



UNIVERSITI KUALA LUMPUR  
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

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FINAL EXAMINATION  
OCTOBER 2025 SEMESTER

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COURSE CODE : SCB35503 (V2)  
COURSE TITLE : INTERNAL COMBUSTION ENGINE  
PROGRAMME NAME : BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN  
MECHANICAL (AUTOMOTIVE)  
DATE : 29 JANUARY 2026  
TIME : 2:00PM - 4:30PM  
DURATION : 2 HOURS 30 MINUTES

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INSTRUCTIONS TO CANDIDATES

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1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet.  *Tick if applicable*
9. Refer to the attached Formula/ Appendies.  *Tick if applicable*

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THERE ARE 7 PAGES OF QUESTIONS INCLUDING THIS PAGE

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## SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

## Question 1

An internal combustion engine is a machine where fuel burns inside a cylinder to make power. It works by mixing air and fuel, compressing it, then burning it to push a piston. This movement turns parts of the engine and makes cars, bikes and machines work. There are two main types: spark ignition engines (use a spark plug) and compression ignition engines (like diesel engines, where fuel ignites from heat).

- (a) Sketch and describe the engine working operation for two stroke spark ignitions (SI) engine

(8 marks)

- (b) Discuss the function and requirements of a fuel injection system of a diesel engine.

(6 marks)

- (c) Compression Ignition (CI) engines generally operate under globally fuel-lean conditions leading to hydrocarbon (HC) emissions that are roughly one-fifth of those generated by Spark Ignition (SI) engines. Discuss the environmental and health impacts associated with hydrocarbon emissions.

(6 marks)

**Question 2**

An internal combustion engine is a mechanical device that converts the chemical energy of fuel into mechanical energy by burning the fuel inside the engine itself. The energy released during combustion moves parts inside the engine, which then powers vehicles or machinery.

- (a) Compare and contrast Spark Ignition (SI) engines and Compression Ignition (CI) engines in terms of their operating principles and key characteristics. (8 marks)
- (b) Provide a concise explanation of how knocking impacts the performance and operation of an internal combustion engine (ICE). (6 marks)
- (c) Explain three primary factors that contribute to the formation of hydrocarbon (HC) emissions in the exhaust gases of a Spark Ignition (SI) engine. (6 marks)

## SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

## Question 1

The efficiency of an engine is a measure of how effectively it converts the chemical energy in the fuel into useful mechanical energy to drive a vehicle or power machinery.

- (a) Explain the mechanical fuel injection system, highlighting its role in controlling fuel delivery and combustion efficiency in diesel engines.

(4 marks)

- (b) A 4-cylinder petrol engine has a bore of 56mm and a stroke of 90mm. Its rated speed is 2700 rev/min and it is tested at this speed against a brake which has a torque arm of 0.356m. The net brake load is 155N and the fuel consumption is  $1.376 \times 10^{-3}$  kg/s and it has a lower calorific value,  $Q_{\text{net,v}}$  of 44200kJ/kg. A Morse test is carried out and the cylinders are cut in the order 1,2,3,4 with corresponding brake loads of 111, 106.5, 104.2 and 111 N respectively. Calculate for this speed; the engine torque, brake mean effective pressure, brake thermal efficiency, specific fuel consumption, mechanical efficiency and indicated mean effective pressure.

(16 marks)

## Question 2

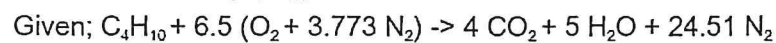
Motor fuel is a fuel that is used to provide power to the motor in motor vehicles. Currently, most motor vehicles worldwide are powered by gasoline or diesel. Other energy sources include ethanol, biodiesel, propane, compressed natural gas (CNG), electric batteries, and hydrogen (either using fuel cells or combustion).

- (a) Internal combustion engines do not operate based on a closed thermodynamic cycle; instead they follow a mechanical cycle. Explain the concept of an adiabatic process.

(4 marks)

- (b) Calculate the stoichiometric air fuel ratio  $(A/F)_s$  (mass basis and mole basis) for;

- i. 1 mole of butane ( $C_4H_{10}$ )



(4 marks)

- ii. 1 mole of ethane ( $C_2H_6$ )

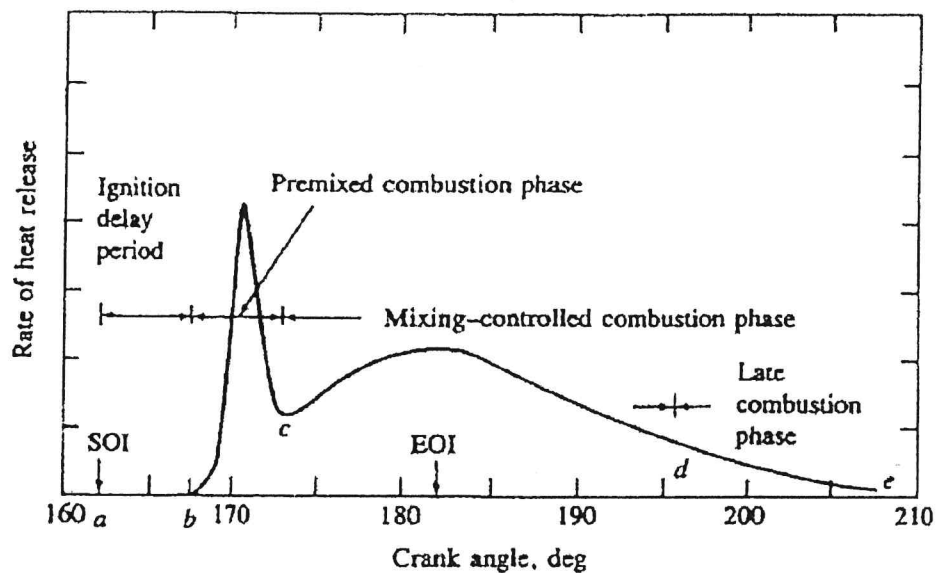
(The molecular weights of oxygen, nitrogen, carbon and hydrogen are 16, 14, 12 and 1 respectively)

(12 marks)

## Question 3

A diesel engine is a type of engine that runs by compressing air to make it very hot then spraying in diesel fuel. The fuel burns on its own because of the high temperature, creating power. Diesel engines are strong, last a long time and use fuel efficiently.

- (a) Diesel combustion refers to the process by which fuel burns within a diesel engine to generate power. This process occurs in four main stages as illustrated in the figure below. Explain the phase of diesel combustion.



(8 marks)

- (b) A diesel engine has an inlet temperature and pressure of  $25^{\circ}\text{C}$  and  $1\text{atm}$  respectively. The compression ratio is  $10:1$  and the maximum cycle temperature is  $1100^{\circ}\text{C}$ . Calculate the air standard thermal efficiency based on the diesel cycle. (Assume  $\gamma = 1.4$ ,  $C_p = 1.005\text{ kJ/kgK}$ ,  $C_v = 0.718\text{ kJ/kgK}$ )

(12 marks)

## Question 4

A spark-ignition engine (SI engine) is an internal combustion engine, generally a petrol engine, where the combustion process of the air-fuel mixture is ignited by a spark from a spark plug. This contrasts with compression-ignition engines, typically diesel engines where the heat generated from compression together with the injection of fuel is enough to initiate the combustion process, without needing any external spark.

- (a) Examine how wall temperature influences engine combustion.

(6 marks)

- (b) A single cylinder gasoline engine working on the Otto Cycle has a cylinder of diameter 76 mm and stroke 88 mm. The clearance volume is 36 cc. Calculate the air standard efficiency. (Assume  $C_p=1.004$  kJ/kgK,  $C_v=0.717$  kJ/kgK)

(6 marks)

- (c) Abnormal combustion, commonly known as knocking, is undesirable in engine operation. There are two main types of abnormal combustion: surface ignition and auto-ignition. Discuss about auto ignition, surface ignition and techniques in preventing abnormal combustion.

(8 marks)

END OF EXAMINATION PAPER

## APPENDIX

$$r_c = \frac{\text{max\_cylinder\_volume}}{\text{min\_cylinder\_volume}} = \frac{V_d + V_c}{V_c}$$

$$\bar{S}_p = 2LN$$

$$BP = P_b = 2\pi NT; T = Fb$$

$$P_{ig} = P_b + P_f$$

$$\eta_{in} = \frac{BP}{m_f \times Q_{net}}$$

$$\eta_m = \frac{P_b}{P_{ig}} = 1 - \frac{P_f}{P_{ig}} = \frac{bP}{iP} = \frac{bmep}{imep}$$

$$Bmep = \frac{2bP}{ALnN}$$

$$V_s = ALnN; \eta_v = \frac{V_a}{V_s}$$

$$sfc = \frac{\dot{m}_f}{BP}$$

$$\frac{V_1}{V_2} = \frac{V_1}{V_6} = \frac{V_3}{V_6} = \frac{V_{BDC}}{V_{TDC}} = r_c$$

$$W_{Comp} = U_1 - U_2 = mC_v(T_1 - T_2)$$

$$W_{c,i} = W_{Comp} + W_{Exp}$$

$$\eta_{f,i} = \frac{W_{c,i}}{Q_{in}} = \frac{mc_v[(T_1 - T_2) + (T_3 - T_4)]}{mc_v(T_3 - T_2)} = 1 - \frac{(T_4 - T_1)}{(T_3 - T_2)}$$

$$\frac{T_3}{T_2} = \frac{V_3}{V_2}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = r_c^{\gamma-1} \Rightarrow T_2 = T_1 r_c^{\gamma-1}; \text{where, } \gamma = \frac{c_p}{c_v}$$

$$\frac{T_3}{T_4} = \left(\frac{V_4}{V_3}\right)^{\gamma-1} = r_c^{\gamma-1} \Rightarrow T_3 = T_4 r_c^{\gamma-1}$$

$$\frac{V_4}{V_3} = \frac{V_4}{V_2} \times \frac{V_2}{V_3} = \frac{V_1}{V_2} \times \frac{V_2}{V_3}$$

$$\eta_{f,i} = \frac{W_{c,i}}{Q_{in}} = \frac{mc_v[(T_1 - T_2) + (T_3 - T_4)]}{mc_v(T_3 - T_2)} = 1 - \frac{(T_4 - T_1)}{(T_3 - T_2)} = 1 - \frac{Q_2}{Q_1} = 1 - \frac{1}{r_c^{\gamma-1}}; r_c = c_r$$

$$\eta_{f,i} = 1 - \frac{\beta^\gamma - 1}{(\beta - 1)r_c^{\gamma-1}}; \beta = \frac{V_3}{V_2}$$

