UNIVERSITI KUALA LUMPUR
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	SCB23603 (V2)
COURSE TITLE	:	THERMAL SCIENCE
PROGRAMME NAME	:	BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN MECHANICAL (AUTOMOTIVE)
DATE	:	27 JANUARY 2026
TIME	:	2:00PM - 5:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

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*

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

Answer all of the following questions.

(a) Classify the system below either closed system, control volume or isolated system.

i. Car Engine

(1 marks)

ii. Turbine

(1 marks)

iii. Soda Can

(1 marks)

iv. Ice box

(1 marks)

(b) Compressed liquid is heated at a constant pressure to a saturated vapour state. Draw the *T-v* and *P-v* diagrams for the process.

(4 marks)

(c) A piston cylinder device contains 0.01 m^3 of liquid water and 0.008 m^3 of water vapour in equilibrium at 1 MPa. Heat is transferred at constant pressure until the temperature reaches 360°C.

i. Determine the initial temperature of water.

(1 marks)

ii. Find the total mass of the water.

(5 marks)

iii. Calculate the final volume.

(6 marks)

Question 2

Answer all of the following questions.

(a) A rigid tank contains 50 kg of saturated liquid water at 90°C. Determine:

i. the pressure in the tank

(1 marks)

ii. the volume of the tank

(2 marks)

(b) Find the enthalpy and internal energy of 2 kg of steam at 10 bar and quality of 0.70.

(4 marks)

(c) A piston cylinder device contains 0.25 kg liquid water and 0.75 kg water vapor in equilibrium at 800 kPa. Heat is transferred at constant pressure process until the temperature reaches 300°C.

i. Show the process on a P-v diagram with respect to saturation lines.

(4 marks)

ii. Determine the initial and the final volume.

(9 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Answer all of the following questions.

(a) A frictionless piston-cylinder device initially contains 0.2 m^3 of saturated liquid refrigerant-134a. The piston is free to move, and its mass is such that it maintains a pressure of 800 kPa on the refrigerant. The refrigerant is now heated until its temperature rises to 50°C. Calculate the work done during this process.

(8 marks)

(b) A closed rigid tank contains 2 kg of water initially at 80°C and a quality of 0.6. Heat transfer occurs until the tank contains only saturated vapour. Kinetic and potential energy effects are negligible. For the water as the system, determine the amount of heat transfer by heat, in kJ.

(12 marks)

Question 2

Answer all of the following questions

(a) A piston cylinder device initially contains 0.25 kg of nitrogen gas at 130 kPa and 180°C. The nitrogen is now expanded isothermally to a pressure of 80 kPa. Determine the boundary work done during this process.

(5 marks)

(b) Air enters an adiabatic nozzle steadily at 400 kPa, 177°C, and 50 m/s and leaves at 200 kPa and 120 m/s. The inlet area of the nozzle is 110 cm^2. Determine:

i. The mass flow rate through the nozzle

(4 marks)

ii. The exit temperature of the air

(8 marks)

iii. The exit area of the nozzle

(3 marks)

Question 3

Answer all of the following questions.

(a) Steam flows steadily into a turbine with a mass flow rate of 20000 kg/h. The inlet and the exit conditions are given in Figure 1. If the power generated by the turbine is 3 MW, determine the rate of heat loss from the steam, in MW.
Refer Below - Figure1 : Turbine .

(10 marks)

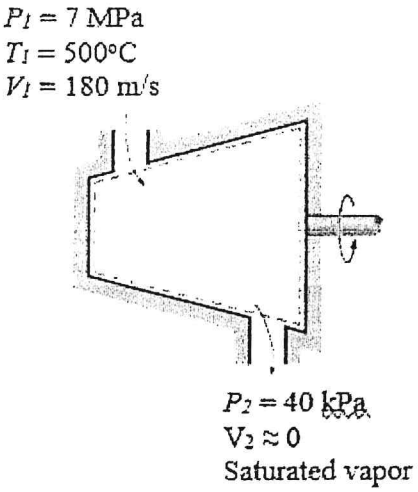

Figure 1: Turbine

(b) Explain the Second Law of Thermodynamics according to:

i. Kelvin-Planck statement

(2 marks)

ii. Clausius Statement

(2 marks)

(c) A heat pump with a coefficient of performance, COP of 2.5 supplies energy to a room at a rate of 63300 kJ/h. Determine:

i. The electrical power input to the heat pump, in kW.

(3 marks)

ii. The rate of heat absorption from the outside air, in kW.

(3 marks)

Question 4

Answer all of the following questions.

(a) A refrigeration cycle in the following figure removes 18,000 kJ/h of energy by heat transfer from a space maintained at -40°C and discharges energy by heat transfer to surroundings at 20°C. If the COP of the cycle is 40% of that of a reversible refrigeration cycle operating between thermal reservoirs at these two temperatures, determine the power input to the cycle, in kW.

Refer Below - Figure2 : Refrigerant Cycle .

(6 marks)

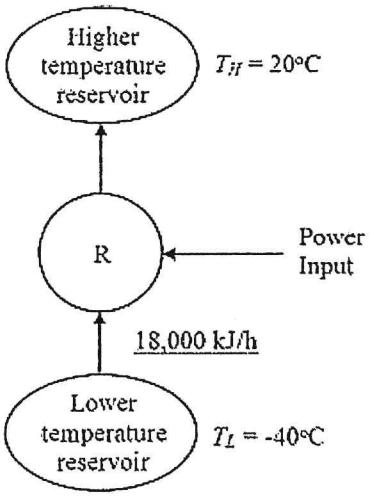

Figure 2: Refrigerant Cycle

(b) A heat engine with a thermal efficiency of 45% produces 880 kJ of work. Heat transfer to the engine is from a reservoir at a temperature of 550 K, and the heat transfer from the engine to the surrounding air is at 300 K.

i. Sketch a schematic diagram to represent the heat engine system.

(2 marks)

ii. Determine the heat transfer to and from the heat engine.

(6 marks)

iii. If the heat engine is replaced by a Carnot heat engine producing the same work output, determine the heat transfer to and from the Carnot heat engine.

(6 marks)

END OF EXAMINATION PAPER