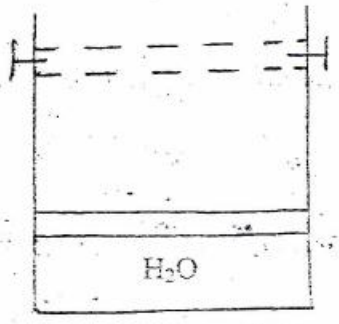
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, BME	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.*

1. Define these terms: (a) Quasi-equilibrium process (b) An open system (c) Thermodynamic equilibrium (d) Intensive property. [4]
2. Define stored and transient energies with examples. [2+2]
3. Define the terms saturated vapor, superheated vapor and critical point. Also derive an expression for specific volume of a two phase mixture in terms of quality. [3+3]
4. Derive unsteady state energy equation for an open system. Apply this equation to derive governing equations for the discharge of a gas from a cylinder. [6]
5. State and explain Kelvin-Planck and Clausius statement of second law of thermodynamics. Also prove their equivalence. [8]
6. Sketch the Brayton cycle on P-V and T-s diagrams and derive an expression for its efficiency in terms of pressure ratio. [6]
7. Derive an expression for inside overall heat transfer coefficient for a hollow cylinder subjected to convection on both sides. [6]
8. A cylinder with a frictionless piston contains $0.1m^3$ of gas at 200KPa pressure. The piston is connected to a coil spring, which exerts a force proportional to displacement from its equilibrium position. The gas is heated until the volume is doubled at which pressure is 500KPa. Determine the work done by the gas. Take atmospheric pressure equal to 100KPa. [4]
9. A piston cylinder arrangement shown in figure below contains 0.5kg of water initially at a pressure of 400KPa with a quality of 50%. The system is heated to a position where the piston is locked, and then cooled till it becomes a saturated vapor at a temperature of 60°C. Sketch the process on P-v and T-v diagrams and determine total work transfer. [8]



10. Steam enters a turbine operating at steady state with a mass flow rate of 4600kg/h. The turbine develops a power output of 1000kW. At the inlet, the pressure is 6000kPa, the temperature is 400°C, and the velocity is 10m/s. At the exit, the pressure is 100kPa, the quality is 0.9, and the velocity is 50m/s. Calculate the rate of heat transfer between the turbine and surroundings in kW? (Refer the attached table for properties of steam). [8]

11. A heat engine working on Carnot cycle converts one-fifth of the heat input into work. When the temperature of the sink is reduced by 80°C, the efficiency gets doubled. Make calculations for the temperature of source and sink. [6]

12. Determine the efficiency of an ideal Rankine cycle operating between boiler pressure of 1.6MPa and condenser pressure of 6KPa. Steam leaves the boiler as saturated vapor. [8]

13. An exterior wall of a house may be approximated by a 10cm layer of common brick [k=0.7W/m°C] followed by a layer of a 3.8cm layer of cement plaster [k=0.48W/m°C]. What thickness of loosely packed rock-wool insulation [k=0.065W/m°C] should be added reduce the heat loss (or gain) through the wall by 80 percent? [6]

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