04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division

2069 Chaitra

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 *(ME402)*

- ✓ 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. Write features of a thermodynamic property. Also differentiate between state function and path function with examples. [4]
2. Differentiate between heat and work. [4]
3. Define compressed liquid, degree of superheat, moisture content and saturated vapor. [4]
4. Define cyclic process State and explain first law of thermodynamics for a control mass undergoing a cyclic process. [6]
5. Explain the directional feature of the natural process with any one example. State the second of thermodynamics for an isolated system. Also explain the entropy generation. [6]
6. Sketch P-v and T-s diagram for a Brayton cycle. Also derive an expression for its efficiency in terms of pressure ratio. [6]
7. Derive expressions for inside overall heat transfer coefficient and outside overall heat transfer coefficient for a hollow tube subjected to convection medium on its both inner and outer surface. [6]
8. The Piston of a vertical Piston cylinder device containing as gas has a Mass of 50 kg and cross sectional area of $0.02m^2$, [6]
   i) Determine the pressure inside the cylinder.
   ii) During some process heat is lost by the gas to the surroundings and it's volume decreases to $\frac{3}{4}^{th}$ of the initial volume, determine it's final pressure. [Take Patm = 100 KPa and $g = 9.81\ M/s^2$]
9. A piston cylinder device shown in figure P.9 contains 0.2 Kg of a mixture of saturated liquid water and saturated water vapor at a temperature of 50°C and a volume of $0.03m^3$. The mass of the piston resting on the stops is 50 Kg and the cross sectional area of the piston is 12.2625 cm^2. The atmospheric pressure is 100 kPa. Heat is transferred until it becomes saturated vapor. Sketch the process on P-v and T-v diagrams and determine: [8]
   i) The final pressure, and
   ii) The total work transfer. [Take $g = 9.8\ ms^{-2}$] [Refer attached table for the properties of steam]

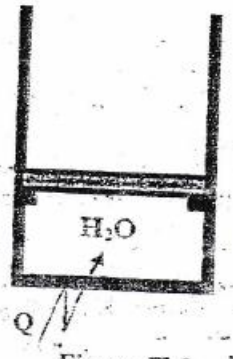

Figure P. 9

10. Air flows at a rate of 1.2 kg/s through a turbine entering at 500 kpa, 150°C; with a velocity of 120 m/s and leaving at 100 kpa, 25°C; with velocity of 60 m/s. Heat lost by the turbine to the surrounding is found to be 20 kJ/kg. Calculate the power developed by the turbine and diameter of inlet and enhast pipes. [Take R = 287 J/kg.k, and Cp = 100 SJ/kg.k] [8]

11. A heat Pump having COP of 5 maintains a building at a temperature of 24°C by supplying heat at a rate of 72000KJ/h, when the surroundings is at 0°C. The heat Pumps run 12 hours in a day and the electricity costs Rs 10/Kwh. [8]

    i) Determine the actual and minimum theoretical cost per day.
    ii) Compare the actual operating cost with the cost of direct electric resistance heating.

12. Steam at 2 MPa, 350°C is expanded in a steam turbine working on a Rankine cycle to 8 kPa. Determine the net work per kg of steam and the cycle efficiency assuming ideal processes. What will be the difference in efficiency if pump work is neglected? [Refer attached table for the properties of steam] [8]

13. A gas turbine blade is modeled as a flat plate. The thermal conductivity of the blade material is 15 W/mk and its thickness is 1.5 mm. The upper surface of the blade is exposed to hot gases at 1000°C and the lower surface is cooled by air bled of the compressor. The heat transfer coefficients at the upper and lower surfaces of the blade are 2500 W/m^2k and 1500 W/m^2k respectively. Under steady state conditions, the temperature, at the upper surface of the blade is measured as 850°C; determine the temperature of the coolant air. [6]

***