

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering



0021

Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : DMX5208 Automobile Engineering
Academic Year : 2024/25
Date : 12th March 2026
Time : 1330-1630h
Duration : 3 hours

INDEX NO:

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General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of Five (5) questions in Seven (7) pages.
3. Answer all questions.
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).

Question 01

- I. A four-stroke 3.5-litre V6 petrol engine is tested on an engine dynamometer. The specifications of the test engine are as follows. Engine was tested at 3500 RPM.

Engine Specifications:

- Displacement volume = 3.5 liters, Number of cylinders = 6
- Compression ratio = 9.5:1, Ratio of specific heats (γ) = 1.4
- Mechanical efficiency = 88%

The test results of the engine are as follows.

Test Results:

- Torque developed = 350 Nm
- Fuel flow rate = 0.0095 kg/s
- Air flow rate = 0.09 m³/s
- Ambient temperature = 27°C
- Ambient pressure = 1.0 bar
- Calorific value of fuel = 44 MJ/kg

From the given data determine the,

- Power output at 3500 RPM 2 marks
- BMEP and IMEP at 3500 RPM 4 marks
- Calculate the thermal efficiency at 3500 RPM and the air standard Otto cycle efficiency. Hence calculating relative efficiency and commenting on the difference. 8 marks
- Calculate the volumetric efficiency at 3500 RPM 2 marks
- Calculate the air-fuel ratio at 3500 RPM and comment on whether the engine is operating at a rich or lean mixture. 4 marks

Question 2

- State four advantages of a Common Rail Diesel Fuel Injection system over a conventional distributor pump injection system 4 marks
- Figure Q2 below shows the Injection Quantity Calculation Method used by the ECU in a Common Rail Diesel Engine.

With reference to Figure Q2, answer the following:

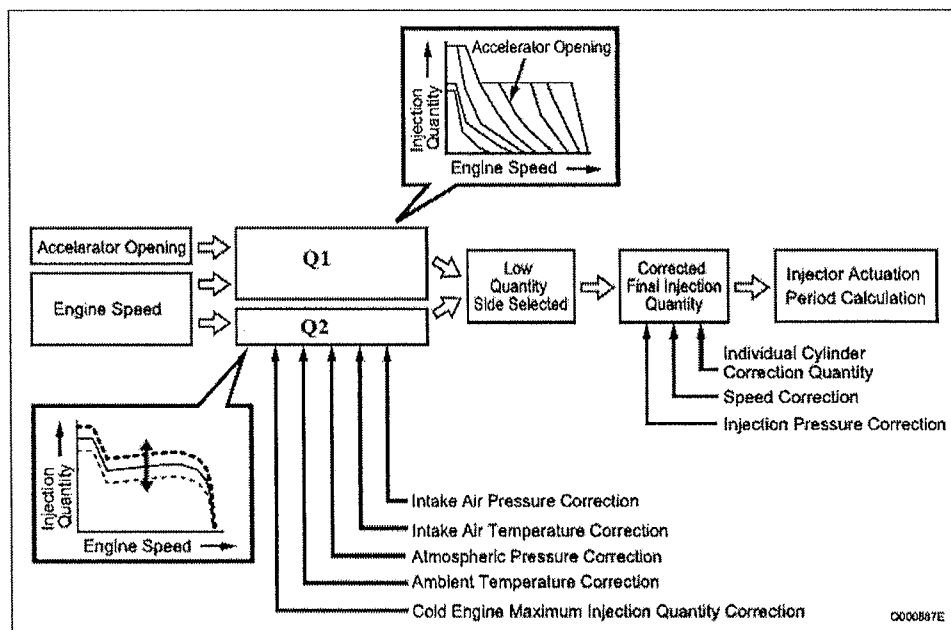


Figure Q2: Injection Quantity Calculation Diagram

- a) Name the two injection quantities (Q1 and Q2) 2 marks
- b) Explain the reason for selecting the lowest quantity (either Q1 or Q2) as the basis for the final injection quantity. 3 marks
- c) Briefly explain the "Injection Pressure Correction" affects the final Injector Actuation Period Calculation. 3 marks
- III. Name the five sensor inputs used to calculate the injection quantity (Q-2) 5 marks
- IV. Consider a situation where the intake air temperature sensor sends an erroneous data to the ECU indicating 80 °C (extremely hot air). Describe the result due to this on the vehicles "Corrected Final Injection Quantity" and driver-perceived power 3 marks

Question 03

- I. State main three primary pollutants emitted from a petrol engine exhaust and identify the source of each. 6 marks
- II. Figure Q3.1 below shows a cross-section of a combustion chamber indicating the quenching zones. 4 marks

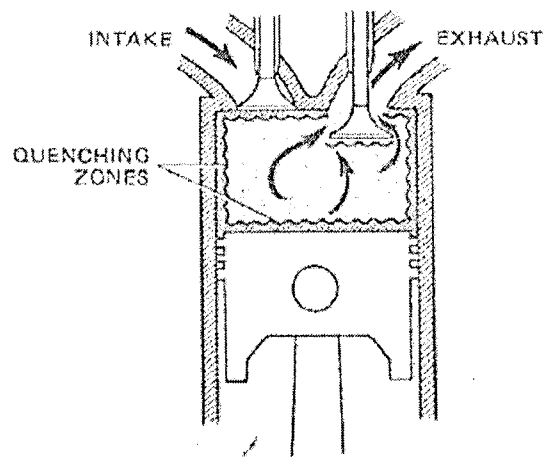


Figure Q3.1: Quenching Zones of a Cylinder

With reference to Figure Q3.1, explain the quenching phenomenon and describe how it contributes to the formation of carbon monoxide (CO) and unburnt hydrocarbons (HC) in the exhaust gas.

III. Figure Q3.2 represents the variation of petrol vehicle emission with speed.

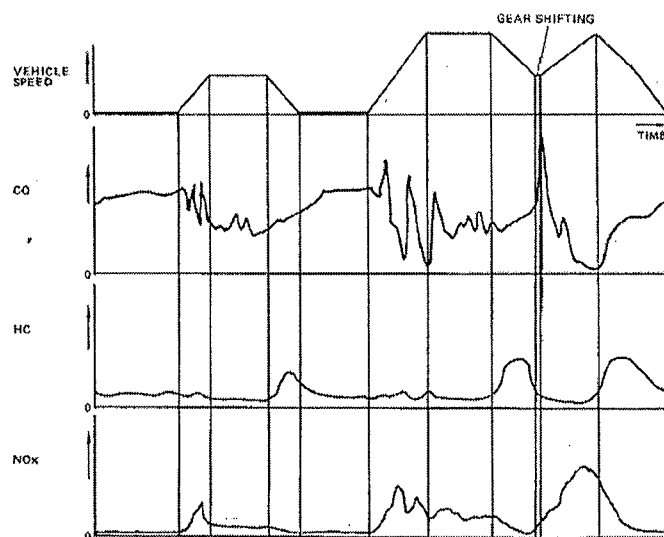


Figure Q3.2: Variation of Vehicle Emission with Speed

With reference to the above graph, explain the reasons for production of CO and HC gases for the following operating conditions.

- | | |
|-----------------|---------|
| a) Warmup | 2 marks |
| b) Idling | 2 marks |
| c) Acceleration | 2 marks |
- IV. Briefly describe the operating principle of Exhaust Gas Recirculation (EGR) system and state the main pollutant in this system is designed to reduce. 4 marks

Question 04

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|---|---------|
| I. State four alternative fuels that can be used in automobile engines. | 4 marks |
| II. Figure Q4 below shows the effect of biodiesel concentration on the emission characteristics of a CI engine. | |

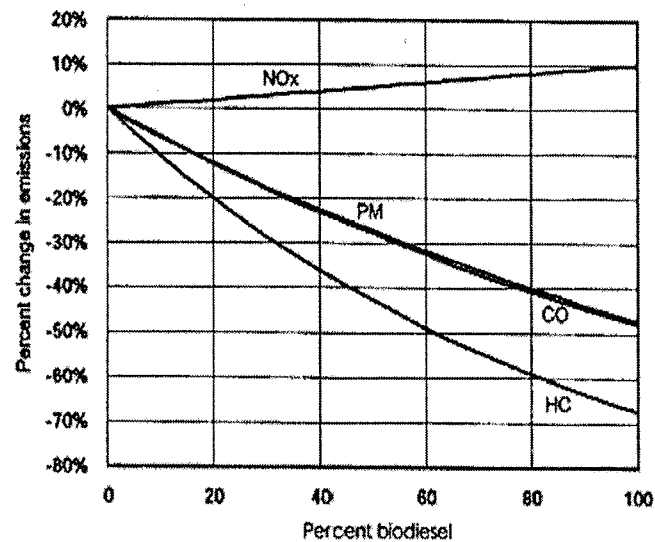


Figure Q4: Percentage in Change in Emission with the Percentage Biodiesel

- a) Describe how CO and HC emissions change as the biodiesel concentration increases from 0% to 100%. Give a reason for the trend observed 3 marks
- b) Describe how NOx emissions change as the biodiesel concentration increases and explain why this trend is opposite to that of CO and HC 3 marks
- III. Table 1 below shows the combustion characteristics of three fuel blends tested at low engine speed (1200 RPM), with the same start of injection at -17 Crank Angle (CA). All the crank angles in minus values are given before TDC.
- Note: The fuels in Table 1 are defined as follows:
- Diesel – Pure petroleum diesel
- B20 – 20% biodiesel blended with 80% diesel
- B40 – 40% biodiesel blended with 60% diesel

Table 1 – Combustion Characteristics of Fuel Blends at Low Load

Fuel	Cetane Number	Start of Injection (CA)	Start of Combustion (CA)
Diesel	50	-17	-0.22
B20	51.5	-17	-0.45
B40	53.0	-17	-0.65

- a) Define ignition delay and calculate the ignition delay for B20 using the data in Table 1 3 marks
- b) With reference to the cetane numbers in Table 1, explain why B20 has a shorter ignition delay than pure diesel 3 marks
- c) Explain how a shorter ignition delay affects the rate of pressure rise in the combustion chamber and discuss its implication on engine noise (diesel knock) at low load 4 marks

Question 05

- I. State four input sensors used in a modern Motronic gasoline engine management system. For each sensor, identify the parameter it measures and state how that parameter is used by the ECU 8 marks
- II. A motor vehicle equipped with modern Motronic fuel injection system is operating on a fully warmed up engine at steady cruise. The Lambda sensor is active, and the system is in closed-loop fuel control. The following conditions are recorded.
- $\text{Lambda } (\lambda) = 1.15$
 - Short Term Fuel Trim (STFT) = +18%
 - Long Term Fuel Trim (LTFT) = +16%
 - Coolant temperature = 85°C
 - Theoretical AFR = 14.7:1
- a) Based on the Lambda value (1.15) state whether the engine is running Rich or Lean. 1 mark
- b) Define the purpose of Short-Term Fuel Trim (STFT) and Long-Term Fuel Trim (LTFT). 3 marks
- c) The vehicle has a total fuel trim of +34% (STFT +18% and LTFT +16%). State three common reasons why an engine would have such high positive fuel trim values. 3 marks
- III. Modern Motronic gasoline engine management system operates in either closed-loop or open-loop fuel control depending on **some engine conditions**.

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- a) State two operating conditions under which it switches from closed-loop to open-loop fuel control. 2 marks
- b) For each condition stated in part (a), explain why the ECU must switch to open-loop fuel control. 3 marks
- State one consequence of open-loop fuel control operation on exhaust emissions.

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