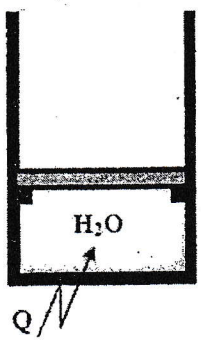
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

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

Subject: - Fundamentals 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 thermodynamic property. Explain intensive and extensive property with examples. [4]
2. Define polytropic process. Sketch polytropic processes with n = 0, 1, γ and ∞ on a common P-V diagram. Derive and enprossion for work transfer for a polytropic process. [4]
3. Derive an expression for the specific volume of a two phase mixture in term of quality. Which takes more energy to vaporize 1 kg of saturated liquid water at 100°C or 120°C? Why? [4]
4. Define a cyclic process. Derive first law of thermodynamics for a control mass undergoing a cyclic process. Also write down the statements for a power cycle and refrigeration cycle. [6]
5. Define heat engine, heat pump and refrigerator. Explain how first and second law are applied to determine performance of heat engine. [6]
6. Explain the working principle of a Brayton cycle. Sketch the cycle on p-v and T-s diagrams and explain the variation of its efficiency with pressure ratio. [6]
7. Derive the overall heat transfer coefficient for composite for plane wall consisting of two layers with convection on both sides. [6]
8. A piston-cylinder device contains 0.05 m^3 of a gas initially at 200 kPa. At this state, a linear spring that has a spring constant of 150 kN/m is touching the piston but exerting no force on it. Now heat is transferred to the gas, causing the piston to rise and to compress the spring until the volume inside the cylinder doubles. If the cross-sectional area of the piston is 0.25 m^2, determine: [6]
   i) The final pressure inside the cylinder
   ii) The total work done by the gas
9. A piston cylinder device shown in figure below contain 2 kg of H_2O with an initial temperature and volume of 80°C and 0.05 m^3 respectively. It requires a pressure of 400 kPa to lift the piston from the stops. The system is heated until its temperature reaches 250°C. Sketch the process on P-v and T-v diagrams and determine the total work transfer. [8]



10. Air flows at a rate of 1.2 kg/s through a compressor, entering at 100 kPa, 25°C, with a velocity of 60 m/s and leaving at 500 kPa, 150°C, with a velocity of 120 m/s. Heat lost by the compressor to the surrounding is estimated to be 20 kJ/kg. Calculate the power required to drive the compressor and diameters to inlet and exhaust pipes. [8]
[Take R = 287 J/kgK and c_p = 1005 J/kgK]

11. Five kg of water at 30°C is mixed with 1 Kg of ice at 0°C. Assuming the process of mixing is adiabatic, find the change in entropy. Latent heat of ice = 336kJ/kg, C_p for water = 4.2kJ/kgK. [8]

12. In a Rankine cycle stream leaves the boiler and enters the turbine at 4Mpa, 400°C. The condenser pressure is 10 kPa. Determine the cycle efficiency. [8]

13. A steel pipe having an outer diagram of 4 cm is maintained at a temperature of 80°C in a room where the ambient temperature is 25°C. The emissivity of the surface is 0.8 and the convection heat transfer coefficient between the surface and air is 10 W/m^2K. Determine the total heat loss from the unit length of the pipe. [Take $\sigma = 5.67\times10^{-8}$ w/m^2k^4] [6]

***