ONBOARD DIAGNOSIS (OBD):

In the year 1988, SAE required all automotive manufacturers to provide an Onboard Diagnostic system capable of identifying faults in the computer-controlled systems and to notify the driver by means of a malfunction indicator light if the fault exists. This system was capable of monitoring the functionality of a component within the fuel metering system, EGR system, and additional emission related components. In addition a diagnostic trouble code (DTC) was stored in the computer’s memory.

**Purpose of OBD II:-**

**OBD II stands** for on-board diagnostics, second generation. The Clean Air Act of 1990 directed the Environmental Protection Agency (EPA) to develop new regulations for on-board diagnostics. Starting with the 1996 model year, all vehicles sold will use the same type of 16-pin **data link connector** (DLC) and must monitor emission-related components.

OBD II implements the use of “generic” scan tools to access the emission related items and DTCs. The standardized data link connector, developed by OBD II and the SAE, allows for these tools to communicate with the PCM.

**On Board Diagnosis (OBD) of MPFI/CRDI system:-**

The OBD of MPFI/CRDI system follows the following procedure:-

1. Connect the Bosch KTS 180 scanner with the pin connector of the ECM.
2. Start the diagnostic procedure as per the recommended procedure
3. Check for the actual values of the sensors for e.g. desired voltage, resistance etc.
4. Go in the error memory to check for errors or the DTCs.
5. The SAE J 2012 Standards for finding a particular DTC is shown below
SAE J2012 STANDARDS DIAGNOSTIC TROUBLE CODES:

SAE published J2012 to describe industry-wide standards for a uniform diagnostic trouble code format. This format allows a generic scan tool to access any OBD II system. The SAE J2012 standards specify that all DTCs will have a five digit alphanumeric numbering and lettering system. The following prefixes indicate the general area to which the DTC belongs: -

1. P – Power train
2. B – Body
3. C – Chassis

The first number in the DTC indicates who is responsible for the DTC definition.

1. 0 – SAE
2. 1 – Manufacturer

The third digit in the DTC indicates the subgroup to which the DTC belongs. The possible subgroups are:

0 – Total system
1 – Fuel & air metering
2 – Injector circuit malfunctions
3 – Ignition system misfires
4 – Auxiliary emission control
5 – Vehicle speed control & idle speed control
6 – Computer output circuit
7 – Transmission
8 – Non EEC power train
The fourth and fifth digits indicate the specific area where the trouble exists.

**Code P1711 has the following interpretation:**

P – Power train DTC

1 – Manufacturer-defined code

7 – Transmission group

11 – Transmission oil temperature (TOT) sensor and related circuits.

**Stand Alone Diagnosis of electronic components:**

Stand alone diagnosis of electronic components means that we have to check the electronic components such as sensors, actuators, diodes etc with the help of measuring instruments like digital multimeter, oscilloscope etc…..

**Testing of the diodes (Rectifier Bridge)**

As the diode allows current to flow in only one direction, it must be tested for continuity in both directions. Using the ohmmeter, connect the test leads to the diode lead and case.

Read the ohmmeter scale. If the diode is good it will show high resistance in one direction and low resistance in the opposite direction.

If both readings are low, the diode is shorted. If there is high resistance in both directions, the diode is open. Test all six diodes and replace any that are defective.

**SENSOR TESTING:**

1. **OXYGEN SENSOR:** - Following procedure is followed to diagnose an oxygen sensor
   a) Disconnect the connector of the oxygen sensor.
   b) Start the engine and warm-up for 2 minutes at 3000 rpm under no load conditions.
   c) Raise the engine speed to 4000 rpm and release the throttle suddenly for at least 5 times.
   d) Within one minute after the engine has been warmed up, measure the
voltage between the connector terminal and body ground.

e) The voltage should be below 0.4 Volts.
f) Replace the oxygen sensor if the voltages are out of the above range.

2. INTAKE AIR TEMPERATURE (IAT) SENSOR: -

Following procedure is followed to diagnose an IAT sensor

a) Remove the IAT sensor from the engine.
b) Place it in a container of water with thermometer.
c) Make sure that more than half of the connecter is submerged in the water.
d) Connect a pair of ohmmeter leads to the sensor terminals.
e) Heat the water in the container and measure the resistance at different temperatures.
   The sensor should have the specified resistance of 0.98 to 1.34K at 40°C and 0.22 to 0.35 K at 80°C
f) Replace the sensor if the resistance values are outside the range.

3. ENGINE COOLENT TEMPERATURE (ECT) SENSOR: -

Following procedure is followed to diagnose an ECT sensor

a) Remove the ECT sensor from the engine.
b) Place it in a container of water with thermometer.
c) Make sure that more than half of the connecter is submerged in the water.
d) Connect a pair of ohmmeter leads to the sensor terminals.
e) Heat the water in the container and measure the resistance at different temperatures.
f) The sensor should have the specified resistance 0.98 to 1.34K at 40°C and 0.22 to 0.35 K at 80°C
g) Replace the sensor if the resistance values are outside the range.

4. THROTTLE POSITION (TP) SENSOR: -

   Following procedure is followed to diagnose a TP sensor

1. With the ignition switch in the RUN position, connect a voltmeter from the sensor signal wire to ground.
2. Slowly open the throttle and observe the voltmeter.
3. The voltmeter reading should increase smoothly and gradually.
4. 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.
5. Always refer to the vehicle manufacturer’s specifications.
6. If the TPS does not have the specified voltage or if the voltages signal is erratic, replace the sensor.
ACTUATOR TESTING:-

ELECTRONIC FUEL INJECTOR TESTING:-

1. SOUND TEST:-
   a. The injector sound test is a method of quickly checking the operation of the pintle on engines where the injectors are accessible.
   b. A port injector that is not functioning may cause a cylinder misfire at low engine speeds.
   c. With the engine idling, a stethoscope pickup may be placed on the side of the injector body.
   d. Each injector should produce the same clicking noise.
   e. If an injector does not produce any clicking noise, the injector, connecting wires or PCM may be defective.
   f. When the injector clicking noise is erratic, the injector plunger may be sticking.
   g. If there is no injector clicking noise, proceed with the injector ohms test to locate the cause of the problem.

2. OHMMETER TEST:-
   a. An ohmmeter may be connected across the injector terminals to check the injector windings after the injector wires are disconnected.
   b. If the ohmmeter reading is infinite, the injector winding is open.
   c. An ohmmeter reading below the specified value indicates that the injector winding is shorted.
   d. A satisfied injector winding should have results between 0.3 to 0.4 ohms.
   e. Replace the injector if the results do not have the specified resistance.
The 'Six-Step' approach for component testing

A simple, but effective approach to diagnostic work is known as the ‘Six-Steps’, approach.

This six-step approach may be recognized as an organized approach to problem solving.

The six steps are:

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

1. Collect Evidence

Collecting evidence means looking for all the symptoms that relate to the fault and not jumping to conclusions, e.g. because the system is controlled by an ECU it must be the ECU that is at fault.

In order to collect the evidence it is necessary to know which components on the vehicle actually form the part of the faulty system. This is where sound basic skills come in. If an engine control system is malfunctioning because one cylinder has poor compression it is important to discover this at an early stage of the diagnostic process.

2. Analyze Evidence

In the case of poor compression on one cylinder, given above as an example, the analysis would take the form of tests to determine the cause of low compression, e.g. burnt valve, blown head gasket etc.

The analysis of evidence that is performed will vary according to the system under investigation. But these steps are obviously important.
3. **Locate the fault**

The Procedure for doing this on an electronics system varies according to the type of test equipment available. It may be the case that the system has some self-diagnostics which will read you to the area of the system which is defective. Let us assume that this is the case and the self-diagnostics report that an engine coolant temperature sensor is defective. How do you know whether it is the sensor, or the wiring between it and the remainder of the system? Again this is where a good basic knowledge of the make-up of the system is invaluable.

4. **Find the cause of the fault and remedy it**

With electronic system repair it is often the case that a replacement unit must be fitted. However, this may not be the end of the matter. If the unit has failed because of some fault external to it, it is important that this cause of failure is found and remedied before fitting the new unit. It is often not just a matter of fitting a new unit.

5. **Give the system a thorough test**

Testing after repair is an important aspect of vehicle work and especially so where electronically controlled systems are concerned. In the case of intermittent faults, such testing’s may need to be extended because the fault may only occur when the engine is hot and the vehicle is being used in a particular way.

**Skills required for effective diagnosis**

Studies, over a period of time, show that the skills possessed by vehicle technicians, who are successful in diagnostic work on vehicle electronic systems, consist of many elements. The most important of these may be classed as 'key skills'. These key skills may be summarized as follows:

- Use appropriate 'dedicated' test equipment effectively.
- Make suitable visual inspection (assessment) of the system under investigation.
- Make effective use of wiring diagrams.
- Use instruction manuals effectively.
- Use multimeters and other (non-dedicated) equipment effectively.
- Interpret symptoms of defective operation of a system and, by suitable processes, trace the fault and its cause.
- Work in a safe manner and avoid damage to sensitive electronic components.
- Fit new units and make correct adjustments and calibrations.
- Test the system, and the vehicle for correctness of performance.

Types of measuring instruments and its applications while checking signals and sensors:

1. Digital Multi-meter:- A Multi-meter is an electrical test meter capable of measuring voltage, resistance, and amperage. In addition, some types of multimeters are designed to test diodes, measure frequency, duty cycle, temperature, and rotation speed. Multimeters are available in analog (swing needle) and digital display.

   With modern vehicles using computer controlled systems, the need for digital multimeters (DMM) is required. Computer systems have integrates circuits that operate on very low amounts of current. Analog meters are not useful as they allow a large amount of current to flow through the circuit. On the other hand most digital multimeters have very high input resistance (impedance) which prevents the meter from drawing current when connected to a circuit. Most DMMs have at least 10 meghaohms of impedance. This reduces the risk of damaging computer circuits and components. DMMs are also referred to as DVOMs (digital volt/ohmmeter).

   Note: - For application of DMM give the example of actuator testing (injector testing) ohmmeter test.

2. Oscilloscope: - The oscilloscope is very useful in diagnosing many electrical problems quickly and accurately.

   Digital and analog voltmeters do not react fast enough to read systems that cycle quickly. The oscilloscope may be considered as a very fast reacting voltmeter that reads and displays voltages.

   The scope allows the technician to view the voltage over time. These voltage readings appear as a trace on the oscilloscope screen.
Today most technicians use a variation of the oscilloscope called a lab scope which is a small portable unit. The screen of a lab scope is divided into small divisions of time and voltage as shown in the figure. The division of screen creates a grid pattern. Time is represented by the horizontal movement of the waveform. Voltage is measured with the vertical position of the waveform.

For example, the vertical scale can be adjusted so each division represents 0.5 volts and the horizontal scale can be adjusted so each division equals 0.005 (5 milliseconds). This allows the technician to view small changes in voltage that occurs in a very short period of time. An example could be observing a fuel injector activity when certain changes occur.
3. **Thermometers:**

For Thermometers as a measuring instrument give the example of sensor testing like ECT and IAT…….

4. **Battery Testers:**

For Battery Testers as a measuring instrument give example of conducting a Battery load test.

5. **Lux Meters:** - Lux meters are generally used to measure the intensity of light energy incident on a surface.

   Its unit in the S.I system is given as “lux” of luminance and luminance emittance measuring luminance flux/unit area.

   Applications:
   
   a. To check the intensity of sunlight
   b. Used to check the intensity of headlights in the automatic ON/OFF headlight system

6. **Frequency Meters:** - Frequency meters are used to measure the vibrations induced in the system. Its unit is Hertz (Hz). Also sometimes it can be used to measure the revolutions per second.

   Applications:
   
   a. To check the vibrations induced in the combustion chamber
   b. To check for the speed of the vehicle as a counter in RPM meter.