Reg.No:

Time: 1¹ᐟ² Hours   Maximum Marks: 50

Answer All Questions

PART - A (5 x 2 = 10 Marks)

1. State "Doppler" effect

The Doppler effect is a phenomenon where the perceived frequency or wavelength of waves changes due to the relative motion between the source of the waves and the observer. This effect has significant applications in various fields, including astronomy, meteorology, and automotive safety.

2. Write short notes on ABS

ABS is a safety system in vehicles that prevents wheel lockup during braking, improving steering control, reducing stopping distances, and reducing the risk of accidents. It is an integral part of modern vehicle safety technology and has become a standard feature in many automobiles.

3. List any four autonomous vehicles launched globally after 2019

   a. Waymo One - Alphabet Inc. (Google's parent company)
   b. Cruise Origin
   c. Aptiv and Hyundai's Autonomous Vehicles
   d. Zoox (Amazon)

4. What are the major components for "Air Induction System"?

   • Air Filter
   • Mass Airflow Sensor (MAF)
   • Throttle Body
   • Intake Manifold
   • Intake Air Temperature (IAT) Sensor
   • Vacuum Lines and Hoses
   • Resonators and Silencers
   • PCV (Positive Crankcase Ventilation) System
   • Air Intake Ducts and Tubes
   • Air Cleaner Housing or Airbox
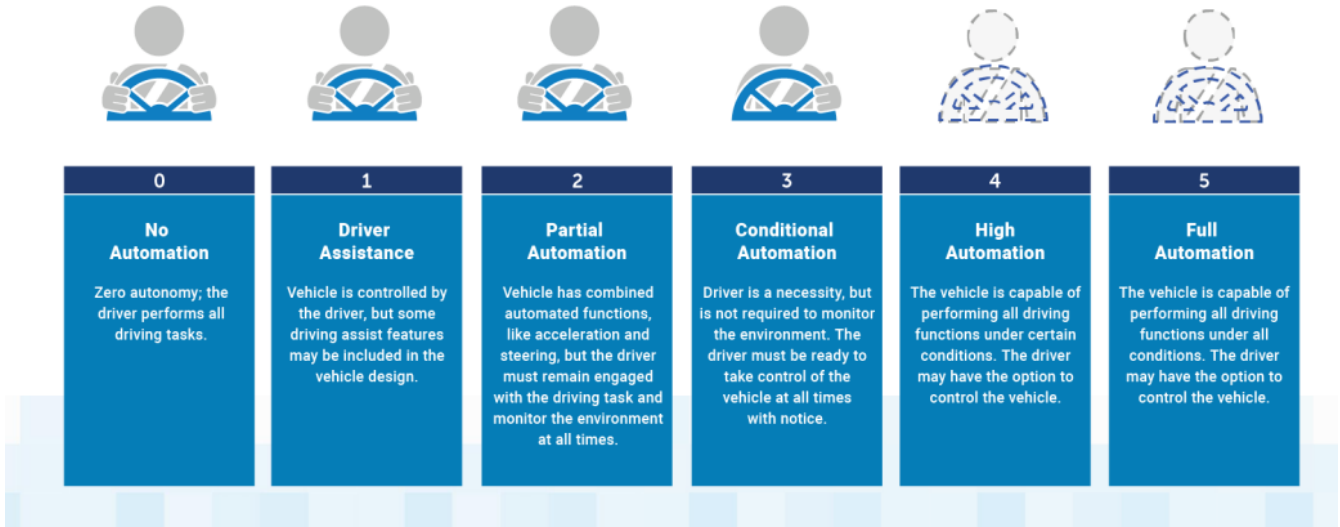   • Turbochargers and Superchargers

5. Mention the role of Oxygen sensor in "Lambda Control"?

The oxygen sensor, specifically the lambda sensor or air-fuel ratio sensor, plays a crucial role in Lambda control. In general, the oxygen sensor in Lambda control acts as a feedback device that helps the engine control unit maintain the optimal air-fuel mixture for efficient and clean combustion. It plays

a crucial role in modern vehicle emissions control systems and is essential for achieving better fuel economy and reduced environmental impact

PART – B (40 Marks)

6. (a) Explain the levels of autonomy with real time examples

0	1	2	3	4	5
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**High Automation**	**Full Automation**
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Autonomy can be understood as the capacity of an entity to make its own decisions and take actions independently. In the context of technology and artificial intelligence, autonomy refers to the level of independence and decision-making capabilities possessed by machines or systems. There are generally five levels of autonomy, as defined by the Society of Automotive Engineers (SAE), that are commonly used in the context of autonomous vehicles.

Level 0 - No Automation:
At this level, the human driver is in complete control of the vehicle, and there is no automation involved. All functions of the vehicle, such as steering, acceleration, and braking, are controlled entirely by the driver. An example of level 0 autonomy is a traditional car without any driver assistance features.

Level 1 - Driver Assistance:
Level 1 autonomy involves basic driver assistance features, such as cruise control or lane-keeping assistance, that can assist the driver with specific tasks. These systems may control either the steering or acceleration/deceleration, but not both simultaneously. An example of level 1 autonomy is adaptive cruise control, which automatically adjusts the vehicle's speed to maintain a safe distance from the vehicle ahead.

Level 2 - Partial Automation:
At this level, the vehicle can simultaneously control both steering and acceleration/deceleration under certain conditions, but the driver must remain engaged and ready to take control at any moment. An example of level 2 autonomy is Tesla's Autopilot, which can steer the car, maintain a set speed, and change lanes with minimal input from the driver, but still requires driver supervision.

Level 3 - Conditional Automation:
Level 3 autonomy enables the vehicle to manage most aspects of the driving task under certain conditions, but it still requires the driver to be ready to intervene when prompted by the system. The driver can hand over control to the vehicle in specific situations, such as highway driving, but must be

prepared to take over when necessary. An example of level 3 autonomy is Audi's Traffic Jam Pilot, which can take full control of the vehicle in slow-moving traffic on highways.

Level 4 - High Automation:
At this level, the vehicle can perform all driving tasks and monitor the driving environment without any human intervention in specific driving scenarios or environments. However, the driver may still have the option to take control if needed. An example of level 4 autonomy is Waymo's fully autonomous vehicles, which can operate without human input under specific conditions or within a defined geographic area.

Level 5 - Full Automation:
Level 5 autonomy represents full autonomy, where the vehicle is capable of performing all driving tasks under all conditions without any human intervention. This level of autonomy allows for driverless operation, meaning there is no need for a human driver to be present. While there are ongoing research and development efforts, there are no widely available level 5 autonomous vehicles as of my knowledge cutoff in 2022.

6. (b) Review the role of sensors and actuators used in vehicles

Sensors and actuators play a crucial role in modern vehicles, enabling various functions that contribute to safety, efficiency, and overall performance. These components work together to collect data, monitor the vehicle's surroundings, and facilitate the execution of actions.

Sensors:
Sensors are devices that detect and respond to changes in the vehicle's internal and external environment. They gather information and send signals to the vehicle's control systems, allowing for real-time monitoring and adjustments. Some common sensors used in vehicles include:

Proximity Sensors: Used for parking assistance and collision avoidance systems, these sensors detect objects in close proximity to the vehicle.
Speed Sensors: Measure the speed of the vehicle and provide data for various control systems, including the anti-lock braking system (ABS) and traction control system (TCS).
Temperature Sensors: Monitor engine temperature, coolant temperature, and ambient temperature, helping to prevent overheating and optimize engine performance.
Oxygen Sensors: Monitor the oxygen levels in the exhaust gases, ensuring optimal fuel efficiency and reducing harmful emissions.
Camera Sensors: Provide visual information for driver assistance systems, such as lane departure warning and forward collision warning systems.
Lidar and Radar Sensors: Used in advanced driver-assistance systems (ADAS) and autonomous vehicles to detect and measure the distance to objects, enabling adaptive cruise control and automated emergency braking.
Actuators:
Actuators are components responsible for converting signals from the vehicle's control systems into physical actions. They enable the vehicle to make adjustments and carry out various functions based on the input received from the sensors.

Engine Actuators: Control the fuel injection, ignition timing, and air intake, ensuring optimal engine

performance and fuel efficiency.

Brake Actuators: Control the application of brakes, enabling features such as ABS and electronic stability control (ESC) to improve braking performance and vehicle stability.

Steering Actuators: Facilitate power steering, enabling easier and more precise control of the vehicle's direction.

Transmission Actuators: Control the shifting of gears in automatic transmissions, ensuring smooth gear changes and efficient power delivery.

Suspension Actuators: Adjust the vehicle's suspension system, providing a comfortable ride and improved handling under different driving conditions.

By working in tandem, sensors and actuators contribute to the overall safety, performance, and efficiency of modern vehicles. They form the backbone of various advanced technologies, including advanced driver-assistance systems (ADAS) and autonomous driving systems, making driving safer and more convenient for users.

7. (a) Explain the construction and working of Lamda control with a neat sketch
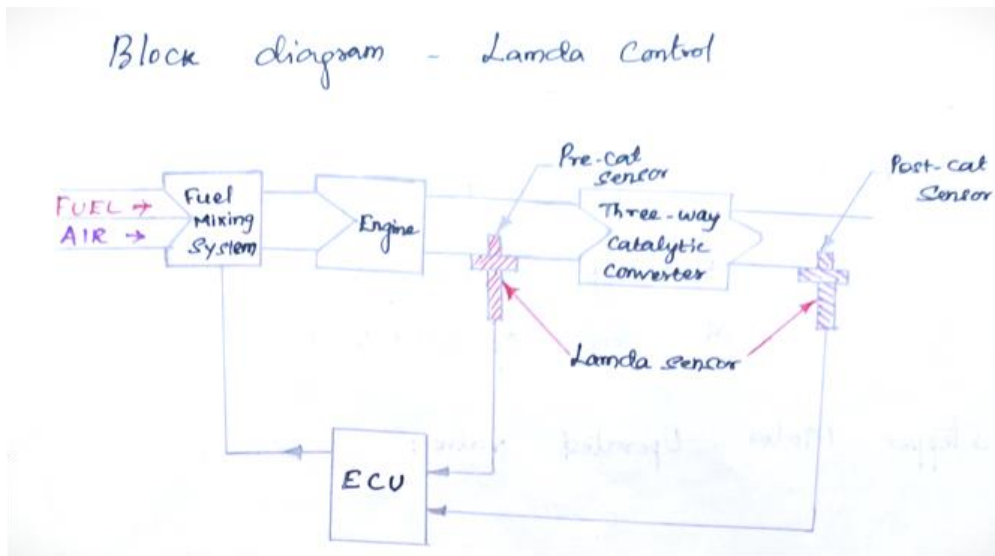
Lambda control, also known as oxygen sensor feedback control or oxygen feedback control, is an essential component of the modern automotive engine management system. It helps regulate the air-fuel ratio in the engine's combustion process, ensuring efficient fuel consumption and reducing harmful emissions.

Construction:
The lambda control system consists of the following main components:

Oxygen Sensor: The oxygen sensor, often referred to as the lambda sensor, is located in the exhaust manifold. It measures the oxygen content in the exhaust gases and generates an electrical signal based on the oxygen concentration.

Electronic Control Unit (ECU): The ECU processes the signals received from the oxygen sensor and adjusts the air-fuel mixture accordingly. It uses this information to determine whether the engine is running rich (too much fuel) or lean (too little fuel).

Fuel Injection System: The fuel injection system is responsible for delivering the right amount of fuel into the engine cylinders based on the feedback received from the ECU.

4

Working:

Monitoring Oxygen Content: The oxygen sensor continuously monitors the oxygen content in the exhaust gases. It generates a voltage signal based on the amount of oxygen present. When the air-fuel mixture is rich (excess fuel), the oxygen concentration in the exhaust decreases, resulting in a low voltage signal from the sensor. Conversely, when the mixture is lean (insufficient fuel), the oxygen concentration in the exhaust increases, leading to a high voltage signal.

Adjusting Air-Fuel Ratio: The ECU receives the voltage signal from the oxygen sensor and uses this information to adjust the air-fuel ratio. If the sensor detects a rich mixture, the ECU reduces the fuel flow to achieve a leaner mixture. Conversely, if the mixture is lean, the ECU increases the fuel flow to achieve a richer mixture.

Optimizing Combustion: By continuously adjusting the air-fuel ratio based on the feedback from the oxygen sensor, the lambda control system ensures that the engine operates at an optimal air-fuel ratio for efficient combustion and reduced emissions.

7. (b) Discuss on Ignition control with appropriate illustrations

Ignition control is a critical aspect of the engine management system in vehicles. It is responsible for precisely timing the ignition spark to ignite the air-fuel mixture in the combustion chamber. This process ensures optimal engine performance, fuel efficiency, and reduced emissions.

Construction:
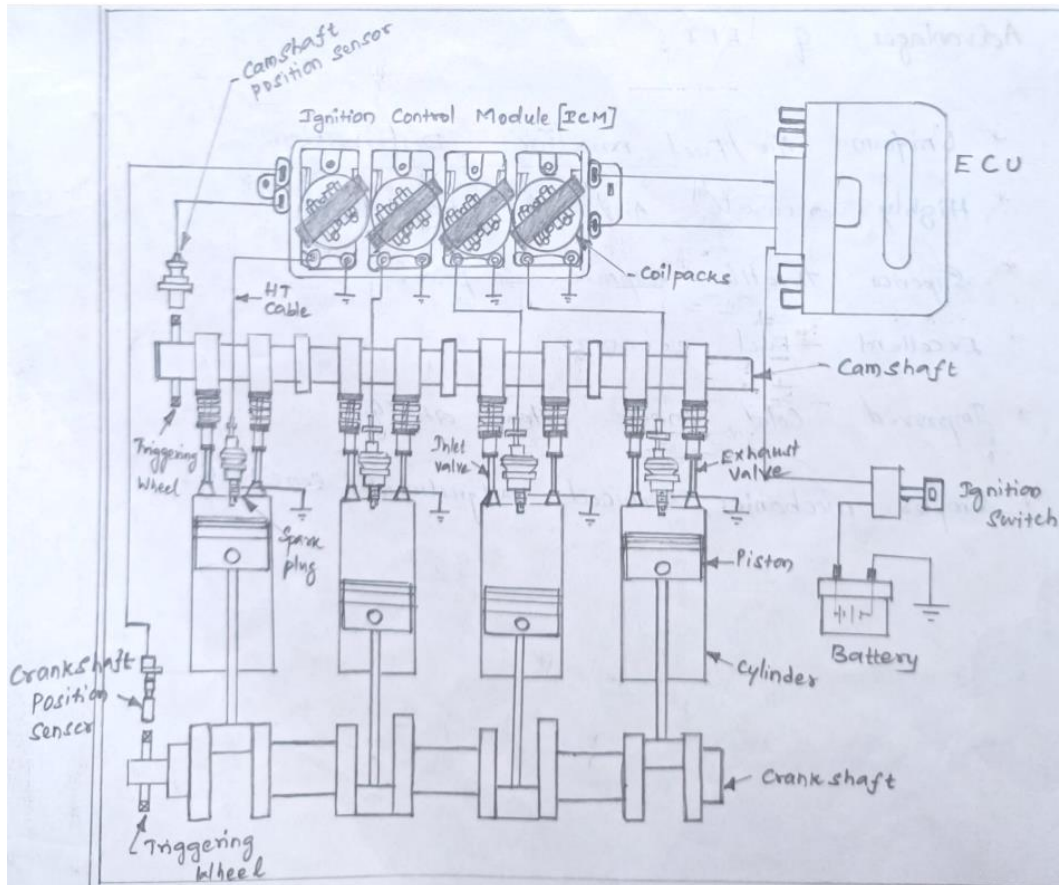
The ignition control system comprises the following key components:

Battery: Provides electrical power to the ignition system.
Ignition Switch: Enables the driver to start and stop the engine.
Ignition Coil: Converts the low-voltage current from the battery into a high-voltage current required for ignition.
Distributor (or Ignition Module): Distributes the high-voltage current to each spark plug at the right time.
Spark Plugs: Produce the spark that ignites the air-fuel mixture in the combustion chamber.
Working:

Ignition Switch Activation: When the ignition switch is turned on, it activates the ignition system, allowing current to flow from the battery to the ignition coil.

Ignition Coil Function: The ignition coil transforms the low-voltage current from the battery into a high-voltage current. This high-voltage current is necessary to create a spark at the spark plugs.

Distributor Timing: In older ignition systems, the distributor rotates and determines the timing for each spark plug. In modern systems, an ignition module or engine control unit (ECU) precisely controls the timing of the spark.

Spark Plug Ignition: The high-voltage current generated by the ignition coil is sent to the spark plugs. The spark plugs then create an electrical spark across the spark plug gap, igniting the air-fuel mixture in the combustion chamber.

Combustion Cycle: The ignited air-fuel mixture combusts, generating the power necessary to drive the engine's pistons, which in turn powers the vehicle.

The ignition control system ensures that the spark plugs ignite the air-fuel mixture precisely at the right time, maximizing engine efficiency and performance. Modern vehicles often employ more advanced electronic ignition systems with precise timing control, contributing to improved fuel economy and reduced emissions.

8. (a) Discuss about autonomous vehicles with suitable case study.

Autonomous vehicles, also known as self-driving cars, are vehicles capable of navigating and operating without human intervention. They utilize a combination of advanced sensors, machine learning algorithms, and real-time data processing to perceive their environment and make decisions similar to those made by human drivers. Autonomous vehicles have the potential to revolutionize transportation by improving road safety, reducing traffic congestion, and providing more accessible mobility options for individuals.

One notable case study in the field of autonomous vehicles is Waymo, a subsidiary of Alphabet Inc. (Google's parent company), which has been at the forefront of developing and testing self-driving technology.

Case Study: Waymo

Waymo has been conducting extensive research and development to create a fully autonomous driving system that can operate without human intervention under various real-world conditions. They have amassed a large amount of data through their testing programs, allowing them to refine their technology and improve its capabilities over time. Waymo's autonomous vehicles utilize a combination of sensors, including radar, lidar, and cameras, to perceive the surrounding environment and make informed decisions while navigating roads.

Key features and advancements of Waymo's autonomous vehicles include:

Advanced Sensor Technology: Waymo's vehicles are equipped with a sophisticated array of sensors, including lidar (light detection and ranging), radar, and cameras, which work together to provide a comprehensive view of the vehicle's surroundings. These sensors enable the vehicle to detect and identify objects such as pedestrians, cyclists, vehicles, and road infrastructure.

Machine Learning and AI Algorithms: Waymo's autonomous driving technology relies on powerful machine learning algorithms and artificial intelligence to interpret sensor data, predict the behavior of other road users, and make complex decisions in real time. Through continuous learning and data analysis, the system improves its capabilities and adaptability to various driving scenarios.

Extensive Testing and Deployment: Waymo has conducted extensive testing of its autonomous vehicles, including real-world driving scenarios, simulation-based testing, and controlled environments. They have also launched commercial autonomous ride-hailing services in select locations, allowing users to experience the benefits of autonomous transportation firsthand.

Safety and Regulation Compliance: Waymo places a strong emphasis on safety, ensuring that its autonomous driving technology meets stringent safety standards and regulations. The company has implemented various safety protocols, redundant systems, and fail-safe mechanisms to minimize the risk of accidents and ensure passenger safety.

Waymo's advancements in autonomous driving technology demonstrate the potential of self-driving cars to transform the future of transportation, making it safer, more efficient, and more accessible for individuals worldwide. Through continued research, development, and collaboration with various stakeholders, Waymo is contributing to the advancement and acceptance of autonomous vehicles on a global scale.

8. (b) Elaborate on the working of Fuel control with relevant sketch

Fuel control in vehicles is a critical aspect of the engine management system, responsible for regulating the amount of fuel delivered to the engine cylinders. The precise control of fuel delivery is crucial for optimizing engine performance, ensuring efficient combustion, and minimizing harmful emissions.

Construction:

The fuel control system typically consists of the following key components:

Fuel Tank: Stores the fuel that is used by the engine.

Fuel Pump: Draws fuel from the tank and delivers it to the engine.

Fuel Injectors: Dispense the fuel into the engine cylinders in a controlled manner.

Engine Control Unit (ECU): Monitors various engine parameters and controls the fuel injection process.
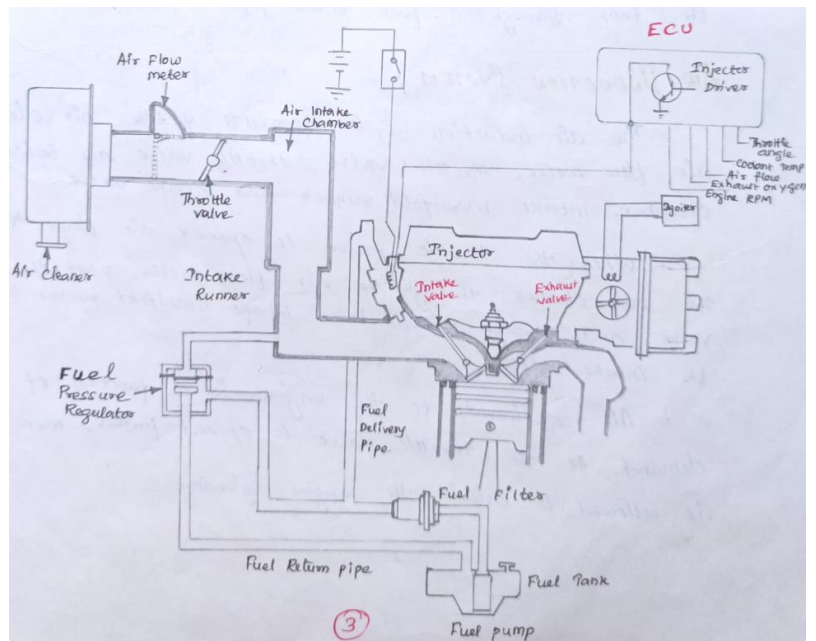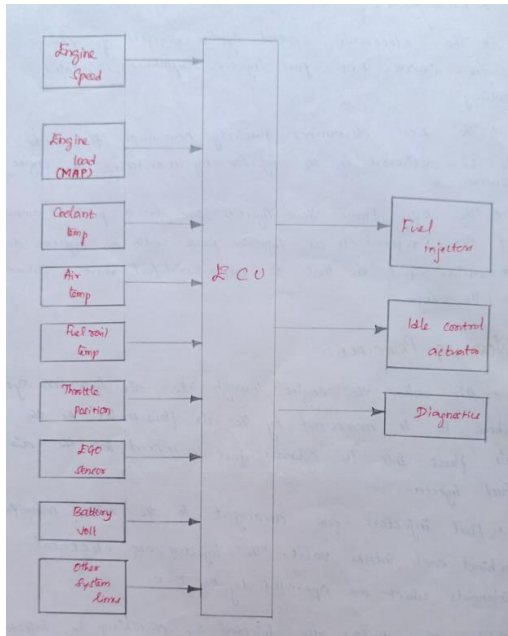
Sensors: Measure parameters such as engine speed, throttle position, air intake, and exhaust composition to provide input to the ECU.

Working:

Fuel Delivery: The fuel pump draws fuel from the tank and delivers it to the engine under pressure, ensuring a steady supply of fuel to meet the engine's demands.

Sensor Inputs: Various sensors, such as the throttle position sensor, air flow sensor, and oxygen sensor, provide real-time data to the ECU about the engine's operating conditions.

Engine Control Unit (ECU) Analysis: The ECU processes the sensor data to determine the optimal fuel quantity required for efficient combustion based on factors such as engine load, temperature, and speed.

Fuel Injection Control: The ECU controls the opening and closing of the fuel injectors based on the calculated fuel requirements. It precisely times the injection of fuel into the engine cylinders, ensuring an accurate air-fuel mixture for efficient combustion.

Optimized Combustion: The fuel is injected into the engine cylinders in a controlled manner, where it mixes with the incoming air. This mixture is ignited by the spark plugs, leading to controlled combustion and the generation of power to drive the vehicle.