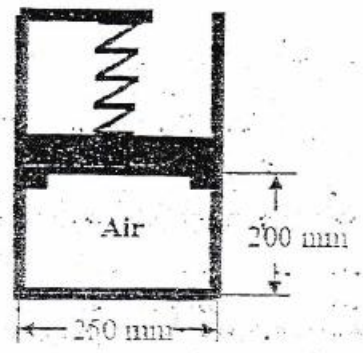
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME, BGE	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

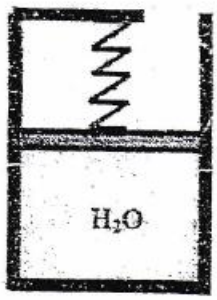
Subject: - Fundamental of Thermodynamics and Heat Transfer *(ME402)*

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

1. State and explain equality of temperature. Also state zeroth law of thermodynamics. [4]
2. Derive an expression for work transfer for any process on a piston cylinder device. Reduce it to get the expression for work transfer during a polytropic process. [4]
3. Define pure substance. State and explain "state postulate". [4]
4. Differentiate between steady state work applications and steady state flow applications. Write down the functions of a thermal turbine and nozzle. Also derive governing equations for them when they operate under steady state condition. [6]
5. State the entropy change statement for a control volume and derive an expression for its entropy generation. [6]
6. Sketch an ideal Otto cycle on P-v and T-s diagrams. Also derive an expression for its efficiency in terms compression ratio. [6]
7. Derive the expression for overall heat transfer coefficient for a composite plane wall consisting of two layers and subjected to convective modium on both sides. [6]
8. Air (0.01 kg) is contained in a piston cylinder device restrained by a linear spring ($k = 500$ kN/m) as shown in figure below. Spring initially touches the piston but exerts no forces on it. Heat is added to the system until the piston is displaced upward by 80 mm. Determine: [6]
   a) The temperature at which piston leaves the stops and
   b) The final pressure. [Take R = 287 J/kg. K, p_{atm} = 100 kPa and g = 9.81 m/s^2]



9. A piston cylinder device with a linear spring initially contains v Mpa and 500°C with the initial volume being 0.1 m^3, as in figure cools until the pressure reaches 1000 kpa. If the piston is at pressure is 300 kpa. Sketch the process on P-v diagram and dete the final temperature and volume and the total work transfer. [Ref properties of steam]



10. Air flows at rate of 1.2 kg/s through a compressor, entering at velocity of 60 m/s and leaving at 500 kpa, 150°C, with a velocity c the compressor to the surrounding is estimated to be 20 kJ/kg required to drive the compressor and diameters of inlet [Take R = 287J/kgK and c_p = 1005 J/kgK].

11. A rigid vessel consists of 0.4 kg of hydrogen initially at 200 transferred to the system from a reservoir at 600 K until its temp Determine the heat transfer, the change in entropy of hydrogen and produced. [Take c_v = 10.183 J/kgK].

12. An ideal gas turbine cycle produces 15 MW of power output. The compression inlet are 100 kpa and 17°C. The pressure ratio for c added per kg of air per cycle is 900 KJ/kg. Determine: (a) Effic maximum temperature during the cycle and (c) Mass flow rate of c_p = 1005 J/Kg.k]

13. A furnace wall 300 mm thick is made up of an inner layer of fir covered with a layer of insulation (k = 0.2 W/mK). The inner su 1300°C and the outer surface is at 30°C. Under steady state condit interface is measured to be 1100°C. Determine:

    a) Heat loss per unit area of the wall and
    b) The thickness of each layer

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