



UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BCE 2124
COURSE	: CHEMICAL ENGINEERING THERMODYNAMICS
SEMESTER/SESSION	: 2-2023/2024
DURATION	: 3 HOURS

Instructions:

1. This booklet contains **4** questions. Answer **ALL** questions.
2. You are allowed to bring "Appendix A" steam table and a sheet of A4 paper containing formulas, notes, etc.
3. All answers should be written in answer booklet.
4. Write legibly and draw sketches wherever required.
5. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 5 PRINTED PAGES INCLUDING COVER PAGE

CHEMICAL ENGINEERING THERMODYNAMICS (BCE 2124)

QUESTION 1

- a) The first law thermodynamics is the principle that states that energy cannot be created or destroyed, but it can be transferred from one to another. Work and heat are two important mechanism for transferring energy in the first law thermodynamics. In mathematical, thermodynamics can be represent by the equation:

$$\Delta U = Q - W$$

Where ΔU is the change in internal energy of the system, Q is the amount of heat added to the system and W the work done by the system. Using the steam turbine generator or any other adequate example, explain briefly the difference between work and heat concept and mechanism

(10 marks)

- b) The substance containing in a cylinder with a piston is classified as a closed system or control mass. As the piston moves, the boundary of control mass also changes. As heat and work across the boundary of the control mass is changes while the matter that composes the control mass can always identified and remain the same. As example, a piston containing 10 kg of water exist as saturated liquid/vapor at 100 kPa with a quality of 50%. If the system is now heated so that the volume triples at the pressure 200 kPa, determine the thermodynamics properties at initial and final state, heat and work changes

(15 marks)

QUESTION 2

Consider the system shown in Figure 1. Tank A has a volume of 100 L and contains saturated vapor water at 200 °C. When the valve is cracked open, water flows slowly into cylinder B. The piston mass requires a pressure of 200 kPa in cylinder B to raise the piston. The process ends when the pressure in tank A has fallen to 200 kPa. During this process, heat is exchanged with the surroundings such that the water always remains at 200 °C.

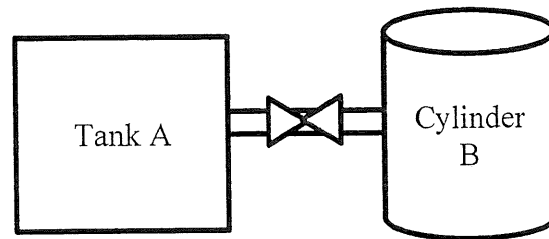


Figure 1

- Indicate the process is control mass or control volume? Develop a continuity equation and energy balance equation for the process with assumptions (6 marks)
- Determine the mass of water at initial stage in Kg (7 marks)
- Determine the work done by the piston in KJ unit (7 marks)
- Determine the heat transfer for the process in KJ unit (5 marks)

QUESTION 3

A turbine is a machine that converts the energy from a fluid flow such as steam into mechanical energy. The operation of turbine is based on principles of thermodynamics which govern the behaviour of energy in various forms such as heat and work. In the operation of steam turbine, throttling is essential process to allow safe and efficient operation of the turbine by controlling the flow rate, pressure and quality of steam entering the turbine. In Figure 2, a small turbine is operated at part load by throttling a 0.25 kg steam supply at 1.4 MPa and 205 °C to 1.1 MPa before enter the turbine, and the exhaust is 10 kPa

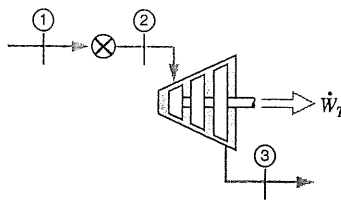


Figure 2

- Produce energy equation for the process, state all the assumptions (5 marks)
- Identify the thermodynamics properties (h) at the inlet, outlet of throttle valve and exit of turbine (3 marks)
- Determine the specific work in kJ/kg at the turbine (3 marks)
- If the turbine produces 110 kW, calculate the exhaust temperature and quality (if saturated) (6 marks)
- If throttle valve is not installed, calculate the power output of turbine with exit state quality as (d) (8 marks)

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QUESTION 4

Consider a coal fired steam power plant that produces 175 MW of electric power. The power plant operates on a simple ideal Rankine cycle with turbine inlet conditions of 7 MPa and 550 °C and a condenser pressure of 15 kPa. The coal has a heating value (energy released when the fuel is burned) of 29,300 kJ/kg. Assuming that 85% of this energy is transferred to the steam in the boiler and that the electric generator has an efficiency of 96%, determine

- a) Thermodynamics properties (h , v , s and x (if any)) for each inlet and outlet (9marks)
for pump, condenser, turbine and boiler.
- b) The work (W) done by pump in kJ/kg (3 marks)
- c) The heat (Q) supplied to the boiler in kJ/kg (3 marks)
- d) The heat (Q) released from the condenser in kJ/kg (3 marks)
- e) Thermal efficiency of the cycle (3 marks)
- f) Considering the loss of energy transferred and generator efficiency, (4 marks)
determine the actual efficiency of this cycle.

-----End of questions-----

