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06ME33

Third Semester B.E. Degree Examination, June/July 2011
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions selecting at least TWO questions from part A and TWO questions from part B.***
2. Use of Thermodynamic Data Hand Book is allowed.

PART – A

1 a. Distinguish between following with an example for each.
   i) Intensive and Extensive property.
   ii) Point and path function.
   iii) Quasistatic and actual process. **(12 Marks)**

b. The temperature t on a Celsius scale is defined in terms of property p by the relation $p = e^{(t-B)/A}$, where A and B are constants. Experiments gives value of p of 1.86 and 6.81 at the ice and steam point respectively. Obtain relation for t and also find the temperature t for the reading of P = 2.5. **(08 Marks)**

2 a. Explain with an example how thermodynamic work id different to mechanics definition of work. **(06 Marks)**

b. What are the similarities and dissimilarities between heat and work? **(06 Marks)**

c. A system containing 5 kg of a substance is stirred with a torque of 1Nm at a speed of 500rpm for 24 hours. The system mean while expands from $1.5m^3$ to $2m^3$ against a constant pressure of 5 bar. Determine the magnitude and direction of net transfer. **(08 Marks)**

3 a. Show that energy is a property of the system. **(06 Marks)**

b. A closed rigid vessel containing 10kg of oxygen at 290K is supplied with heat until its pressure becomes two fold that of initial value. Identify the process and calculate the final temperature, change in internal energy, enthalpy and heat interaction across the system boundary. Take $C_v = 0.65$ kJ | Kg^0 K and R = 259.8 J/kg K. **(06 Marks)**

c. Air flows steadily at the rate of 0.5 kg/s through an air compressor entering at 7 m/s, with a pressure of 100 k Pa and a specific volume of 0.95 m^3/kg and leaving at 5 m/s, with a pressure of 700k Pa and specific volume of 0.19 m^3/kg. The internal energy of the air leaving of 90 KJ/kg greater than that of air entering. Cooling water in the compressor jackets absorbs heat from the air at a rate of 58 KW. Compute the rate of shaft work input to the air in KW and find the ratio of input to output pipe diameters. **(08 Marks)**

4 a. Why it is impossible to carry out the Carnot cycle in real engines? **(04 Marks)**

b. What is a Thermodynamic Temperature Scale and deduce the relation between Q and T as proposed by Lord Kelvin. **(06 Marks)**

c. There are three reservoiers at temperature of 827^0C 127^0C, and 27^0C in parallel. A reversible heat engine operates between 827^0C and 127^0 and a reversible refrigerator operates between 27^0C and 127^0C respectively, 502 kJ of heat are extracted from the reservoier at 827^0C by the heat engine and 251kJ of heat are absorbed by the refrigerator from the reservioer at 27^0C. Find the net amount of heat delivered to the reservoir at 127^0C. Can the heat engine drive the refrigerator and still deliver net amount of work? If so how much? **(10 Marks)**

PART – B

5 a. State and prove principle of increase in entropy? **(06 Marks)**

b. A heat engine is supplied with 278 kJ/s of heat at a constant fixed temperature of 283^{0}C and the heat rejections take place at 5^{0}C. The following results were reported.
i) 208 kJ/s of heat rejected. ii) 139 kJ/s of heat rejected. iii) 70 kJ/s of heat rejected.
Classify which of the results report a reversible cycle, irreversible cycle or impossible cycle. **(06 Marks)**

c. Ten grams of water at 20^{0}C is converted into ice at -10^{0}C at constant atmospheric pressure. Assuming specific heat of liquid water to remain constant at 4.184 J/g^{0}C and that of ice to be half of this value, and taking the latent heat of fusion of ice at 0^{0}C to be 335 J/g, Calculate the total entropy change of the system. **(08 Marks)**

6 a. Define availability and show that availability for a closed system is equals to $To(S_0-S_1) - (U_0 - U_1) - P_0 (V_0 - V_1)$ when U, S and V are the internal energy, entropy and volume of system and U_0, S_0 & V_0 are their final values when the system comes to equilibrium with its environment. **(08 Marks)**

b. A closed system contains 2 kg of air during an adiabatic expansion process and there occurs a change in its pressure from 500 k Pa to 1000 k Pa and in its temperature from 350 k to 320k. If the volume-doubles during the process, make calculations for maximum work, the change in availability and irreversibility. Take for air C_V = 0.718 kJ/kg K and R = 0.287 kJ/kg K. The surrounding conditions are 100 K pa and 300 K. **(12 Marks)**

7 a. With a neat sketch brief the working of a Throttling calorimeter to determine the quality of steam. **(08 Marks)**

b. Draw the phase equilibrium diagram for water on P – T coordinates, indicating triple and critical point. **(06 Marks)**

c. A rigid vessel having a volume of 0.01m^3 contains 4.5 kg of water at 35^{0}C. Calculate the quality of the mixture and masses of liquid and vapour. **(06 Marks)**

8 a. For an Ideal gas prove PV^r = constant, for a system undergoing a reversible adiabatic process. **(08 Marks)**

b. What are law of corresponding states? And compressibility chart? **(06 Marks)**

c. 1.25 m^3 of air at 180^{0}C at 8 bar is undergoing a constant pressure until the volume is doubled. Determine the change in entropy and enthalpy of air. **(06 Marks)**

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