TRIBHUWAN UNIVERSITY
INSTITUTE OF ENGINEERING

Examination Control Division

2069 Chaitra

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

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

- ✓ Candidates are required to give their answer 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 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 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 an expression 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 $0.02 m^2$, [6]
   i) Determine the pressure inside the cylinder.
   ii) During some process heat is lost by the gas to the surroundings and its volume decreases $3/4^{th}$ to of the initial volume, determine its final pressure.
   [Take P_{atm} = 100 KPa and g = 9.81 M/s^2]
9. A piston cylinder device shown in figure P.9 contains 0.2 Kg of e mixture of saturated liquid water and saturated water vapor at a temperature of 50°C and a volume of $0.03 m^3$. 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·21 [Refer attached cable for the properties of steam]

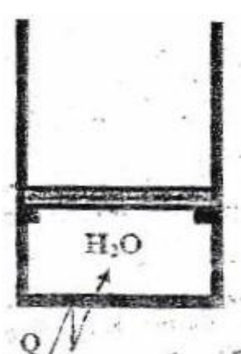

Figure P. 9

10. Air flows at a rate of 1.2 kg/s, through a turbine entering at 500kPa, 150°C; with a velocity of 120m/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/kgK, and Cp = 100 SJ/kgK] [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 gas 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^{2}K and 1500 W/m^{2}K 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]

***