

**FINAL
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : April 2020

Programme : Diploma in Mechanical Engineering (DMEN)

Course : **EGM2172: Engineering Thermodynamics 1**

Date of Examination : 7 August 2020 (Friday)

Time : 8.00am – 10.15am Reading Time : Nil

Duration : 2 Hours 15 Minutes

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Thermodynamics Tables

Examiner(s) : **Ms Nur Hafizah Habideen, Ms Iylia Elena Abdul Jamil**

Chief Moderator : Mr Soo Swee Yoong

This paper consists of 4 printed pages, including the cover page

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2172: ENGINEERING THERMODYNAMICS 1
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

- (a) A well-insulated horizontal rigid cylinder is divided into two compartments by a piston. The piston is made of 5 kg of copper initially at the average temperature of the two gases on both sides. The piston is free to move but does not allow either gas to leak into the other side. Initially, one side of the piston contains 1 m^3 of N_2 gas at 500 kPa and 80°C while the other side contains 1 m^3 of He gas at 500 kPa and 25°C . Thermal equilibrium is established in the cylinder as a result of heat transfer through the piston. Using constant specific heats at room temperature, determine:
- (i) the final equilibrium temperature in the cylinder
(12 marks)
- (ii) what would happen if the piston were not free to move?
(3 marks)
- (b) A 1000-W iron has a base plate made of 0.5-cm-thick aluminum alloy ($\rho = 2770 \text{ kg/m}^3$ and $c_p = 875 \text{ J/kg} \cdot ^\circ\text{C}$). The base plate has a surface area of 0.03 m^2 . Initially, the iron is in thermal equilibrium with the ambient air at 22°C . Assuming 85 percent of the heat generated in the resistance wires is transferred to the plate, determine the minimum time needed for the plate temperature to reach 140°C .
(10 marks)

Question 2

- (a) Property diagrams are useful to visualize the thermodynamics states of substances, and the processes they undergo. Sketch a property diagram for the following processes and states for refrigerant-134a, with respect to the saturated liquid and saturated vapor lines. For each diagram, indicate the process path and initial and final states.
- (i) On the P-v diagram, sketch the constant temperature process through the state $P = 280 \text{ kPa}$, $v = 0.06 \text{ m}^3/\text{kg}$ as pressure changes from $P_1 = 400 \text{ kPa}$ to $P_2 = 200 \text{ kPa}$. Place the value of the temperature on the process curve on the P-v diagram.
(7 marks)

(ii) On the T-v diagram, sketch the constant specific volume process through the state $T = 20^{\circ}\text{C}$, $v = 0.02 \text{ m}^3/\text{kg}$ from $P_1 = 1200 \text{ kPa}$ to $P_2 = 300 \text{ kPa}$. For this data set place the temperature values at states 1 and 2 on its axis. Place the value of the specific volume on its axis.

(9 marks)

(b) A rigid tank is divided into two equal parts by a partition. One part of the tank contains 1.5 kg of compressed liquid water at 300 kPa and 60°C while the other part is evacuated. The partition is now removed, and the water expands to fill the entire tank. Determine the entropy change of water during this process, if the final pressure in the tank is 15 kPa.

(9 marks)

Question 3

(a) In a heat exchanger, the exhaust gases preheat air. This heat exchanger is called the regenerator before it enters the combustion chamber. 1 MPa and 550 K air enters the regenerator at a mass flow rate of 800 kg/min. Heat is transferred to the air at a rate of 3200 kJ/s. Exhaust gases enter the regenerator at 140 kPa and 800 K and leave at 130 kPa and 600 K. Determine:

(i) the exit temperature of the air.

(10 marks)

(ii) the mass flow rate of exhaust gases.

(5 marks)

Assume that the exhaust gas is air.

(b) The second law of thermodynamics states that entropy of a system is always increasing.

(i) When an object cools down, heat is released from it. Does the entropy of the object decrease in this process?

(3 marks)

(ii) Does the above process violate the second law of thermodynamics? Explain your answer.

(5 marks)

(iii) Can zero net entropy ever be achieved?

(2 marks)

Question 4

- (a) A heat pump with a COP_{HP} of 2.4 is used to heat a house. When running, the heat pump consumes 8 kW of electric power. If the house is losing heat to the outside at an average rate of 40,000 kJ/h and the temperature of the house is 3°C when the heat pump is turn on, determine how long it will take for the temperature in the house to rise to 22°C. Assume the house is well sealed and the entire mass within the house is equivalent 2000 kg of air. (10 marks)
- (b) The working fluid of a heat pump is refrigerant-134a. It is used to keep a space at 25°C by absorbing heat from geothermal water that enters the evaporator at 50°C at a rate of 0.065 kg/s and leaves at 40°C. Refrigerant enters the evaporator at 20°C with a quality of 15 percent and leaves at the same pressure as saturated vapor. If the compressor consumes 1.2 kW of power, determine:
- (i) the mass flow rate of the refrigerant (8 marks)
 - (ii) the rate of heat supply (2 marks)
 - (iii) the COP_{HP} (2 marks)
 - (iv) the minimum power input to the compressor for the same rate of heat supply (3 marks)

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