Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2023/2024

COURSE NAME	:	THERMODYNAMICS
COURSE CODE	:	DAM23403
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JANUARY / FEBRUARY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **FIVE (5)** QUESTIONS ONLY
		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 **EIGHT (8)** PAGES

Q1 (a) State the following definitions of:

(i) classical thermodynamics

(1 mark)

(ii) statistical thermodynamics

(1 mark)

(b) Describe the difference between an intensive and an extensive property. Give **two (2)** examples of each type of property.

(6 marks)

(c) The absolute pressure in water at a depth of 7 m is read to be 168 kPa. Determine:

(i) the local atmospheric pressure; and

(ii) the absolute pressure at a depth of 7 m in a liquid whose specific gravity is 0.75 at the same location.

(9 marks)

(d) Why does a bicyclist pick up speed on a downhill road even when he is not pedaling? Does this violate the conservation of energy principle? Explain.

(3 marks)

Q2 (a) Plot and label clearly the following on a T-v diagram of pure substance.

(i) Saturated liquid line

(1 mark)

(ii) Saturated vapor line

(1 mark)

(iii) Critical point

(1 mark)

(iv) Compressed liquid region

(1 mark)

(v) Saturate liquid-vapor mixture region

(1 mark)

(vi) Superheated vapor region

(1 mark)

(b) A 4 kg of refrigerant-134a initially at 140 kPa and 24°C is cooled at constant volume as it is stirred until the temperature drop to -26°C. Determine,

(i) the volume at initial and final state in m^3 and

(3 marks)

(ii) the dryness fraction at final state, and

(2 marks)

(iii) the change in internal energy in kJ/kg and

(6 marks)

(iv) Show the process on a T-v diagram with appropriate labels.

(3 marks)

Q3 (a) Is iced made from water (H20) can be considered pure substance? Explain your answer?

(3 marks)

(b) What is quality (*X*)? Does it have any meaning in the compressed liquid region?

(2 marks)

(c) A piston–cylinder device contains 0.6 kg of steam at 200□ and 0.5 MPa. Steam is cooled at constant pressure until one-half of the mass condenses.

(i) Determine the phase description of the steam inside the piston cylinder device initially (before cooling process)

(1 mark)

(ii) Find the final temperature.

(2 marks)

(iii) Determine the volume change.

(6 marks)

(d) A rigid vessel contains 8 kg of refrigerant-134a (R-134a) at 500 kPa and 120□.

(i) Determine the phase description of R134-a inside the vessel.

(1 marks)

(ii) Calculate the volume of the vessel, (V) in m^3.

(3 marks)

(iii) Calculate the total internal energy, (U) in kJ

(2 marks)

Q4 (a) Sketch a schematic diagram and explain the main function of following steady state device:

(i) compressor

(2 marks)

(ii) heat exchanger

(2 marks)

(iii) throttling valve

(2 marks)

(b) **Figure Q4(b)** showed a feedwater heater at a steam power plant that act as a mixing chamber. The feedwater heater operates at a pressure of 1000 kPa. Feedwater at 50□ and 1000 kPa is to be heated with superheated steam at 200□ and 1000 kPa. In an ideal feedwater heater, the mixture leaves the heater as saturated liquid at the feedwater pressure. Determine the ratio of the mass flow rates of the feedwater

(5 marks)

(b) An adiabatic gas turbine expands air at 1300 kPa and 500□ to 100 kPa and 127□. Air enters the turbine through a 0.2 m^2 opening with an average velocity of 40 m/s, and exhausts through a 1 m^2 opening. Assume air as ideal gas with C_p = 1.048 kJ/kg.K and R = 0.287 kJ/kg.K, determine:

(i) the mass flow rate of air through the turbine

(4 marks)

(ii) the power produced by the turbine.

(5 marks)

Q5 (a) In thermodynamics analysis concept of reversibility, though hypothetical, is very important because a reversible process is the most efficient process. Please state three (3) reversible processes should fulfil the following conditions.

(3 marks)

(b) A house requires 3×10^5 kJ/h for heating in winter. Heat pump is used to absorb heat from cold air outside in winter and send heat to the house. Work required to operate the heat pump is 4×10^4 kJ/h. Determine:

(i) Heat abstracted from outside

(ii) Coefficient of performance

(8 marks)

(c) A Carnot cycle operates between source and sink temperatures of 280 °C and -18 °C. If the system receives 100 kJ from the source, find:

(i) Efficiency of the system

(ii) The net work transfer

(iii) Heat rejected to sink

(9 marks)

Q6 (a) Discuss entropy generation, S_{gen} regarding irreversibility and reversible processes.

(4 marks)

(b) Refrigerant-134a enters an adiabatic compressor as saturated vapor at 100 kPa at a rate of 0.7 m^3/min and exits at 1-MPa pressure. If the isentropic efficiency of the compressor is 87 percent, determine:

(i) the temperature of the refrigerant at the exit of the compressor, and

(8 marks)

(ii) the power input, in kW.

(5 marks)

(iii) show the process on a *T-s* diagram with respect to saturation lines.

(3 marks)

-END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM I 2023/2024
COURSE NAME : THERMODYNAMICS

PROGRAMME CODE : DAM
COURSE CODE : DAM23403

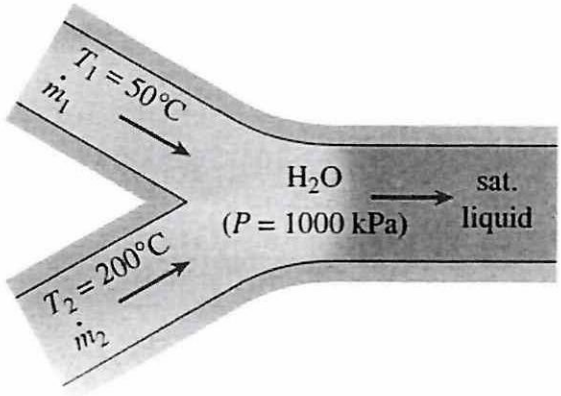

Figure Q4(b): Feedwater heater in Steam Power Plant