

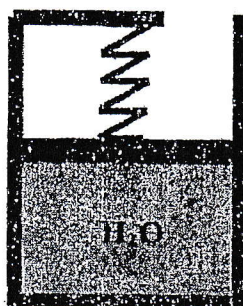
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

| Exam. | Regular / 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.
- ✓ Steam tables are attached herewith.
- ✓ Assume suitable data if necessary.

1. State and explain zeroth law of thermodynamics. Write down its application. [4]
2. Derive an expression for displacement of work transfer. [5]
3. Define the term saturation curve for two phase mixture, Quality and moisture content. [6]
4. Derive general energy conservation equation for control volume. [6]
5. Define reversible and irreversible process with reference to entropy. [3]
6. Sketch otto cycle on P-v and T-s diagram. Derive expression for its efficiency to relate to compression ratio. [6]
7. Explain mode of heat transfer with their types and specific differences with them. [6]
8. During operation of a lift, it can be subjected to a maximum gauge pressure of 500 kPa. If it is designed to lift a mass upto 900 kg, what should be diameter of piston-cylinder? [6]
9. A piston cylinder device with a linear spring initially contains water at a pressure of 4 MPa and 500°C with the initial volume being 0.1 m³, as shown in figure below. If the piston is at the bottom, the system pressure is 300 kPa. The system now cools until the pressure reaches 1000 kPa. Sketch the process on P-v diagram and determine [8]
 - a) the mass of H₂O
 - b) the final temperature and volume, and
 - c) the total work transfer



10. Air expands through an adiabatic turbine from 1100 kPa, 1000 K to 100 kPa, 100 K. The inlet velocity is 10 m/s and exit velocity is 100 m/s. The power output of turbine is 3600 kW. Determine mass flow rate of air and inlet and exit areas. [Take $r = 287 \text{ J/KgK}$, $C_p = 1005 \text{ J/KgK}$] [8]
11. Steam enters into a turbine at 2 MPa, 400°C with a velocity 200 m/sec and saturated vapour exits from turbine at 100 kPa with velocity 80 m/s. The power output of turbine is 800 kW, when mass flow rate is 1.5 kg/sec. Turbine rejects heat to surrounding at 300K. Determine rate at which entropy is generated within the turbine. [8]

{ $h_1 = 3247.5 \text{ kJ/kg}$, $s_1 = 7.1269 \text{ kJ/kg}$ }
12. An air standard diesel cycle has a compression ratio of 22 and expansion ratio of 11. Determine its cut off ratio and the efficiency. [6]
13. A hollow cylinder with inner and outer diameter of 8 cm and 12 cm respectively has an inner surface temperature of 200°C and the outer surface temperature of 50°C. If the thermal conductivity of the cylinder material is 60 W/mK, determine heat transfer from the unit length of the pipe. Also determine the temperature at the surface at a radial distance of 5 cm from the axis of the cylinder.