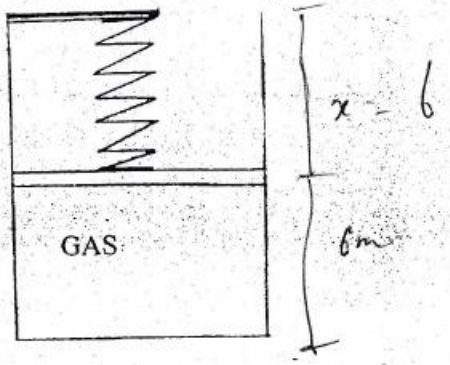
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Chaitra

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

Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME 402)*

- ✓ 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. Differentiate between the microscopic and macroscopic view point in thermodynamics with suitable examples. [4]
2. Define internal energy. Derive an expression for displacement work transfer for a polytropic process. [4]
3. State two property rule for a state. Explain the importance of graphical and tubular data presentation. [5]
4. Derive a general expression for energy conservation for a control volume and reduce it for steady state condition. [6]
5. Differentiate between heat engine and refrigerator. Also explain the factors used for their performance evaluation. [6]
6. Explain the working principle of the Rankine cycle with the corresponding process on P-V and T-S diagrams. [6]
7. a) Derive an expression for steady state heat transfer through a composite cylinder consisting of two different materials. [4]
   b) Define terms black body and gray body. [2]
8. A piston cylinder arrangement loaded with a linear spring as shown in figure below has cross sectional area of $0.01m^2$, contains gas piston mass of 80kg. Initially spring touches the piston but exerts no pressure on it. Heat is supplied to the system until its volume doubles. Determine the final pressure. [Take $g = 9.81 m/s^2$, outside atmospheric pressure = 100kPa, spring const, k = 50KN/m, initial volume = $0.06m^3$ of gas] [6]

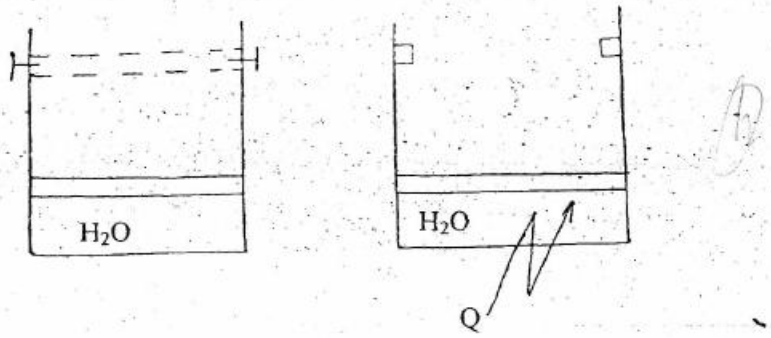


9. A vessel having a volume of $0.4m^3$ contains 2.0 kg of liquid water and water vapor mixture in equilibrium at a pressure of 250kPa. Calculate: [7]

a) The volume and mass of liquid
b) The volume and mass of vapor
c) Temperature
e) Enthalpy

(Refer the attached table for properties of steam)

10. A piston cylinder device shown in figure below contains 2kg of water initially at saturated liquid state of 1MPa. There is heat transfer to the system until it hits the stops at which time its volume is $0.3m^3$. There is further heat transfer to the device until water is completely vaporized. Sketch the process on P-v and T-v (pressure - specific volume) diagrams and determine total work and heat transfer. [8]



11. Steam enters into a turbine at a rate of 2kg/s with P_1 = 2MPa, T_1 = 600°C and exits at P_2 = 9kPa. Find: [8]

a) Power output if the turbine is isentropic
b) Power output if isentropic efficiency of turbine is 80% and
c) Outlet enthalpy of steam from the real turbine

12. At the beginning of the compression process of an air standard Otto cycle, P_1 = 100kPa, T_1 = 290K, V_1 = $400cm^3$. The maximum temperature in the cycle is 2200K and the compression ratio is 8. Determine: [8]

a) The heat addition, in kJ
b) The network, in kJ
c) The thermal efficiency
d) The mean effective pressure

[Take R = 287 J/kgK, C_v = 718 J/kgK]

13. A 3cm thick 50cm × 75cm plate (K = 50W/mK) has inner surface temperature of 310°C. Heat is lost from the plate surface by convection and radiation to ambient air at 20°C. If the emissivity of the surface is 0.85 and convection heat transfer coefficient is $20W/m^2K$, determine outer surface temperature of the plate. [6]

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