Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	BNJ 20703
PROGRAMME CODE	:	BNG
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Sketch ***P-v*** diagrams for steam and label the pressure, specific volume, temperature clearly, and then specify the phase of each state (on the diagrams) based on the following conditions:

(i) $P = 20$ bar, $T = 250°C$,

(3 marks)

(ii) $T = 212.4°C$, $v = 0.09959$ m^3/kg,

(3 marks)

(iii) $P = 10$ bar, $h = 2650$ kJ/kg, and

(3 marks)

(iv) $P = 6$ bar, $h = 3166$ kJ/kg.

(3 marks)

Note: You should sketch **FOUR (4)** diagrams based on the above conditions.

(b) Discuss and sketch from state 1 to state 2 in either ***T-v*** diagram or ***T-s*** diagram for the following processes:

(i) isentropic process,

(2 marks)

(ii) isothermal process,

(2 marks)

(iii) isobaric process, and

(2 marks)

(iv) isochoric process.

(2 marks)

Note: You should sketch **FOUR (4)** diagrams based on the above processes.

Q2 (a) Air flows steadily at the rate of 0.4 kg/s through an air compressor as shown in **Figure Q2 (a)**. The air enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves it at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The specific internal energy of the air leaving the compressor is 88 kJ/kg greater than that of the air entering it. Cooling water absorbs heat from the air at the rate of 59 kW in a jacket surrounding the compressor cylinder. Calculate:

(i) the power required to drive the compressor, and

(6 marks)

(ii) the inlet and outlet cross-section areas of the pipe.

(4 marks)

(b) 12 kg of R-134a at 320 kPa fills a rigid container whose volume is 16 L as shown in **Figure Q2 (b).** Determine the temperature and total enthalpy in the container. The container is now heated until the pressure is 600 kPa. Determine:

(i) the temperature

(4 marks)

(ii) and total enthalpy when the heating is completed.

(6 marks)

Q3 (a) A steam turbine operates at steady and adiabatic condition. The inlet steam has a pressure of 5000 kPa, at temperature 573.15 K and a velocity of 90 m/s. Meanwhile, for the exit conditions are 60 kPa, 85% quality and 55 m/s. Give the steam mass flow rate is 25 kg/s. Determine:

(i) the change of kinetic energy,

(2 marks)

(ii) power output in MW,

(4 marks)

(iii) turbine inlet area, and

(2 marks)

(iv) turbine exit area

(2 marks)

(b) A hot-water stream at 80°C enters a mixing chamber with a mass flow rate of 0.5 kg/s where it is mixed with a stream of cold water at 20°C. If it is desired that the mixture leaves the chamber at 42°C. Determine the mass flow rate of the cold-water stream. Assume all the streams are at a pressure of 250 kPa.

(10 marks)

Q4 (a) A household refrigerator with a COP of 1.7 removes heat from the refrigerated space at a rate of 80 kJ/min. Determine:

(i) the electric power consumed by the refrigerator in kW, and

(3 marks)

(ii) rate of heat transfer to the kitchen air in kW.

(3 marks)

(iii) sketch the schematic diagram of the refrigerator systems with the obtained results from Q4 (a) (i) and Q4 (a) (ii), and

(4 marks)

(iv) explain how each mechanical device works in the refrigerator system.

(4 marks)

(b) Refrigerant-134a enters the condenser of a residential heat pump at 800 kPa and 35°C at a rate of 0.018 kg/s, and leaves at 800 kPa as a saturated liquid. If the compressor consumes 1.2 kW of power, determine:

(i) COP of the heat pump, and

(4 marks)

(ii) rate of heat absorption from the outside air.

(2 marks)

Q5 (a) Sketch a Mollier diagram (***h-s*** diagram) for a fluid gone through an adiabatic steady flow nozzle, label accordingly and indicate its actual and isentropic process, kinetic energies, and pressure curves on the diagram.

(6 marks)

(b) Air enters an adiabatic steady flow nozzle at 470 kPa and 527°C with low velocity, and exits at 260 m/s. If the isentropic efficiency of the nozzle is 92%, determine the exits temperature and pressure of the air.

(14 marks)

END OF QUESTIONS

FINAL EXAMINATION

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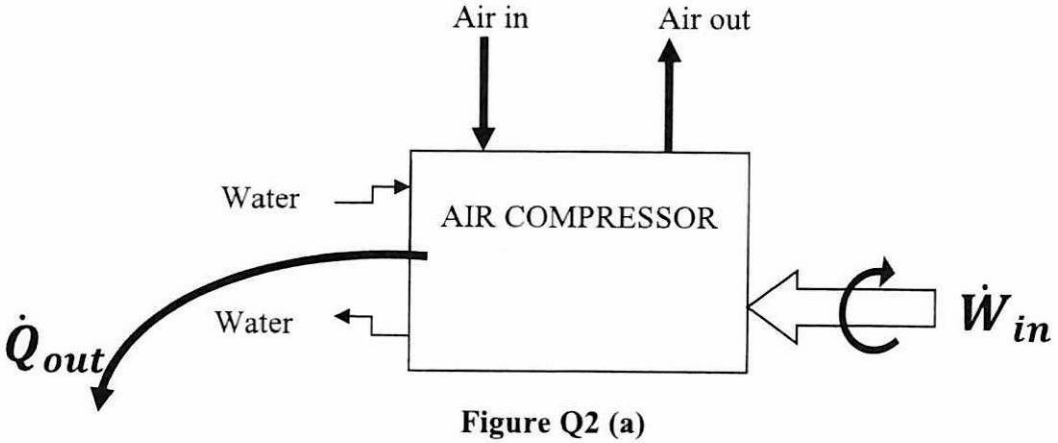

Figure Q2 (a)

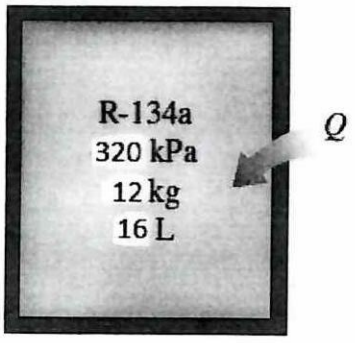

Figure Q2 (b)