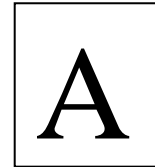




SNS College of Technology, Coimbatore-35.
(Autonomous)



B.E/B.Tech- Internal Assessment - II

Academic Year 2023-2024 (ODD)

19MCE402 – AUTOTRONICS

ANSWER KEY

PART – A

What are the types of ignition system?

1.
 - **Conventional (Mechanical) Ignition System:** This older system uses a distributor to send high-voltage electricity to the spark plugs at the right time.
 - **Electronic Ignition System:** This system replaced the conventional system and uses electronic components to control the ignition timing more precisely.
 - **Distributorless Ignition System (DIS):** DIS systems use multiple ignition coils, one for each cylinder, eliminating the need for a distributor.
 - **Direct Ignition System (DIS):** DIS systems further enhance ignition control by placing an ignition coil directly on each spark plug.
 - **Crankshaft Position Sensor (CPS):** In some modern systems, ignition timing is controlled by the engine's crankshaft position sensor, often in conjunction with a camshaft position sensor.

List the factors to be considered while designing an ignition system.

2.
 - Engine Type
 - Ignition Timing
 - Voltage and Spark Energy
 - Spark Plug Selection
 - Environmental Conditions
 - Safety and Durability
 - Cost and Manufacturing

What is EGR system?

3.
 - It is a system used in internal combustion engines to reduce nitrogen oxide (NOx) emissions. The EGR system recirculates a portion of the engine's exhaust gases back into the combustion chamber, diluting the air-fuel mixture and reducing peak combustion temperatures, which in turn lowers the formation of NOx gases.

4. List the types of sensors using in automotive system.

Modern automobiles use various sensors for monitoring and control. Some common types include,

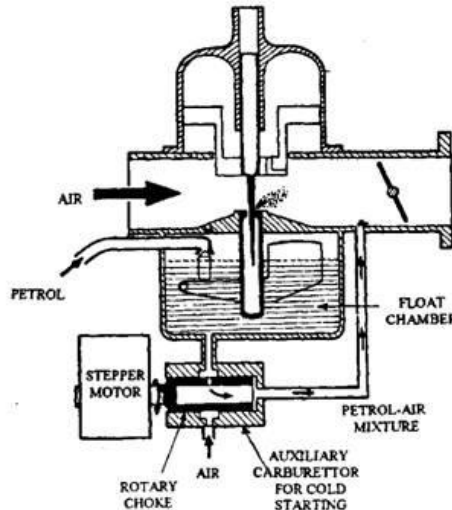
- Mass Airflow Sensor (MAF)
- Throttle Position Sensor (TPS)
- Oxygen Sensor (O2)
- Camshaft Position Sensor (CMP)
- Crankshaft Position Sensor (CKP)
- Coolant Temperature Sensor
- Knock Sensor
- Speed Sensor (Vehicle Speed Sensor - VSS)
- ABS Wheel Speed Sensor
- Pressure Sensors

What is the importance of sensor in Automobile field? Write down name of different sensors and its function. Sensors are crucial in the automotive industry for several reasons:

5.
 - **Performance Optimization:** Sensors enable real-time monitoring and adjustment of various engine parameters, leading to improved fuel efficiency, power output, and emissions control.
 - **Safety:** Sensors are vital for safety systems such as airbags, anti-lock brakes, and stability control.

- **Emissions Control:** Sensors help meet environmental standards by optimizing combustion, reducing pollution, and monitoring exhaust gases.
- **Driver Assistance:** Sensors are the basis of advanced driver assistance systems (ADAS), including parking sensors, adaptive cruise control, and collision avoidance.
- **Diagnostic and Maintenance:** They assist in diagnosing and detecting issues, making maintenance more efficient.
- **Fuel Efficiency:** Sensors contribute to optimizing fuel injection, transmission control, and other factors that affect fuel efficiency.

6. (a) List all the main components of an electronic carburation control system and state the purpose of each component.



Basic electronic control of carburetion, also known as electronic carburetor control, is a system that uses electronic sensors and controllers to manage the air-fuel mixture delivered to an internal combustion engine. This system has largely been replaced by electronic fuel injection (EFI) systems in modern vehicles, but it's still relevant in some older or simpler engines. **Fuel Injector:** Injects precise amounts of fuel into each cylinder's intake manifold for combustion, ensuring an optimal air-fuel mixture.

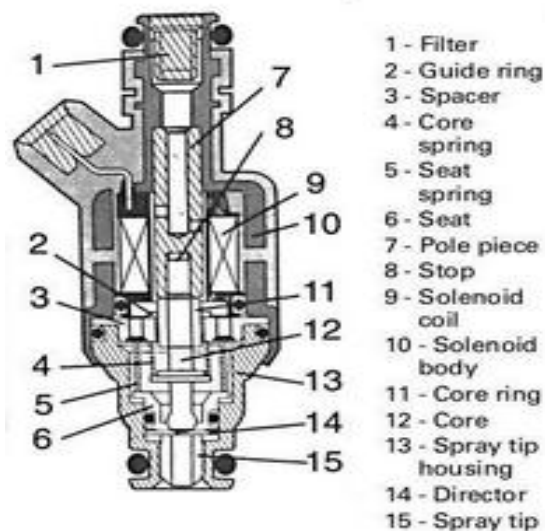
1. **Electronic Control Unit (ECU):** The "brain" of the system that receives input from various sensors and controls the fuel injectors' timing and duration to achieve the desired air-fuel mixture and optimize engine performance.
2. **Sensors:**
 - **Mass Airflow Sensor (MAF):** Measures the amount of air entering the engine to determine the required amount of fuel.
 - **Throttle Position Sensor (TPS):** Monitors the position of the throttle valve to adjust the air-fuel mixture and engine load.
 - **Oxygen Sensor (O₂):** Measures the oxygen content in the exhaust gases to adjust the air-fuel ratio in real-time.
 - **Coolant Temperature Sensor:** Monitors engine temperature to adjust fuel delivery for cold starts and temperature-related performance.
 - **Crankshaft Position Sensor (CKP):** Detects the position and speed of the crankshaft for proper fuel injection timing.
 - **Camshaft Position Sensor (CMP):** Determines the position of the camshaft to optimize valve timing.

- **Knock Sensor:** Detects engine knock or detonation, allowing the ECU to adjust the ignition timing.
3. **Fuel Pump:** Supplies pressurized fuel to the injectors.
 4. **Fuel Pressure Regulator:** Regulates fuel pressure in the fuel rail to ensure the injectors receive a consistent supply of fuel.
 5. **Throttle Body:** Controls the amount of air entering the engine by adjusting the throttle valve.
 6. **Intake Manifold:** Distributes the air-fuel mixture to the engine cylinders.
 7. **Idle Air Control Valve (IAC):** Regulates the engine's idle speed by controlling the airflow when the throttle is closed.
 8. **Map Sensor (Manifold Absolute Pressure):** Measures the pressure in the intake manifold to help the ECU calculate engine load.
 9. **Wiring and Connectors:** Provides electrical connections between the components and the ECU.
 10. **Fuel Lines:** Transport fuel from the tank to the injectors.
 11. **Engine Temperature Sensor:** Measures engine temperature for various functions, including optimizing the air-fuel mixture.

The purpose of these components is to work together to precisely control the air-fuel mixture and optimize engine performance, emissions, and fuel efficiency based on various operating conditions and sensor inputs. This results in a more efficient and cleaner combustion process compared to traditional carburetion systems.

(or)

- (b) Make a clearly labelled sketch to show the operation of a fuel injector.
- The primary function of a fuel injector is to provide fuel to an internal combustion engine. The fuel is pressurized and passed through a filter and flows into the body. The needle prevents the fuel from passing through the body which is held down by a spring. Once the chamber is full the solenoid coil is energized and moves the plunger back, opening up the tip of the injector allowing fuel to be sprayed.
 - The needle is then closed after the solenoid is no longer energized and the spring pushes the needle tip back. The entire process takes milliseconds and varies depending on engine performance.



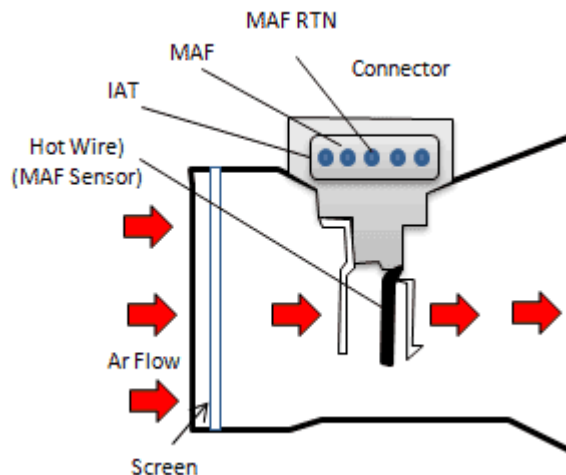
Types of Fuel Injectors

- Top-feed - Fuel enters from the top and exits the bottom.
- Side-feed - Fuel enters on the side on the injector fitting inside the fuel rail.
- Throttle body injectors - (TBI) Located directly in the throttle body.

Operation of a Fuel Injector:

1. **Fuel Inlet:** The fuel injector has a fuel inlet where high-pressure fuel is supplied to it from the fuel rail.
2. **Electromagnetic Coil:** Inside the injector, there is an electromagnetic coil that is connected to the vehicle's electronic control unit (ECU).
3. **Nozzle:** At the tip of the injector is a nozzle that is positioned inside the engine's intake manifold near the intake valve.
4. **Solenoid Valve:** The electromagnetic coil, when energized by the ECU, causes the solenoid valve to open.
5. **Fuel Spray:** When the solenoid valve opens, high-pressure fuel from the fuel rail is allowed to flow into the injector and out of the nozzle.
6. **Atomization:** The high-pressure fuel is sprayed out of the nozzle in a fine mist or spray pattern. This atomization is crucial for efficient combustion.
7. **Intake Valve:** The spray of fuel enters the engine's intake manifold and is directed toward the intake valve of the corresponding cylinder.
8. **Cylinder Intake Stroke:** During the intake stroke of the engine's piston, the intake valve opens, and the air, along with the atomized fuel, is drawn into the cylinder.
9. **Combustion:** When the air-fuel mixture is compressed by the piston during the compression stroke, the spark plug ignites it, leading to combustion and the generation of power.
10. **Exhaust Stroke:** After the power stroke, the exhaust valve opens, expelling the burnt gases from the cylinder.
11. **Repeat:** This process is repeated for each cylinder in the engine, with the fuel injectors timing their operation to provide the right amount of fuel at the right moment for each cylinder.

7. (a) Elaborate the concepts of airflow rate sensor.



An airflow rate sensor, also known as a Mass Airflow Sensor (MAF), is a critical component in the modern automotive engine management system. Its primary function is to measure the amount of air entering the engine's intake manifold. This information is crucial for the engine control unit (ECU) to determine the appropriate amount of fuel to inject into the engine cylinders, resulting in the optimal air-fuel mixture for combustion. Here are the key concepts related to airflow rate sensors:

1. **Measurement Principle:**

- Airflow rate sensors use various measurement principles, but the most common type is the "hot wire" or "hot film" MAF sensor.
- In a hot wire MAF sensor, a thin wire or film is electrically heated to a constant temperature. As air flows over the wire or film, it cools it down, causing a change in its electrical resistance.
- The change in resistance is directly proportional to the mass of air passing over the sensor. The sensor then converts this change in resistance into an electrical signal that the ECU can interpret.

2. **Location:**

- MAF sensors are typically located in the engine's intake tract, between the air filter and the throttle body. This position allows them to measure incoming air before it reaches the combustion chamber.

3. **Signal Output:**

- The MAF sensor produces an analog voltage signal or a digital signal that corresponds to the amount of air passing through it.
- This signal is sent to the ECU, which uses it to calculate the required fuel injection pulse width and timing.

4. **Calibration:**

- MAF sensors require precise calibration to ensure accurate measurements. This involves establishing a linear relationship between the airflow rate and the sensor's output signal.
- Calibration factors can be programmed into the ECU to compensate for factors like sensor aging, dirt buildup, and changes in atmospheric conditions.

5. **Temperature Compensation:**

- MAF sensors also incorporate temperature compensation because the density of air changes with temperature.
- The sensor must account for variations in air density to provide accurate measurements.

6. **Diagnostic Capabilities:**

- Many MAF sensors have built-in diagnostic features to detect sensor malfunctions or contamination. If the sensor fails, the ECU can often operate in a default mode to keep the engine running.

7. **Engine Efficiency:**

- Accurate airflow measurement is essential for optimizing engine efficiency, power output, and emissions control. It ensures that the correct air-fuel mixture is delivered under varying driving conditions.

8. **Fuel Economy and Emissions Control:**

- MAF sensors play a crucial role in achieving fuel efficiency and emissions reduction goals. By precisely measuring air intake, they help the ECU adjust the fuel injection accordingly, resulting in cleaner and more efficient combustion.

9. Adaptation to Engine Load:

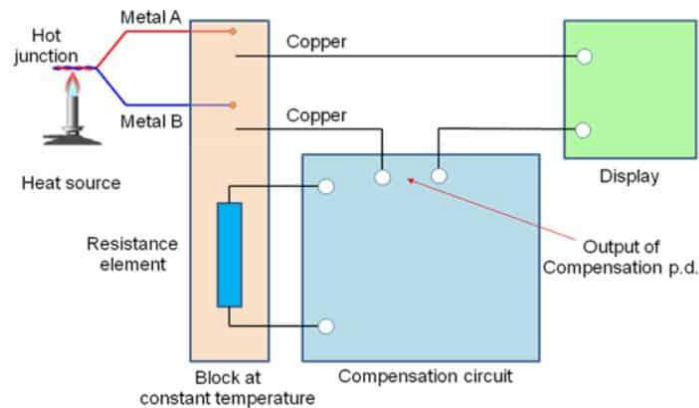
- MAF sensors work in conjunction with other sensors, such as the throttle position sensor and manifold absolute pressure sensor, to help the ECU determine engine load and tailor fuel injection for optimal performance.

10. Maintenance and Cleaning:

- Over time, MAF sensors can become dirty or contaminated, leading to inaccurate measurements. Regular maintenance may involve cleaning or, in severe cases, sensor replacement to ensure proper engine operation.

(or)

(b) Explain the working principle of temperature sensor with a neat sketch.



A temperature sensor is a device used to measure temperature and convert it into an electrical signal that can be read, displayed, or used for control purposes. One common type of temperature sensor is the Resistance Temperature Detector (RTD), which is based on the principle that the electrical resistance of a material changes with temperature. Here's an explanation of the working principle of an RTD temperature sensor, along with a simplified sketch:

Working Principle of an RTD Temperature Sensor:

1. Basic Structure:

- An RTD consists of a thin wire or film made of a temperature-sensitive material, such as platinum (Pt).
- The wire or film is typically wound into a coil or placed on a ceramic substrate.

2. Resistance Variation:

- The key principle behind an RTD is that the electrical resistance of the temperature-sensitive material changes with temperature.
- As the temperature of the material increases, its resistance also increases in a linear and predictable manner.

3. Electrical Circuit:

- The RTD is connected to an electrical circuit. Typically, it is part of a Wheatstone bridge circuit, which includes additional resistors to balance the circuit.

4. Excitation Current:

- A constant current is passed through the RTD element. This excitation current is supplied by an external voltage source.

5. **Measurement Circuit:**

- The voltage drop across the RTD element is measured.
- The RTD is one of the resistors in the Wheatstone bridge circuit, and as its resistance changes with temperature, it causes an imbalance in the bridge.

6. **Output Voltage:**

- The bridge circuit generates an output voltage that is proportional to the resistance of the RTD.
- The output voltage is directly related to the temperature of the RTD element.

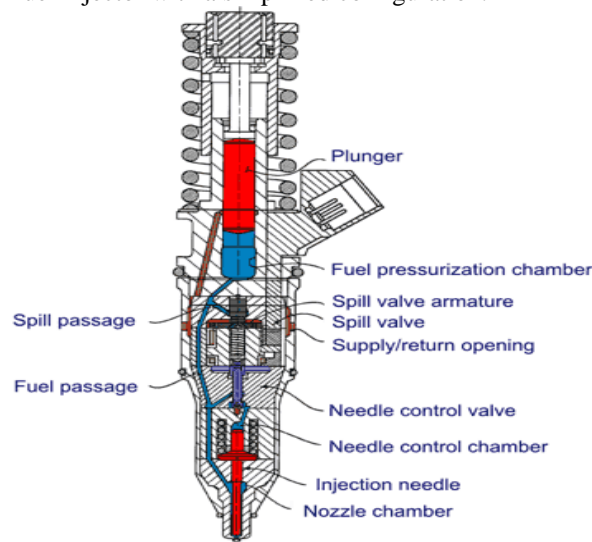
7. **Signal Conditioning:**

- The output voltage is usually quite small, so it may need to be amplified or converted to a more usable signal format (e.g., analog voltage or digital signal) for further processing.

8. **Temperature Measurement:**

- The relationship between resistance and temperature for the specific RTD element is well-characterized and can be represented by a calibration curve.

8. (a) Discuss the concepts of fuel injector with a simplified configuration.



A fuel injector is a critical component in the modern automotive engine management system. Its primary function is to precisely deliver fuel into the engine's intake manifold or directly into the combustion chamber. This is done to create an optimal air-fuel mixture for combustion.

Concepts of a Fuel Injector:

1. **Precise Fuel Delivery:** Fuel injectors are designed to deliver a highly controlled and precise amount of fuel into the engine. This precision is essential for achieving efficient combustion and optimizing power output.
2. **Spray Pattern:** Fuel injectors disperse fuel in the form of a fine mist or spray pattern. This atomization ensures that the fuel mixes thoroughly with incoming air, promoting efficient and complete combustion.
3. **Electromagnetic Operation:** Most fuel injectors use an electromagnetic coil, often referred to as a solenoid, to control the opening and closing of the injector nozzle. The injector is electronically controlled by the vehicle's Engine Control Unit (ECU).

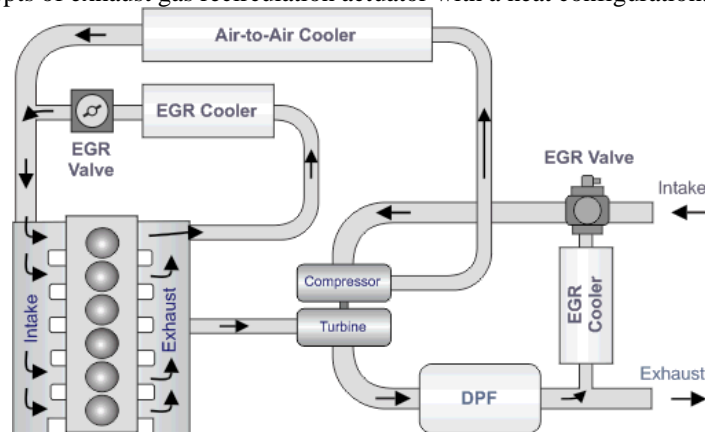
4. **Pulse Width Modulation (PWM):** The ECU adjusts the injector's pulse width to control the duration of fuel injection. This means that the ECU can vary the amount of fuel delivered by changing the duration of the injector's open cycle.
5. **Timing and Synchronization:** The ECU determines the precise timing for each injection event, ensuring that the right amount of fuel is delivered at the right moment in the engine's four-stroke cycle (intake, compression, power, exhaust).
6. **Injector Duty Cycle:** The duty cycle is the ratio of the time the injector is open to the total available time. By adjusting the duty cycle, the ECU controls the amount of fuel injected for various engine operating conditions.

Major Components

- **Injector Nozzle:** The nozzle is the part of the fuel injector that sprays the fuel into the intake manifold or directly into the combustion chamber. It is designed to create the desired spray pattern for optimal mixing with air.
- **Solenoid (Electromagnetic Coil):** The solenoid is an electromagnetic coil that controls the operation of the injector. When energized by the ECU, it pulls a plunger or valve off its seat, allowing fuel to flow.
- **Fuel Inlet:** Fuel is supplied to the injector through a fuel inlet. The injector is connected to the vehicle's fuel system, which provides high-pressure fuel.
- **Fuel Filter:** Some fuel injectors have a built-in fuel filter to prevent contaminants from entering the nozzle.
- **Electrical Connector:** The injector is connected to the vehicle's electrical system via an electrical connector. The ECU provides the necessary voltage and signal to control the injector's operation.
- **O-Rings:** O-rings are used to seal the injector within the intake manifold or combustion chamber to prevent fuel leaks.
- **Flow Rate:** Fuel injectors are available in different flow rates, which determine the amount of fuel they can deliver per unit of time.
- **Fuel Pressure Regulator:** In some systems, a fuel pressure regulator is used to maintain consistent fuel pressure in the fuel rail, ensuring that the injector receives a constant supply of fuel.
- **Mounting:** Fuel injectors are mounted at specific locations in the intake manifold, either close to the intake valve or directly into the combustion chamber (in the case of direct fuel injection).

(or)

- (b) Explain the concepts of exhaust gas recirculation actuator with a neat configuration.



- An Exhaust Gas Recirculation (EGR) actuator is a critical component within the EGR system of an internal combustion engine. The EGR system is designed to reduce nitrogen oxide (NOx) emissions by recirculating a portion of exhaust gases back into the engine's intake manifold.
- The EGR actuator plays a vital role in controlling the flow of these recirculated exhaust gases. Here's an explanation of the EGR actuator with a simplified configuration:

Concepts of an EGR Actuator:

1. **EGR System Purpose:** The EGR system is intended to lower NOx emissions by reintroducing inert exhaust gases into the combustion chamber. This dilutes the air-fuel mixture and reduces the combustion temperature, resulting in less NOx formation.
2. **Actuator Control:** The EGR actuator, sometimes called an EGR valve actuator, is responsible for regulating the EGR valve's position. It adjusts the flow of exhaust gases into the intake manifold based on input from the engine control unit (ECU).
3. **Position Control:** The EGR actuator can precisely modulate the EGR valve's position, enabling fine-tuned control over the rate of EGR flow. This control is crucial for balancing emissions reduction with engine performance.
4. **Feedback Sensors:** EGR systems often include feedback sensors, like EGR position sensors, to provide information to the ECU about the actual position of the EGR valve. This feedback enables the ECU to make precise adjustments to meet emissions and performance requirements.
5. **EGR Valve Types:** EGR valves can be either mechanical (pneumatic) or electronic (electric). The type of EGR actuator used depends on the EGR valve's design.
6. **Regulation:** The EGR actuator regulates the amount of recirculated exhaust gases by controlling the EGR valve's opening and closing. It must respond quickly to the ECU's commands to maintain the desired EGR rate.