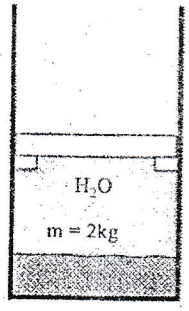
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

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 *(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.*
- ✓ *Take C_p=1005J/kgK, R=287J/kgK, γ=1.4 for air.*

1. Explain how you would find out whether a given variable is a thermodynamic property or not. Also differentiate between state function and path function with examples. [4]
2. Define Polytropic process and polytropic index. Find the value of polytropic index for isochoric reduction. [2+2]
3. Define the following terms: [4×1]
   a) Saturation pressure
   b) Superheated vapor
   c) Critical point
   d) Degree of super heat
4. Explain first law of thermodynamics for a control mass undergoing cyclic process. Write down statements of first law for power cycle and refrigeration cycle. [6]
5. Explain second law of thermodynamics for a control mass with necessary derivations. [6]
6. Explain the working principle of Vapour compression Refrigeration cycle with corresponding processes on P-h and T-S diagram. [6]
7. Derive an expression for radial steady state heat transfer through a composite cylinder with two different materials with a convective layer on the inside only. [6]
8. At the inlet and exhaust of a turbine the absolute steam pressure are 5000kPa and 5.0 cm of Hg, respectively. Barometric pressure is 76cm of Hg. Calculate the gauge pressure for the entering steam and the vacuum gauge pressure for the exhaust steam. [Take ρ_{Hg}=13600kg/m^3 and g = 9.81m/s^2] [6]
9. A piston cylinder device shown in figure below contains 2kg of water with an initial temperature and volume of 80°C and 0.05m^3. It requires a pressure of 400kPa to lift the piston from the stops. The system is heated until its temperature reaches 250°C. Sketch the process on P-V diagram and determine the total work transfer. [8]



10. Air at 90kPa, 27°C and 220m/s enters a diffuser at a rate of 4 kg/s and leaves at 42°C. The exit area of the diffuser is 450cm^2. The air is estimated to lose heat at a rate of 25kJ/s during this process. Determine:

    a) the inlet area of the diffuser
    b) the exit velocity and
    c) the exit pressure of the air. [8]

11. An air conditioning unit having a COP 65% of the theoretical maximum maintains a house at a temperature of 17°C by cooling it against the surrounding temperature. The house gains energy at a rate of 0.6kW per degree temperature difference. For a maximum work input of 1.8kW, determine the maximum surrounding temperature for which it provides sufficient cooling. [8]

12. The following data relate to an air standard Diesel cycle. The pressure and temperature at the end of suction stroke are 100kPa and 30°C respectively. Maximum temperature during the cycle is 1800°C and compression ratio is 16. Determine:

    a) the percentage of stroke at which cut-off takes place
    b) the temperature at the end of expansion stroke, and
    c) thermal efficiency. [8]

13. A 100mm diameter pipe carrying steam is covered by a layer of insulation (k=0.06W/mK) having a thickness of 50mm. The heat transfer coefficient between the outer surface of insulation and the ambient air is 20W/m^{2}K. Determine the required thickness of another insulating layer (k=0.1 W/mK) that must be added to reduce the heat transfer by 40% assuming that the heat transfer coefficient remains the same. [6]

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