04 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

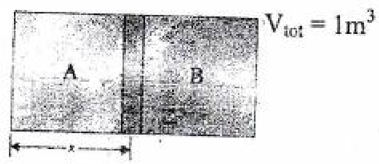
2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME402)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Define macroscopic and microscopic viewpoint as applied to the study of thermodynamics. Also list their features. [4]
2. Define stored energy and transient energy. Also list their features. [4]
3. Define quality. Explain why it is necessary to define the state of two phase mixture. Also derive an expression for specific volume of a two-phase mixture. [4]
4. Differentiate between steady state and unsteady state control volume. Derive mass and energy conservation equation for a process in which gas is being supplied to a rigid cylinder. [6]
5. Write down the similarities and differences between heat pump and refrigerator. Explain how first and second laws can be applied to analyze the performance of a heat pump. [6]
6. Sketch ideal Vapour compression refrigeration cycle and explain the processes on P-h and t-s diagram. Also write an expression for theoretical COP of the cycle used as heat pump. [6]
7. Differentiate between free and forced convection with examples. Write down the expressions for thermal resistance for a plane wall, a hollow cylinder and convective layer of fluid. [6]
8. The device shown in figure below has a free moving piston between the two chambers. The initial total volumes of A and B are equal with $vA = 100\ m^3/kg$ and $vB = 50\ m^3/kg$. If the piston is moved so that x is one-fourth of the entire length, determine the final specific volumes of chambers A and B. [6]



9. A piston cyclinder arrangement shown in figure below contains 1 kg of water initially at a pressure of 1 MPa and a temperature of 500°C. The water is cooled until it is completely converted into saturated liquid. It requires a pressure of 400 kPa to support the piston. Sketch the process on P-v and T-v diagrams and determine the total work transfer. (Refer the attached table for the properties of water) [8]

10. Steam at 0.4 MPa and 200°C enters into an adiabatic nozzle with a velocity of 50 m/s and leaves the nozzle at 0.1 MPa and with a velocity of 75 m/s. Determine [8]

   a) The exit temperature of the steam.
   b) The ratio of inlet diameter to the exit diameter. (Refer the attached table for the properties of steam)

11. Work output of an ideal engine is 4 times the heat rejected by it. Determine its efficiency. If the sink temperature increases by 300°C, its efficiency reduces to 60%. Determine its source and sink temperatures. [8]

12. An air standard Otto cycle has a compression ratio of 10. At the beginning of the compression stroke, the pressure and temperature are 100 kPa and 20°C respectively. The peak temperature during the cycle is 2000 K. Determine,

   a) The pressure and temperature at the end of each process of the cycle
   b) The thermal efficiency (Take Cv = 718 J/kgk, $\gamma = 1.4$) [8]

13. A thick walled tube of stainless steel (k = 19 W/m°C) with 2 cm inside diameter and 4 cm outer diameter is covered with a 3 cm layer of asbestos insulation (k = 0.2 W/m°C). If the inside and outside wall temperature of the pipe is maintained at 600°C and 100°C. Calculate the heat loss per meter of length. Also calculate the tube-insulation interface temperature. [6]

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