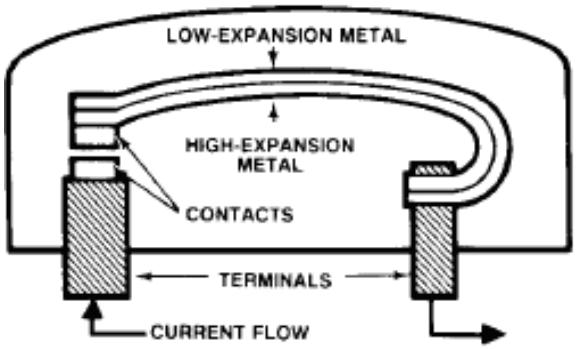
c) List any four components of starting system and state their functions. 4

Answer: ***(List any four components - 2 marks, Function- 2 marks)*** 4

The components of starting system and their functions are as follows:(***any Four***)

1) **Battery:** A starter battery supplies the current to starter motor, needed for engine cranking.
2) **Ignition switch**: It controls the current supplied to the solenoid and to the starter motor for cranking. In starter mode, the switch provides current to solenoid and the starter motor gets supply.
3) **Neutral safety switch:** The switch provides continuity in starter circuit if the transmission is in neutral or clutch is disengaged.
4) **Solenoid:** Solenoid controls a larger cranking current with use of small current carrying circuit that uses a movable core. The core is mechanically linked to the electrical contacts through some form of mechanical linkage.

5) **Starter motor:** Upon receiving current, motor initially provides adequately high torque needed for engine cranking. 6) **Starter drive:** It ensures the starter motor engagement while cranking, and immediate disengagement upon engine starting.	
d) Describe working of power window with simple circuit diagram.	4
Answer: *(Diagram - 2 marks, working- 2 marks ,credit given to equivalent diagram)* **Working of Power window circuit:** Major components of a typical Power windows system are – master control switch, individual window control switches, lock switch and the window drive motors as shown in figure. A permanent magnet motor operates each power window. Each motor raises or lowers the glass when voltage is applied to it. The direction that the motor moves the glass is determined by the supply voltage. The motors are permanent magnet reversible DC motors. The master control switch provides overall system control. A lock switch is safety device to prevent children from opening the windows without the driver's knowledge. Circuit breakers are generally used on power windows to open the circuit if an overload occurs. Without a circuit breaker to open, the motor may be damaged trying to move the window against the ice. As ice is removed, the breaker will cool, close and allow future window operation.  **Figure** A simplified power window circuit.	2 2
e) Explain automatic resetting type circuit breaker.	4
Answer: (Sketch – 2 marks & working -2 marks) The **automatic resetting type circuit breaker** is designed to open when circuit current exceeds a given level. It uses a bimetallic strip that opens if current draw is excessive.	



2

Automatic Resetting type of Circuit breakers - Automatic resetting type of circuit breaker uses a thermally sensitive element (bimetal strip) that snaps open the contact points when overheated by excessive amperage. But after a short cooling-down period, the circuit breaker resets itself. The bimetal strip has two metals of different coefficient of expansion. There is nothing to replace. Circuit breakers range from 5 to 50 amperes.

2

f) State the test procedure of alternator stator and rotor. 4

Answer: :(Procedure of stator & rotor - 2 marks each; credit given to equivalent sketch)
Procedure applied to conduct tests on rotor & stator
For Stator Testing:

1. Connect the test lamp or ohmmeter to the stator frame & one of the stator leads.
2. Record reading of ohmmeter / lamp illumination
3. Connect the test lamp or ohmmeter between each pair of stator leads
4. Record reading of the ohmmeter / lamp illumination

2

If the ohmmeter reads infinity between any two of the three stator windings, the stator is open and, therefore, defective. The ohmmeter should read infinity between any stator lead and the steel laminations. If the reading is less than infinity, the stator is grounded. Stator windings can be tested if shorted because the normal resistance is very low.

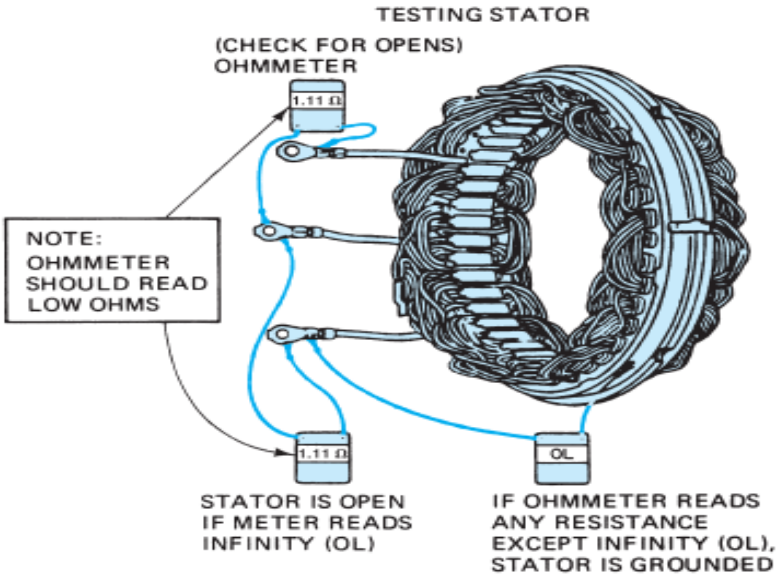
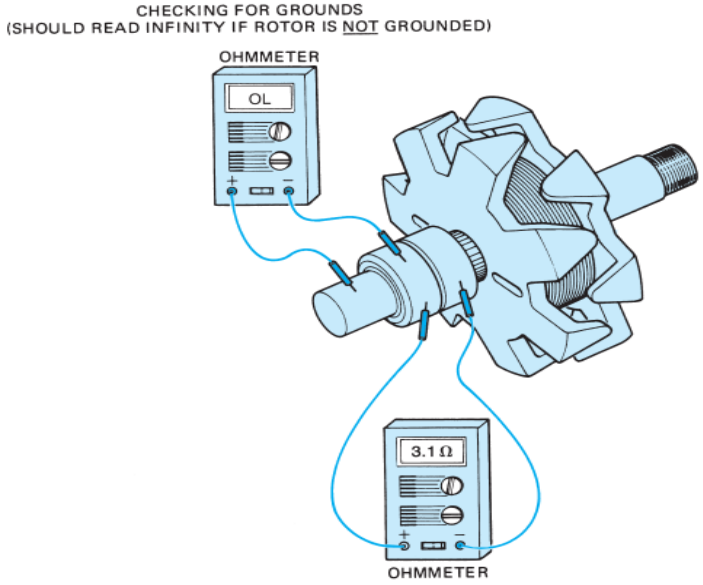
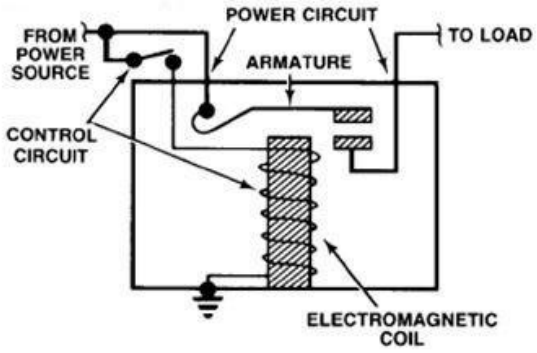
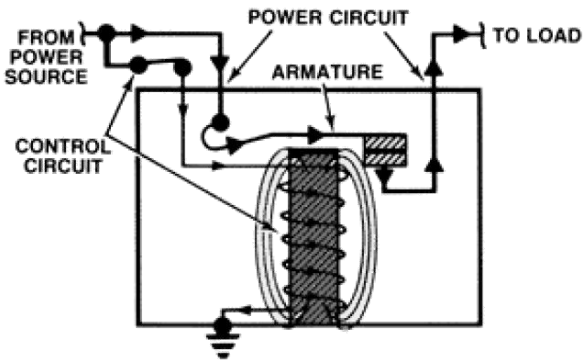
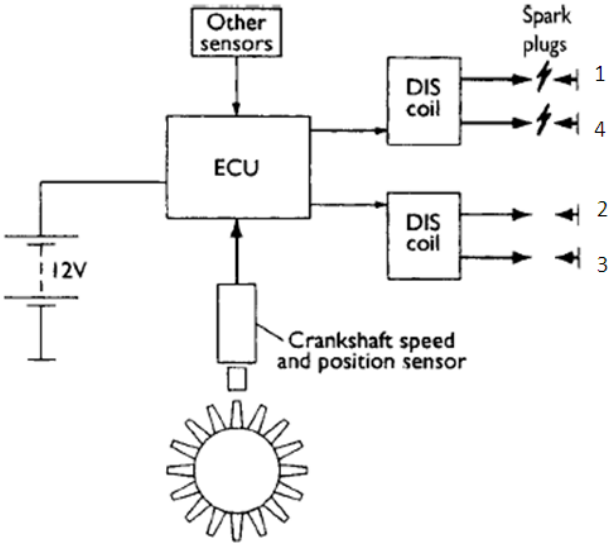


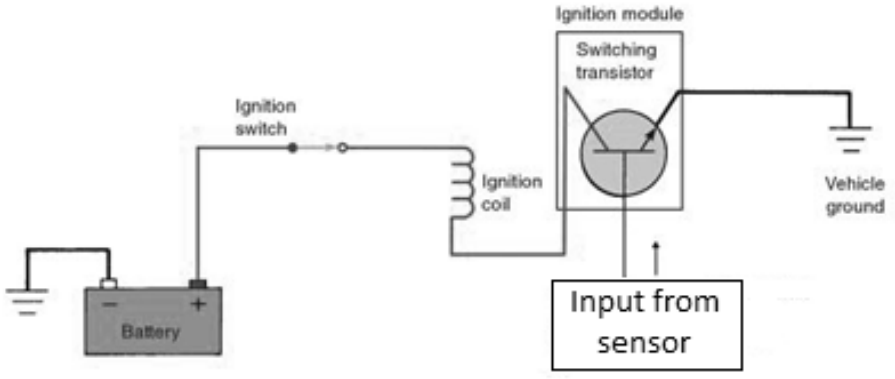
FIGURE: Testing a stator using an ohmmeter.

For Rotor Testing: 1. Remove the rotor from end frame 2. Extract the retainer plate screws 3. Remove the retainer plate 4. Remove the end frame bearing 5. Remove the three attaching screws & separate the stator from end frame. 6. Attach one lead of a 110 volts test lamp or an ohmmeter to either slip ring & outer lead to the rotor- shaft or poles. 7. Note down reading of ohmmeter 8. Attach lamp or ohmmeter connections to each slip ring 9. Note down reading of ohmmeter or observe the lamp light 10. Connect 12 V battery and an ohmmeter in series with the slip rings of rotor 11. Record reading of ammeter 12. Connect an ohmmeter in series with slip ring of rotor 13. Record reading of ohmmeter	2
 **FIGURE:** Testing a rotor using an ohmmeter. ***Note: Equivalent credit shall be given to Block/schematic diagram***	
3. Attempt any FOUR of the following:	16
a) Describe operation of Keyless entry system.	4
Answer: ***(Explanation 4 Marks, credit given to equivalent figure)*** The keyless entry system allows the driver to unlock the doors or trunk lid from outside the vehicle without using a key. The main components of the keyless entry system include: 1) A control module 2) A coded button keypad located on the driver's door 3) Door lock motors The keypad consists of five normally open, single-poles, and single-throw switches. Each switch represents two numbers 1-2, 3-4, 5-6, 7-8, 9-0. The keypad is wired into the circuit to provide input to the control module. The control module is programmed to lock the doors with door lock motors when the 7-8, and 9-0 switches are closed at the same time.	4

The driver's door can be unlocked by entering a five-digit code through the keypad. Remote controlled keyless entry systems are also available. They use a hand held transmitter attached as a key chain. It can be operated within a range of 25 to 50 feet and from any direction. The operating is done by a button press, then driver door is unlocked, theft security is disarmed. During exit, lock button locks all doors.	
b) Enlist any four purpose of OBD-II.	4
Answer: *(Any four purpose -1 Mark each)* **Purposes of OBD-II:** (*any four*) 1. To enable the computer systems to monitor the ability of systems and components to maintain low emission. 2. The standardized data link connector, that allows for these tools to communicate with the PCM. 3. Identifying faults in the computer-controlled systems and to notify the driver by means of a malfunction indicator light if the emission related fault causes an increase in emission up to 1.5 times the allowable standard. 4. In addition a diagnostic trouble code (DTC) was stored in the computer's memory. 5. For easier diagnosis of a problem by a technician by using added information stored in the PCM. 6. It brings standardization in components and systems used by various automobile manufacturers. e.g. Data link connectors, data circuits, diagnostic tests and diagnostic trouble codes and generic codes. 7. It provides almost complete engine control and also monitors parts of the chassis, body and accessory devices, as well as the diagnostic control network of a vehicle.	4
c) Explain operation of normally open type relay with neat sketch.	4
Answer: *(Equivalent Sketch – 2 Marks & Description – 2 marks)* Purpose of relay is to control a larger current carrying circuit with the use of small current carrying circuit. When the control circuit switch is open, no current flows to the coil of the relay, so the winding is de-energized i.e. normally open relay. Relays have two circuits: **A control circuit** & **a load/ power circuit.** Control Circuit has small control coil and Load circuit has a switch.The coil controls the operation of the switch. Current flows through the control coil, iron core intensifies the magnetic field. The magnetic field attracts the upper contact arm and pulls it down, closing the contacts which is part of load circuit. This is allowing power from power source to go to the load. This is called relay is energized. It is used to control the electrical circuit. When the coil is not energized, the contacts are open and no power goes to the load.  **De – engergised state of Normally open Relay** **OR**  **Engergised state of Relay**	2 2

d) Describe operation of computer controlled ignition system.	4
Answer: *(Operation- 2 marks, Equivalent diagram- 2 Marks)* **Operation of Computer controlled OR Distributor less coil ignition system:** **The distributor less ignition system consists of three main components:** i. An ECU ii. Crankshaft speed and crankshaft position sensor. iii. Ignition coils • The system is generally used for four cylinder or six cylinder engines. The basic principle is that of the 'Lost Spark'. • The distribution of the spark is achieved by using two double ended coils, which are fired alternately by using ECU. • The timing is determined by using information from a crank shaft speed and crankshaft position sensors as well as some other sensors such as engine load, coolant temperature and detonation sensor etc. • The coil pack (2 ignition coils for four cylinder engine) gets triggered twice in each cycle of operation by using ECU, so that flow of current through one of the two primary windings is stopped. • When the flow of current is stopped, the magnetic field in the primary winding collapses suddenly and a high voltage is produced in the secondary winding. • When one of the coils is fired, a spark is delivered to two companion cylinders, either 1 and 4 or 2 and 3 for four cylinder engine, at the end of compression and exhaust respectively. • The spark delivered to the cylinder on the compression stroke will ignite the mixture. The spark produced in the other cylinder will have no effect, as this cylinder will be completing its exhaust stroke.  	2 2
e) Explain how primary circuit is triggered in electronic ignitions system.	4
Answer: *(Equivalent Sketch -2 marks & Equivalent Description -2 marks)* Most ignition systems have one or more power transistors that switch the coil on and off. Power transistor can regularly carry 10 amps of current. The power transistor(s) are controlled by a driver transistor that receives a signal from a triggering device.	4

The transistor switches on when a small current is applied to its base. This allows a larger amount of current to flow from the emitter to the collector and through the coil primary winding. When the switching device, or trigger, interrupts the current to the base of the transistor, current flow between the collector and emitter is halted. This results in a spark at the spark plug.



Triggering of primary circuit in ignition system

OR

The triggering may be done by

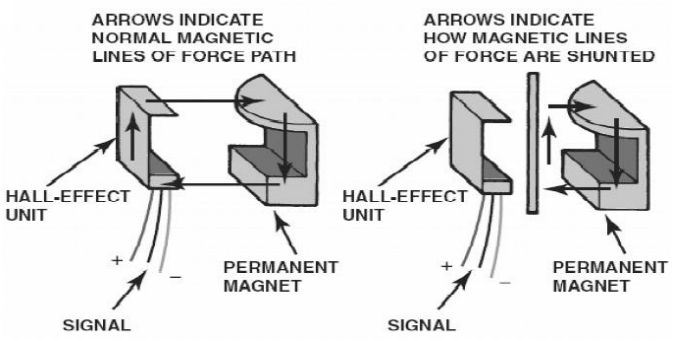
- Inductive pick up,
- hall effect or
- Optical method.

One method of triggering is described for illustration. (*Credit should be given to appropriate description)*

When a moving metallic shutter diverts the magnetic field from reaching the Hall sensor, the Hall-sensor produces a voltage signal. When the shutter blade moves and allows the magnetic field to reach the Hall sensor, the Hall-sensor does not generate voltage signal.

After leaving the Hall layer, the signal is routed to an amplifier where it is conditioned, the signal is sent to the ECU (Primary circuit switching unit).

The electronic control units can be designed to either turn on or turn off the ignition coil primary current when the shutter blades are blocking.



As the central shaft of the distributor rotates, the chopper plate attached under the rotor arm alternately covers and uncovers the Hall chip. The number of vanes corresponds with the number of cylinders. In constant dwell systems the dwell is determined by the width of the vanes. The vanes cause the Hall chip to be alternately in and out of a magnetic field. The result of this is that the device will produce almost a square wave output, which can then easily be used to switch further electronic circuits.

The three terminals on the distributor are marked '_ 0 _'; the terminals _ and _ are for a voltage supply and terminal '0' is the output signal. Typically the output from a Hall effect sensor will switch between 0 V and about 8V. The supply voltage is taken from the ignition ECU and on some systems is stabilized at about 10 V to prevent changes to the output of the sensor when the engine is being cranked.	
4. A) Attempt any THREE of the following:	12
a) Describe operation of automatic headlight dimming.	4
Answer: (*Description – 4 marks & credit should be given to sketch)* Automatic Headlight Dimming automatically switches the headlights from high beams to low beams under two different conditions: • When light from oncoming vehicles strikes the photocell-amplifier, or • Light from the taillights of a vehicle being passed strikes the photocell-amplifier. Modern automatic headlight dimming systems use solid-state circuitry and electromagnetic relays to control the beam switching. **Most systems consist of the following major components:** 1. Light sensitive photocell and amplifier unit. 2. High-low beam relay 3. Sensitivity control 4. Dimmer switch 5. Flash-to-pass relay 6. Wiring harness • The photocell is a variable resister that uses light to change resistance. The photocell-amplifier is usually mounted behind the front grill. • The sensitivity control is a potentiometer which sets the intensity level at which the photocell amplifier will energize. • The sensitivity can be adjusted to the surrounding ambient light conditions by the driver with the help of a control knob. • An increase in the sensitivity level will make the headlights switch to a low beam sooner (Approaching vehicle is far away). • A decrease in the sensitivity level will switch the headlights to low beams when the approaching vehicle is closer.	4
b) List any four purpose of antitheft system. Enlist different types of antitheft systems.	4
Answer: *(Purposes – 02 marks & types – 02 marks)* **Purposes of antitheft systems:** 1. Anti-theft systems are warning systems. 2. It is designed to scare off car thieves by sounding alarms. 3. It is also used to disable the ignition system when car is tampered (vehicle immobilization systems). 4. Used to prevent or deter the unauthorized appropriation of items considered valuable. 5. To secure vehicle from theft. **Types of antitheft systems:** Three basic types of antitheft devices are available: **1. Locking devices,** **2. Disabling devices, and** **3. Alarm systems.**	2 2

Other devices are, i. locks and keys ii. Passkey Systems iii. Keyless Entry Systems iv. Alarm Systems v. RFID system vi. Engine start arming disarming vii. Steering wheel lock viii. GPS ix. Message on mobile	
c) State the following terms related to OBD-II: i) Drive cycle ii) Trip	4
Answer: **1) Drive Cycle:** A drive cycle may be defined as an engine startup and vehicle operation that allows the PCM to enter closed loop and allows all the monitors to complete their function. **OR** An OBD- II drive cycle is a method of driving that begins with an engine starts. The engine is then run until the system goes into closed loop. The drive cycle continues to include whatever specific operating conditions are necessary either to initiate and complete a specific monitoring sequence or to verify a symptom or verify a repair. **2) Trip:** **A** trip is defined as an engine operating drive cycle that contains all of the necessary conditions for a particular test to be performed. **OR** A trip for a particular diagnostic test is defined as a key on and key off cycle in which all the enabling criteria for a given diagnostic test have been met. For example, for the EGR test to be performed, the engine	2 2
d) Describe Ohmmeter testing of electronic fuel injector.	4
Answer: **Following are the steps of Ohm meter test for electronic fuel injector:** • An ohmmeter is connected across the injector terminals to check the injector windings after the injector wires are disconnected. • If the ohmmeter reading is infinite, the injector winding is open. • An ohmmeter reading below the specified value indicates that the injector winding is shorted. • A satisfied injector winding should have resistance between 0.3 to 0.4 ohms. • Replace the injector if the results do not have the resistance as specified by manufacturer.	2

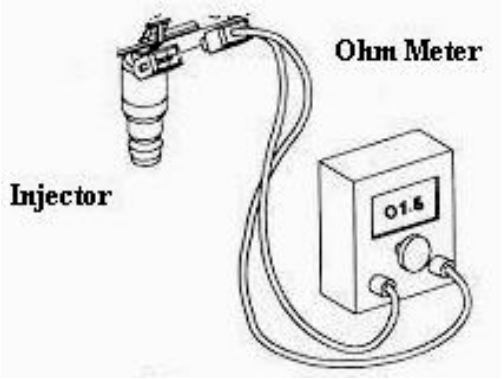


Fig- Electronic Fuel injector testing — 2

B) Attempt **any ONE of the following:** — 6

a) Enlist different components of alternator and state their functions. — 6

Answer: *(Any Six components with function – 1 marks each)* — 6

Alternator components with its function: (Any Six – 1 marks each)

i) **Rotor:** It creates magnetic field when field winding carries current.

ii) **Stator:** It provides a path of magnetic flux using laminated iron core and holds stator windings.

iii) **Stator winding:** It generates electricity by cutting the rotor magnetic flux.

iv) **Field winding:** It generates the magnetic lines of flux.

v) **Brushes and Slip ring:** They provide a means of maintaining electrical continuity between stationary and rotating components-battery and field winding through regulator.

vi) **Housing:** It supports the rotor and stator parts. It holds rectifier and regulator.

vii) **Diode Rectifier Bridge:** It is used to rectifier current output of AC generator.

viii) **Cooling Fan:** It cools the stator and rotor and diodes of alternator.

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b) Differentiate between primary and secondary ignition circuit of ignition system. — 6

Answer: *(Any six points- 1 mark each)* — 6

Sr. No.	Primary ignition circuit	Secondary ignition circuit
1	Primary Ignition circuit includes the components like – Battery, Ignition switch, Ammeter, Primary winding of ignition coil, triggering device like contact breaker points / pickup coil, igniter, condenser, ballast resistor and wiring harness.	Secondary Ignition circuit includes the components like – Secondary winding of ignition coil, Distributor, HT wires, Spark plug.
2	It is working on a low voltage (6 or 12 V).	It has a voltage of about 20KV to 60KV.
3	Primary Windings are made up of several hundred turns of heavy wire wrapped around or near the secondary windings.	Secondary Windings consist of several thousand turns of very fine wire, located inside or near the secondary windings
4	Low Voltage Lead – carries low voltage from the battery or armature to primary side of coil	High Voltage Lead – carries high voltage from the secondary side of the coil to the spark plug

5	To get a spark out of an ignition coil, the primary coil circuit must be turned on and off by triggering devices	After triggering the primary circuit, the high voltage is generated in the secondary winding of the ignition coil. This high voltage is transferred to spark plug through spark plug wires.	
6	Size of wires/cables is small.	Size of wires/cables is large.	
7	This is a control circuit of ignition system.	This is distribution or load circuit of ignition system.	
8	Maintenance required for this circuit's components is less.	Maintenance required for this circuit's components is more.	

5. Attempt any FOUR of the following: 16

a) Enlist the uses of microprocessor in vehicle. 4

Answer: Uses of microprocessor in vehicle: ***(Any four uses - 1 mark each)*** 4

1. **Power train and chassis control:** Engine, automatic transmission, hybrid control, steering, brake, and suspension.
2. **Body electronics:** Instrument panel, key, door, window, lighting, air bag, seat belt.
3. **Multimedia applications:** Car audio, Car navigation, traffic information, electronic toll collection.
4. **Integrated systems/ services:** Electronic Stability control, Pre-crash safety, lane keeping assistance, parking assistance.

OR

Microprocessor is used in management of following systems:

1. Engine and drive train control,
2. Instrumentation, ride control,
3. Antilock braking and other safety systems,
4. Entertainment
5. Heating/air conditioning control
6. Anti-theft devices
7. Automatic seat position control

b) Draw block diagram of GPS and describe working of GPS. 4

Answer: ***(Block diagram -2 marks and working -2 marks; Credit should be given to equivalent diagram, if drawn)***

Global Positioning System (GPS) technology fulfills goals of accurate location, navigation, and asset tracking. It makes automotive commute safer and easier. 2

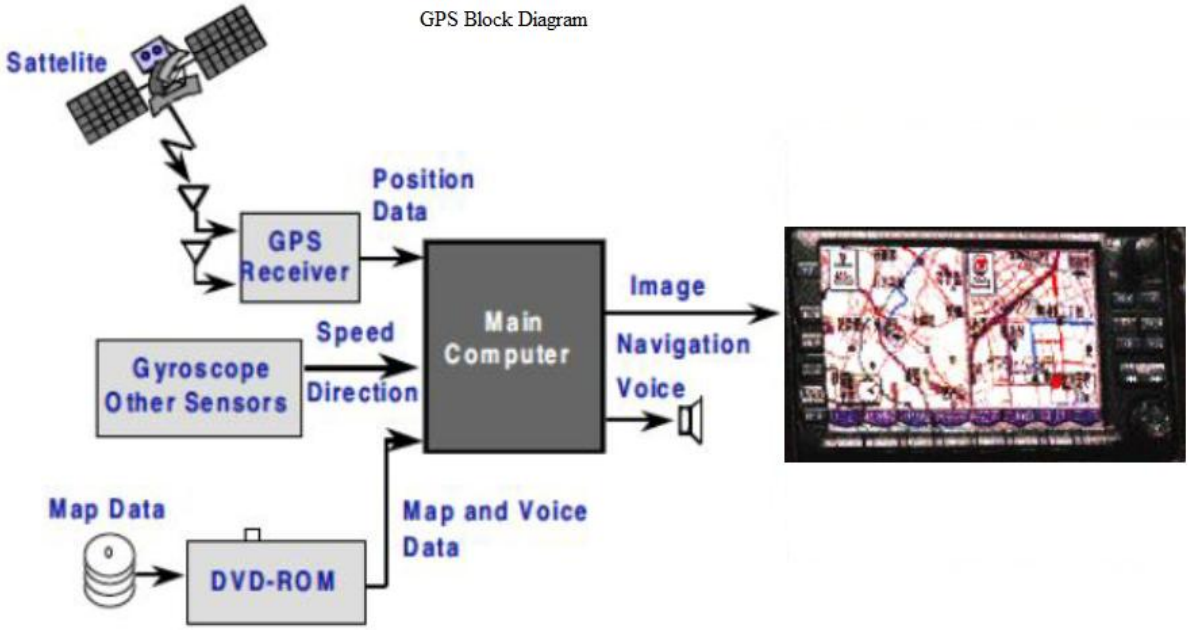
Working:

A **GPS** receiver must be locked on to the *signal of 4 or more satellites* to calculate a 3-D position of user (latitude, longitude and altitude) and track movement.

The GPS satellites transmit signals to a GPS receiver. These receivers passively receive satellite signals; they do not transmit and require an unobstructed view of the sky, so they can only be used effectively outdoors. GPS operations depend on a very accurate time reference, which is provided by atomic clocks on board the satellites.

Each GPS satellite transmits data that indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant. The signals, moving at the speed of light, arrive at a GPS receiver at slightly different times because some satellites are further away than others. The distance to the GPS satellites can be determined by estimating the

amount of time it takes for their signals to reach the receiver. When the receiver estimates the distance to at least four GPS satellites, it can calculate its position in three dimensions.



2

c) How "State of charge of battery" test is performed with help of hydrometer. 4

Answer: ***(Sketch 2 marks and Explanation 2 marks)***

State of charge test of battery with hydrometer:

On unsealed batteries, the specific gravity of the electrolyte can be measured to give a fairly good indication of the battery's state of charge. Squeezing the hydrometer bulb pulls electrolyte into the reservoir. 2

When filled with test electrolyte, the sealed hydrometer float floats in the electrolyte. The depth to which the glass float sinks in the test electrolyte indicates its relative weight compared to water. The reading is taken off the scale by sighting along the level of the electrolyte.

The specific gravity of the electrolyte decreases as the battery discharges. This is why measuring the specific gravity of the electrolyte with a hydrometer can be a good indicator of how much charge the battery has lost. Temperature correction is needed because specific gravity changes with temperature.

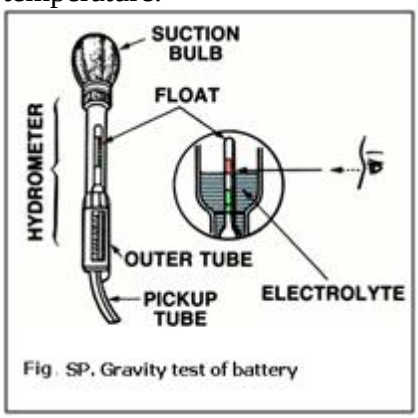


Fig. SP. Gravity test of battery

Following table shows specific gravity readings in various stages of charge at a temperature of 26.7°C.

Specific Gravity	Percentage of Charge
1.265	100%
1.225	75%
1.190	50%
1.155	25%
1.120 or lower	Fully discharged

2

OR

d) Write the test procedure of manifold absolute pressure sensor. — 4

Answer: ***(Procedure - 4 marks)*** — 4

- **Testing the MAP sensor using a scan tool**:

1. Remove the MAP sensor from the air cleaner assembly and disconnect the MAP sensor from its vacuum hose.
2. Connect your vacuum pump to the MAP sensor's vacuum nipple. If you had to disconnect the MAP sensor from its electrical connector to remove it, reconnect it to it now.

A scan tool can be used to test a MAP sensor by monitoring Injector pulse width (in milliseconds) when vacuum is being applied to the MAP sensor using a hand operated vacuum pump.

Step 1: Apply about 51cm of Hg vacuum (Idling vacuum) to the MAP sensor and start the engine.

Step 2: Observe the Injector pulse width. On a warm engine, the Injector width will normally be 1.5 to 3.5 ms.

Step 3: Slowly reduce vacuum to the MAP sensor and observe the pulse width. A lower vacuum to the MAP sensor indicates a heavier load on the engine and the injector pulse width should increase.

OR

- **Testing the MAP sensor using Digital multimeter.**

(when vacuum is being applied to the MAP sensor using a hand operated vacuum pump**)**

(Use T-pins to back probe the connector to access the MAP sensor wiring. Most MAP sensors use 3 wires.

- A 5.12V wire from the computer
- An output signal wire to the computer
- A ground wire.)

Steps

3. Connect the red voltmeter terminal and the black meter lead to the COM meter terminal.
4. Select DC volts. A digital multi-meter is set to test a MAP sensor.
5. Connect the test leads to the sensor signal wire and the ground wire.
6. Read the voltage as the vacuum is applied to the sensor.
7. Compare the vacuum reading and voltage reading to the specification.

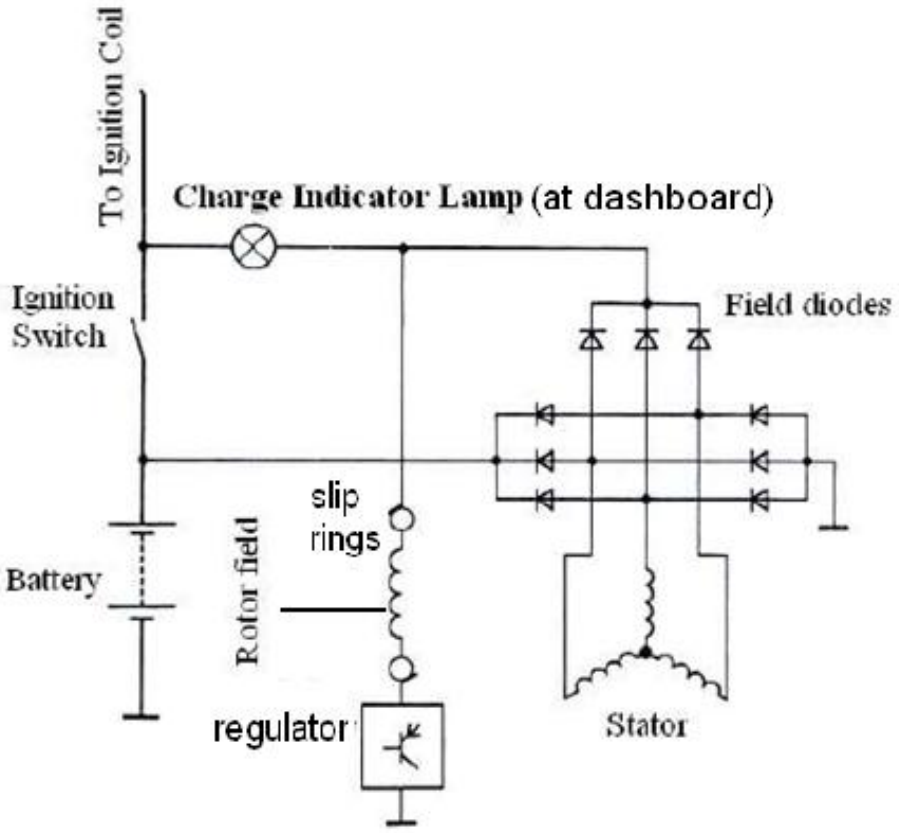
Vacuum / Pressure	Engine operating condition/ Throttle opening (Key On, Engine Off)	MAP sensor voltage
Atmospheric pressure	Full load/ Wide open throttle (WOT)	4.8 V
25.5 cm of Hg vacuum	Cruise or Light load/ Part throttle	2.94 V
51 cm of Hg vacuum	No load / Idle	1.1 V

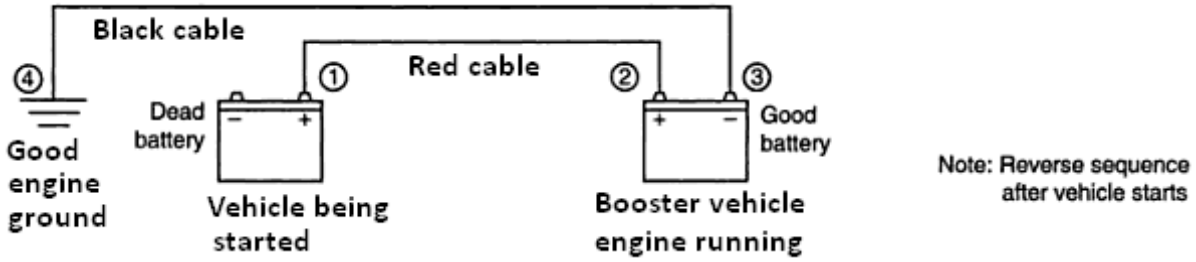
e) State the need of voltage regulator in charging system. — 4

Answer: ***(Any 4 points - 4 marks)*** — 4

Need of Voltage Regulator in charging system:

1. It is needed to control output of alternator, to meet the electrical load demand.
2. It is needed to prevent the battery from being overcharged
3. It is needed to protect the electrical equipment from excessive voltage.
4. On a 12 volt generator, the regulator sets the alternator voltage to a maximum of 14.2 volts. Since this voltage corresponds to a fully-charged battery, the alternator must be made to vary its field current to suit the state-of-charge of the battery.

5. At the maximum voltage the voltage regulator operates and keeps the output voltage at 14.2 V irrespective of the current being generated. 6. It controls charging voltage based on the ambient temperature. i.e. At high temperature, it reduces charging voltage and avoids battery overcharging. 7. It monitors both battery and stator voltages and depending on the measured voltages, the regulator will adjust the amount of rotor field current to control alternator output.	
f) Describe operation of charge indicator light circuit with simple wiring diagram.	4
Answer: credit should be given to sketch. **Operation of Charge Indicator Light Circuit:** • When the engine is to be started, the ignition is switched on. • This connects the Charge Indicator Lamp to the battery and makes a circuit through rotor field and regulator to earth. • At this stage the charge indicator lamp is illuminated and the field is excited to the extent controlled by the wattage of the lamp; a typical lamp size is 12V, 2W. • As alternator speed is raised, the potential difference on the output side of the field diodes is increased. • This gradually reduces the voltage applied to the lamp so the light slowly fades and goes out when the output voltage of the alternator equals the battery voltage; i.e. when the alternator "cuts –in" and starts to charge. • When this happens the field diodes will be providing the entire field current.  	4

6. Attempt any FOUR of the following:	16
a) Explain jump starting procedure with neat block diagram.	4
Answer: (Procedure - 2 marks, block diagram - 2 marks) Jump starting requires proper battery connecting procedures to prevent sparks. Jump start a vehicle using following **procedure:** 1. Engage the parking brake and put the transmission in park or neutral. 2. Make sure the two vehicles are not touching. 3. Turn on the heater blower motor in the vehicle with the dead battery. This will allow the battery to help absorb any damaging voltage spikes. Turn off all other switches and lights. 4. Connect the two positive cables using the positive jumper leads. 5. Connect one end of the negative jumper lead to the booster battery. 6. Lastly connect the other lead of the negative jumper lead to a good ground on the vehicle with the dead battery. This location could be • The vehicle frame • The engine block. 7. Start the jumper vehicle and run at fast idle and try to start the disabled one. 8. Crank the engine. As soon as the dead vehicle starts, disconnect the jumper cables in reverse order of connection. 9. Run the host vehicle at 2000 rpm to allow charging system to recharge the battery. Connection Steps: 1-2-3-4 Disconnection Steps: 4-3-2-1 Using this method ensures that any possible sparks occur away from the battery. Note: The battery jumper leads should be high quality and have large wire gauge (such as 4 gauge) to safely carry the current necessary to jump start a vehicle.  	2 2
b) Write the procedure of current draw test related to starting system.	4
Answer: ***(Procedure - 4 marks, credit may be given to sketch, if drawn)*** The current draw test measures the amount of current the starter draws when actuated. It determines the electrical and mechanical condition of the starting system. Starting System Current draw test procedure: 1. Connect the large red and black test leads on the battery posts, observing polarity. 2. Zero the ammeter of VAT (Volt amp. tester). 3. Connect the ampere inductive probe around the battery ground cable. If more than one ground cable is used, clamp the probe around all of them. 4. Make sure all loads are turned off (lights, radio and so on). 5. Disable the ignition system to prevent the vehicle from starting. This may be done by removing the ignition coil secondary wire from the distributor cap and putting it to ground OR by removing the ignition system fuse / fuel pump fuse / PCM fuse, OR by disconnecting the primary wires from the coils of an EI system.	4

6. Crank the engine and note the voltmeter reading.Never crank the engine for more than 15 seconds
7. Read the ammeter scale to determine the amount of current draw.

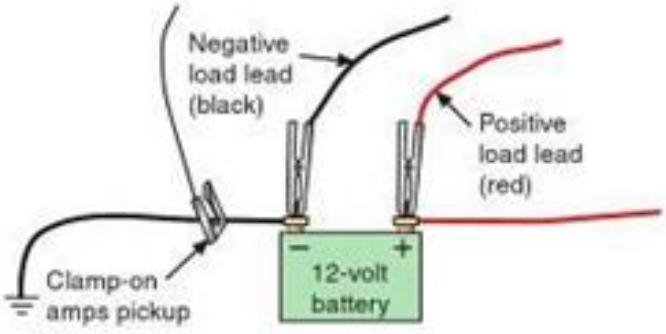


FIGURE **Connecting the VAT leads to perform the starter current draw test.**

c) Enlist any eight precautions to be taken during handling and charging of vehicle battery. 4

Answer: (Total 8 Precautions combining handling and charging of vehicle battery - 4 marks) 4

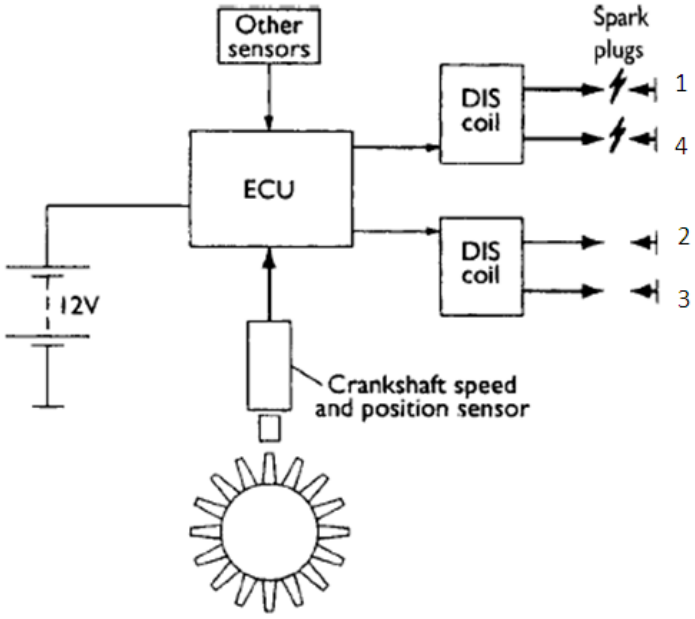
Precautions during handling of a battery:

1) Battery acid is very corrosive. Do not allow it to come in contact with skin, eyes or clothing. If battery acid gets into your eyes, rinse them thoroughly with clean water and receive immediate medical attention.
2) If battery acid comes in contact with skin, wash with clean water. Baking soda added to water will help to neutralize the acid.
3) When making connections to a battery, be careful to observe polarity, POSITIVE TO POSITIVE & NEGATIVE TO NEGATIVE.
4) When disconnecting the battery cables, always disconnect the negative (ground) cable first.
5) When connecting the battery cables, always connect the negative cable last.
6) Never smoke or allow other sources of ignition near a battery. Avoid any arcing or open flames near a battery. The vapours produced by the battery cycling (discharging) are very explosive. Do not smoke around a battery.
7) Follow manufacturer's instructions when charging a battery. Charge the battery in a well ventilated area. Do not connect or disconnect the charger leads while the charger is turned on.
8) Do not add additional electrolyte to the battery if it is low. Add only distilled water.
9) Do not wear any jewelry or watches while servicing the battery. These items are excellent conductors of electricity. They can cause severe burns if current flows through them by accidental contact with the battery positive terminal and ground.
10) Never lay tools across the battery. They may come into contact with the battery terminals, shorting out the battery and causing it to explode.
11) Wear safety glasses or face shield when servicing the battery.

Precautions during charging:

1. Always follow manufacturer's instructions.
2. Before placing a battery on charge, ensure that the terminals are clean.
3. Verify that the electrolyte level is proper in all the cells. If not, add enough distilled water to cover the plates.

4. Remember to wear eye protection and gloves. 5. If battery has vent plugs, the same are removed along with exhaust tube. 6. Connect the charger to the battery, observing proper polarity- the positive charger lead to the positive battery post and the negative charger lead to the negative post. Make sure the connections are tight. 7. Turn the charger on and slowly increase the charging rate until the recommended ampere value is reached. 8. Charging should be done in a well ventilated area, away from sparks and open flames. 9. During charging, the battery electrolyte temperature should be monitored. If the temperature reaches 54°C, then discontinue charging. Resume charging after allowing the battery to cool to 45°C. 10. The charger should be off before connecting or disconnecting the leads to the battery. When the battery is charged, turn the charger off and disconnect it. 11. Do not add additional electrolyte to the battery, during recharging. If electrolyte level is low, add only distilled water. 12. If there is any evidence of smoke or dense vapour or liquid coming out of the battery, shut off the charger. The battery should be rejected or the charging rate reduced or temporarily halted.	
d) Describe with neat block diagram, operation of distributor-less ignition system.	4
Answer: (Sketch – 2 Marks & explanation – 2 Marks) **The Distributor less ignition system consists of three main components:** i. An ECU ii. Crankshaft speed and crankshaft position sensor. iii. Ignition coils • The system is generally used for four cylinder or six cylinder engines. The basic principle is that of the 'Lost Spark'. • The distribution of the spark is achieved by using two double ended coils, which are fired alternately by using ECU. • The timing is determined by using information from a crank shaft speed and crankshaft position sensors as well as some other sensors such as engine load, coolant temperature and detonation sensor etc. • The coil pack (2 ignition coils for four cylinder engine) gets triggered twice in each cycle of operation by using ECU, so that flow of current through one of the two primary windings is stopped. • When the flow of current is stopped, the magnetic field in the primary winding collapses suddenly and a high voltage is produced in the secondary winding. • When one of the coils is fired, a spark is delivered to two companion cylinders, either 1 and 4 **or** 2 and 3 for four cylinder engine, at the end of compression and exhaust strokes. • The spark delivered to the cylinder on the compression stroke will ignite the mixture. • The spark produced in the other cylinder will have no effect, as this cylinder will be completing its exhaust stroke.	2

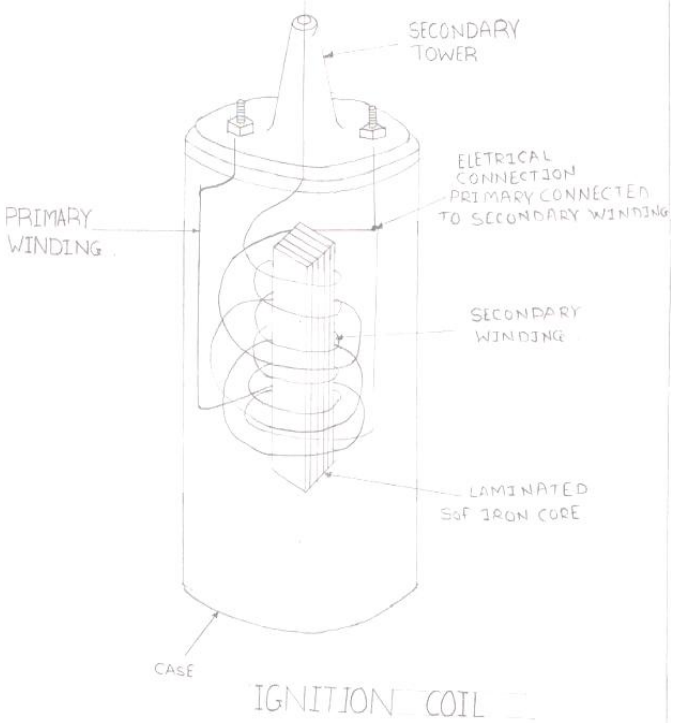


2

e) State the functional operation of Ignition coil in ignition system. 4

Answer: ***(Sketch - 2 marks, Operation - 2 marks)***

Operation of Can type of Ignition Coil: When the ignition switch is turned on , the current flows from the battery to the primary winding. When the contact breaker points open, the primary circuit breaks and the magnetic field collapses. Rapid collapsing of magnetic field induces high voltage in secondary winding. This high voltage current flowing through the secondary winding goes to the distributor. Distributor sends this current to various spark plugs in firing order. 2



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