TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

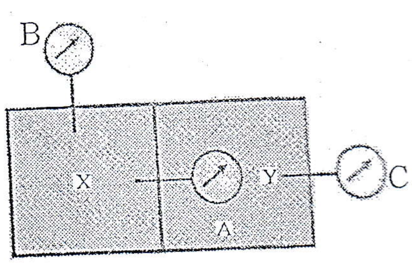
2079 Bhadra

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

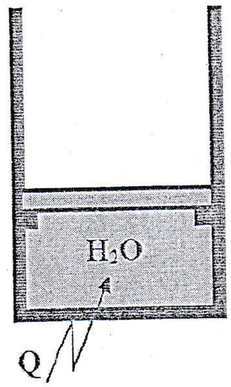
Subject: **- Fundamental of Thermodynamics and Heat Transfer (*ME 402*)**

- ✓ 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.*
- ✓ *For air take Cp = 1005J/kgk and Cv = 718 J/kgk.*

1. How will you find out whether a given variable is a thermodynamic property? How are those properties classified? Give examples. [4]
2. Define transient energy with its salient features. Differentiate between molecular potential energy and macroscopic potential energy of a system. [4]
3. Show how saturation curve is formed on P-v diagram by sketching constant temperature process lines. Sketch saturation curve and show all important points, lines and regions. [4]
4. State first law of thermodynamics for a power cycle and a refrigeration cycle. Write down general mass and energy conservation equations for a control volume and reduce them for a steady state process. [2+4]
5. Define entropy. State and explain second law of thermodynamics for an isolated system. [1+5]
6. Derive an expression for compression ratio for an internal combustion engine in terms of cylinder dimensions. Also explain how the thermal efficiency of an air standard otto cycle can be increased with respect to the cylinder dimensions. [6]
7. Derive expressions for overall heat transfer coefficients for a composite cylinder consisting of two layers and subjected to convection medium on outside of the composite cylinder only. [6]
8. A large chamber is separated into two compartments which are maintained at different pressure, as shown in figure below. Pressure gauge A reads 200kPa and pressure gauge B reads 120 kPa. If the barometric pressure is 100 kPa, determine the absolute pressure existing in the compartments and reading of gauge C. [6]



9. Water (1 kg) at 0.2 MPa is initially enclosed within a volume of 0.1 m^3 and the piston rest on stops as shown in figure below. The piston will move when the pressure is 1 MPa. A total heat transfer of 2500 kJ is added to the water. Determine the total work done and draw the P-V and T-V diagram. [8]



10. Air at 100 kPa and 130°C enters an adiabatic diffuser at a rate of 1.5 kg/s and leaves at a pressure of 150 kPa. The velocity of the air is decreased from 250 m/s to 50 m/s as it passes through the diffuser. Determine the exit temperature of the air and exit area of the diffuser. [8]

11. A cold storage is to be maintained at -5°C while the surroundings are at 40°C. The heat leakage from the surroundings into the cold storage is estimated to be 1.35 kW per degree temperature difference. The actual COP of the refrigeration plant is 75% of an ideal plant working between the same temperatures. Find the power required to drive the plant. [8]

12. A steam power plant works on Rankine cycle that operates between boiler pressure of 1.6 MPa and condenser pressure of 600 kPa. Steam leaves the boiler as saturated vapor. The mass flow rate of the steam is 40 kg/s. Determine: [8]

    a) the pump work and turbine work of the cycle, in kW,
    b) the heat transferred to boiler
    c) the efficiency of the cycle
    d) the efficiency of Carnot cycle working between same temperature limit

13. A hot room wall has made of 40 cm of brick on the outside, 12 cm of plastic foam and finally 2 cm of the fire clay on the inside. The inside and outside temperatures are 590°C and 220°C respectively. If inside and outside heat transfer coefficients are 56 W/m^2K and 6 W/m^2K and thermal conductivities of brick, foam and fire clay are 0.98 W/mK, 0.02 W/mK and 0.09 W/mK respectively. Determine: [6]

    a) rate of heat loss from the hot room if the total wall area is 100 m^2 and
    b) the temperature at the interface

***