SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

AN AUTONOMOUS INSTITUTION

Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

INTERNAL ASSESSMENT EXAMINATION – I

VI Semester

B.E- Mechanical & Mechatronics Engineering (Additive Manufacturing)

19OE120 – Automotive Electronics

Regulations 2019

Part-A

1) List the emission content in exhaust.

- Carbon dioxide (CO2)
- Carbon monoxide (CO)
- Nitrogen oxides (NOx)

2) Write the function of catalytic converter?

Catalytic convertors are used in automobiles to reduce emissions of harmful compounds.

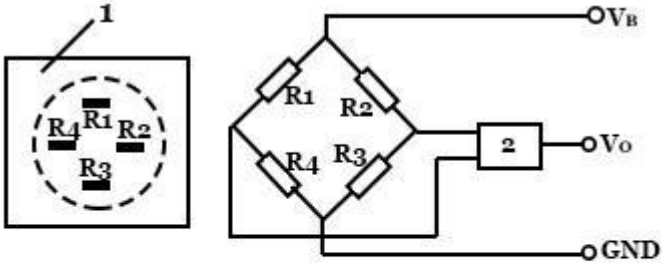
3) **Name the engine performance terms**.

- Compression
- Fuel efficiency
- power

4) Name any two types of speed sensors

- Inductive sensors
- Variable reluctance magnetic speed sensors

5) Draw the circuit diagram of manifold pressure sensor



a) Semiconductor strain gauge position b) Sensor measurement circuit

1-Silicon diaphragm 2-Integrated amplifier circuit

R1 R2 R3 R4-Semiconductor strain gauge

PART - B

6) a) **Analyse the characteristics of an engine which has compression ratio in the range 10:1**

An engine with a compression ratio of 10:1 refers to the ratio of **the maximum volume of the combustion chamber** (when the piston is at the bottom dead center) to the **minimum volume of the combustion chamber** (when the piston is at the top dead center). A **higher compression ratio** generally indicates a more **efficient engine** with **improved power and fuel efficiency**. Let's analyze the characteristics of an engine with a compression ratio in the range of 10:1:

1**. Efficiency**: Higher compression ratios result in **improved thermal efficiency**. When the air-fuel mixture is compressed to a smaller volume, the combustion process becomes more efficient, leading to better fuel economy. This means the engine can extract more energy from the same amount of fuel, resulting in improved mileage.

2. **Power output**: An engine with a higher compression ratio tends to produce more power. The increased compression ratio allows for a more efficient combustion process, generating higher pressure within the combustion chamber. This higher pressure translates into greater force applied to the piston, resulting in increased torque and power output.

3. **Combustion characteristics**: With a compression ratio of 10:1, the engine would likely operate in the range of a conventional gasoline engine. The combustion process would be a combination of spark ignition and the flame front propagating from the spark plug. This type of combustion is commonly found in gasoline-powered internal combustion engines.

4. **Knock resistance**: Knock refers to the undesirable phenomenon where the air-fuel mixture ignites prematurely and causes uncontrolled combustion, leading to knocking sounds. Higher compression ratios increase the likelihood of knock because the mixture is under greater pressure and temperature. Therefore, engines with a compression ratio of 10:1 might require careful tuning and appropriate fuel selection to prevent knock. Using higher octane fuel with better knock resistance can mitigate this issue.

5. **Heat management**: Higher compression ratios generate more heat during the combustion process. The engine design should consider effective heat dissipation through cooling systems, lubrication, and materials that can withstand the increased thermal stress.

6. **Design considerations**: Achieving a compression ratio of 10:1 requires careful design and engineering of the engine components. The cylinder head, piston, valves, and fuel injection systems need to be designed to handle the increased pressure and thermal loads associated with the higher compression ratio.

It's worth noting that while a compression ratio of 10:1 offers improved efficiency and power, it is not the highest compression ratio possible. Some modern engines, especially diesel engines, can have significantly higher compression ratios, ranging from 15:1 to 20:1 or even higher, depending on the specific application.

6) b) **One of the four wheeler manufacturer panned to develop 85 bhp engine for bs6 standards, highlight the keys performance factor to be considered during engine development**.

When developing an 85 bhp engine for BS6 standards, several key performance factors need to be considered. Here are some of the important factors:

1. **Power Output**: The power output of the engine is crucial, as it determines the overall performance of the vehicle. Achieving 85 bhp requires optimizing various aspects such as combustion efficiency, intake/exhaust systems, and tuning of engine components.

2. Emissions Compliance: BS6 standards are designed to reduce harmful emissions from vehicles. The engine needs to meet stringent emission norms for pollutants such as nitrogen oxides (NOx), carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM). Incorporating technologies like selective catalytic reduction (SCR), exhaust gas recirculation (EGR), and advanced after-treatment systems may be necessary.

3. **Fuel Efficiency**: Developing an engine with good fuel efficiency is vital for reducing running costs and minimizing environmental impact. Improvements can be made through optimizing the combustion process, reducing friction losses, and incorporating technologies like direct injection and variable valve timing.

4. **Durability and Reliability**: The engine should be designed to withstand the demands of daily usage and provide reliable performance. Considerations such as material selection, cooling systems, lubrication, and robust engineering practices are essential to ensure longevity and trouble-free operation.

5**. NVH (Noise, Vibration, and Harshness):** Reducing noise and vibrations is important for enhancing the overall driving experience and comfort. Implementing measures such as improved engine mounts, acoustic insulation, and balancing techniques can help achieve desired NVH levels.

6**. Performance Consistency**: Ensuring consistent performance across different driving conditions is crucial. The engine should deliver adequate power and torque throughout the operating range, allowing for smooth acceleration, overtaking, and climbing gradients.

7. **Throttle Response**: The engine's responsiveness to driver inputs is a key aspect of performance. Quick and linear throttle response contributes to a more engaging and satisfying driving experience.

8. **Heat Management**: Efficient cooling and heat dissipation are vital for engine longevity and optimal performance. Designing an effective cooling system and ensuring proper heat transfer within the engine are important considerations.

9. **Weight and Packaging**: Minimizing the weight and optimizing the packaging of the engine contribute to overall vehicle performance. Lightweight materials, compact design, and efficient layout help improve handling, agility, and fuel efficiency.

10. **Cost-effectiveness**: Developing an engine that meets performance requirements while considering production costs is important for commercial viability. Balancing performance with affordability is crucial for market competitiveness.

These are some of the key performance factors that need to be considered when developing an 85 bhp engine for BS6 standards. Each factor requires careful engineering and integration to achieve the desired performance goals while complying with emission regulations and customer expectations.

7) a**) How exhaust emission can be controlled in SI engine in order to meet stringent emission norms by catalytic reaction. Describe its function and chemical reaction in details**.

Exhaust emissions from SI (spark-ignition) engines include harmful pollutants such as carbon monoxide (CO), nitrogen oxides (NOx), and unburned hydrocarbons (HC). To meet stringent emission norms, catalytic converters are used to reduce the amount of these pollutants in the exhaust gases.

A catalytic converter is a device that contains a catalyst which helps to convert harmful pollutants into less harmful compounds. The catalyst is usually made of precious metals such as platinum, palladium, and rhodium. When exhaust gases pass over the catalyst, a chemical reaction takes place which converts harmful pollutants into less harmful ones.

The function of the catalytic converter can be described in three main steps:

1. Oxidation of Carbon Monoxide (CO)
The first step involves the oxidation of carbon monoxide (CO) to carbon dioxide (CO2). This reaction is facilitated by the presence of a platinum and palladium catalyst:

$$\mathbf{2CO + O2 \rightarrow 2CO2}$$

2. Reduction of Nitrogen Oxides (NOx)
The second step involves the reduction of nitrogen oxides (NOx) to nitrogen (N2) and oxygen (O2). This reaction is facilitated by the presence of a rhodium catalyst:

$$\mathbf{2NOx \rightarrow xO2 + N2}$$

3. Oxidation of Unburned Hydrocarbons (HC)
The third step involves the oxidation of unburned hydrocarbons (HC) to carbon dioxide (CO2) and water (H2O). This reaction is facilitated by the presence of a platinum catalyst:

$$\mathbf{HC + O2 \rightarrow CO2 + H2O}$$

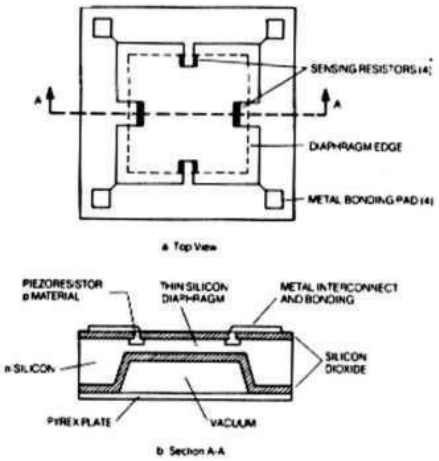
In addition to these main reactions, there are also secondary reactions that take place in the catalytic converter, which help to further reduce the amount of pollutants in the exhaust gases.

Overall, catalytic converters play a crucial role in reducing the amount of harmful pollutants emitted by SI engines. By facilitating these chemical reactions, they help to convert pollutants into less harmful compounds, thereby reducing the environmental impact of the engine.

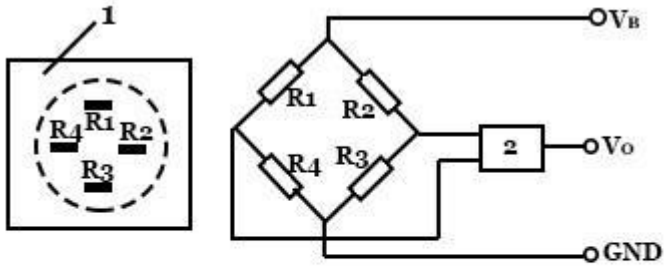
7) b) **Describe strain gauge MAP sensor with circuit diagram**.

Manifold Absolute Pressure (MAP) Sensor:

- Several MAP sensor configurations have been automotive applications.
- The earliest sensors were derived from aerospace instrumentation concepts, but these proved more expensive than desirable for automotive applications and have been replaced with more cost-effective designs.
- It is interesting to note that none of the MAP sensors in use measure manifold pressure directly, but instead measure the displacement of a diaphragm that is deflected by manifold pressure.
- **Strain Gauge MAP Sensor**



- One relatively inexpensive MAP sensor configuration is the silicon diaphragm diffused strain gauge sensor
- This sensor uses a silicon chip that is approx millimeters square outer edges, approximately 250 micrometers(1micro million meter) thick, but the center are 25 micrometers thick and forms a diaphragm.
- The edge of the chip is sealed to a pyrexp thereby forming a vacuum chamber center area of the silicon chip.
- A set of sensing resistors is formed around the edge of this chamber, as indicated in Figure. The resistors are formed by diffusing a doping impurity into the silicon.
- External connections to these resistors are made through wires connected to the metal bonding pads. This entire assembly is placed in a sealed housing that is connected to the intake manifold by a small-diameter tube.
- Manifold pressure applied to the diaphragm causes it to deflect.
- The resistance of the sensing resistors changes in proportion to the applied manifold pressure by a phenomenon that is known as **piezoresistivity**.
- Piezoresistivity occurs in certain semiconductors so that the actual resistivity (a property of the material) changes in proportion to the strain (fractional change in length).



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1-Silicon diaphragm 2-Integrated amplifier circuit

R1 R2 R3 R4-Semiconductor strain gauge

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- Piezoresistivity occurs in certain semiconductors so that the actual resistivity (a property of the material) changes in proportion to the strain (fractional change in length).
- The resistors diffused into the diaphragm are denoted R_1, R_2, R_3, and R_4 in Figure a.
- When there is no strain on the diaphragm, all four resistances are equal, the bridge is balanced, and the voltage between points A and B is zero. When manifold pressure changes, it causes these resistances to change in such a way that **R_1 and R_3 increase by an amount that is proportional to pressure; at the same time, R_2 and R_4 decrease by an identical amount**.
- This unbalances the bridge and a net difference voltage is present between points A and B. The differential amplifier generates an output voltage proportional to the difference between the two input voltages (which is, in turn, proportional to the pressure), as shown in Figure.

PART-C

8) a) **In the modern scenario, emission control is one of the mandatory requirements in highly populated metro cities. What kind of engine suitable to meet the requirement of emission content less than 60mg/km of NO: (nitrogen oxide) and 4.5mg/km of articulate Matter (PM). Justify.**

To meet the emission requirements of less than 60mg/km of NOx (nitrogen oxide) and 4.5mg/km of particulate matter (PM), one suitable engine technology is the modern gasoline direct injection (GDI) engine with a particulate filter.

Gasoline direct injection engines have several advantages over traditional port fuel injection engines. They provide better fuel efficiency, improved power output, and reduced CO2 emissions. Additionally, when equipped with appropriate after-treatment systems, GDI engines can effectively reduce NOx and PM emissions.

Here's a justification for using a GDI engine with a particulate filter to meet the mentioned emission requirements:

1. NOx Reduction: GDI engines inherently have a leaner air-fuel mixture, which helps reduce NOx emissions. However, to further control NOx, advanced GDI engines employ various technologies such as cooled exhaust gas recirculation (EGR), lean NOx traps, and selective catalytic reduction (SCR) systems. These technologies significantly reduce NOx emissions, enabling the engine to meet the specified limit of less than 60mg/km of NOx.

2. Particulate Matter (PM) Reduction: GDI engines can produce higher levels of particulate matter compared to traditional port fuel injection engines. To address this concern, modern GDI engines can be equipped with a particulate filter, also known as a gasoline particulate filter (GPF). The GPF effectively captures and reduces PM emissions from the engine exhaust. It traps and oxidizes soot particles, ensuring compliance with the specified limit of 4.5mg/km of PM.

By combining a GDI engine with advanced NOx reduction technologies and a particulate filter, the emission requirements for both NOx and PM can be met. However, it's important to note that the actual performance and compliance depend on

various factors, including the design, calibration, and maintenance of the engine and its after-treatment systems.

It's worth mentioning that other engine technologies, such as diesel engines with advanced exhaust after-treatment systems (such as SCR and diesel particulate filters), can also achieve low NOx and PM emissions. However, considering the specified limits and the focus on metro cities, where gasoline-powered vehicles are more prevalent, a GDI engine with a particulate filter is a suitable choice due to its inherent advantages and ability to meet the mentioned emission requirements.

8) b**) One of the leading petrol engine manufacturers has received a complaint from his customer that during full load testing they observed abnormal sound in the engine block. What kind of corrective action engine manufacturer should bring in the engine.**

When a customer reports an abnormal sound in the engine block during full load testing, the engine manufacturer should take the following corrective actions:

1. **Investigate the Issue**: The manufacturer should thoroughly examine the engine to determine the source and nature of the abnormal sound. This may involve disassembling and inspecting various components, such as pistons, connecting rods, crankshaft, valves, and bearings.

2. **Identify the Root Cause**: Once the issue is identified, the manufacturer should determine the underlying cause of the abnormal sound. It could be due to a manufacturing defect, faulty component, improper assembly, or an operational issue.

3**. Rectify the Defect:** Based on the root cause analysis, the manufacturer should develop a plan to rectify the defect. This may involve repairing or replacing the faulty component, ensuring proper assembly, or making adjustments to the engine's operational parameters.

4. **Quality Control Measures**: The manufacturer should review their quality control processes to identify any gaps or potential areas for improvement. They should implement measures to prevent similar issues from occurring in future engine production.

5**. Customer Communication**: It is important for the engine manufacturer to maintain open communication with the customer throughout the process. They should inform the customer about the identified issue, the corrective actions being taken, and the expected resolution timeline.

6. **Testing and Validation**: After implementing the corrective actions, the manufacturer should conduct thorough testing and validation of the engine to ensure that the abnormal sound has been eliminated. This may involve further full load testing or other specialized tests to verify the engine's performance and reliability.

7. **Warranty Considerations**: If the engine is under warranty, the manufacturer should review the warranty terms and assess whether the reported issue is covered. They should coordinate with the customer to ensure that any warranty claims are processed appropriately.

8. **Continuous Improvement**: The engine manufacturer should use this incident as an opportunity for continuous improvement. They should evaluate their overall

manufacturing processes, quality control measures, and customer feedback mechanisms to enhance product quality and customer satisfaction.

By following these corrective actions, the engine manufacturer can address the abnormal sound issue and ensure that the engine meets the required performance and reliability standards.