04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

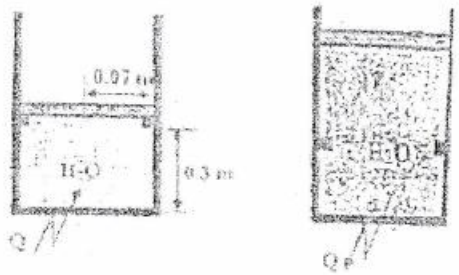
Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

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 figures and tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. Define thermodynamic equilibrium. Explain reversible and irreversible processes with reference nature of intermediate states. [4]
2. Define internal energy, potential energy, kinetic energy and total energy of a thermodynamic system. Also differentiate between microscopic potential energy and macroscopic potential energy. [4]
3. Define saturation pressure, saturation temperature and critical point. Write down the effect of pressure on
   a) Specific volume of a saturated liquid (V_f)
   b) Specific volume of a saturated vapor (V_g)
   c) Change in specific volume due to evaporation (V_{lg}) [4]
4. State and explain conservation of energy for a control volume. [6]
5. Differentiate between thermal and mechanical irreversibilities. Explain why most of the real processes are irreversible. Also explain how they can be assumed to be reversible. [6]
6. Explain with the help of neat diagrams the various processes of any Rankine cycle and derive an expression for its efficiency. [6]
7. Derive an expression with appropriate diagram for conduction heat transfer through a composite cylinder tube consisting of three layers of different materials. [6]
8. A piston cylinder has a diameter of 0.1 m. With an outside atmospheric pressure of 100 kPa, determine the piston mass that will create an inside pressure of 500 kPa. What would be the new pressure if the piston mass is halves. [Take $g = 9.81\ m/s^2$] [6]
9. Steam is contained in a closed rigid container. Initially, the pressure and temperature of the steam are 1500 kPa and 250°C, respectively. The temperature drops as a result of heat transfer to the surroundings. Determine the pressure at which condensation first occurs and the fraction of the total mass that gas been condensed when the temperature reaches 100°C. What percentage of the volume is occupied by saturated liquid at the final state? [8]
10. A piston cylinder devices shown in figure below contains water initially at 105°C with quality 10%. Heat is added to the system until it becomes saturated vapor. It takes pressure of 1000 kPa to lift the piston from the stops. Sketch the P-v, T-v diagram and determine: [8]
    a) The mass of water in system
    b) The total work transfer

c) The total heat transfer *[Refer the attached table for properties of water]*



11. 2 kg water at 100°C is mixed with 4 kg of water at 20°C in an isolated system. Calculate the net change in entropy due to the mixing process. [Take specific heat of water c = 4.18 kJ/K] [8]

12. An ideal Brayton cycle has pressure ratio of 10. The temperature of air at compressor and turbine inlets are 300K and 1200K respectively. Determine its thermal efficiency and mass flow rate of air required to produce net power output of 80MW. [Take Cp = 1005 J/Kg.K, $\gamma = 1.4$] [8]

13. A 200 mm diameter 50 m long pipe carrying steam is covered with 40 mm thick of high temperature insulation (k = 0.1 W/m) and 30 mm thick of low temperature insulation (k = 0.05 W/m). The inner and outer surfaces of the insulating layer are at 400°C and 40°C respectively. Determine:

    a) The rate of heat loss from the pipe,
    b) The temperature at the interface of two insulating layer. [6]

***