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10ME/AU33

Third Semester B.E. Degree Examination, Jan./Feb.2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of thermodynamics data hand book is permitted.***
3. ***Assume any missing data suitably, if any.***

PART – A

1 a. Distinguish between
(i) Point function and path function (ii) Microscopic and macroscopic approaches. **(08 Marks)**

b. The emf in a thermocouple with test junction at t˚C on gas thermometer scale and reference junction at ice point is given by, $\varepsilon = 0.20t - 5\times10^{-4}t^2$ mV. The millivoltmeter is calibrated at ice (0˚C) and steam (100˚C) points. What will this thermometer read in a place where the gas thermometer reads 60˚C. **(06 Marks)**

c. The temperature t on a thermometric scale is defined in terms of a property 'K' by the relation $t = a\ln k + b$ where a and b are constants. The value of K are found to be 1.83 and 6.78 at the ice point and steam point, the temperatures of which are assigned the number 0 to 100 respectively. Determine the temperature corresponding to a reading of K = 2.42 on the thermometer. **(06 Marks)**

2 a. Distinguish between : (i) Mechanical work and thermodynamic work.
(ii) Heat and work. **(06 Marks)**

b. Derive an expression for work for the following process $PV^n = \text{constant}$. **(06 Marks)**

c. A mass of gas is compressed in a quasi-static process from 80 kPa, 0.1 m^3 to 0.4 MPa, 0.03 m^3. Assuming that the pressure and volume are related by $PV^n = \text{constant}$, find the work done by the gas system. **(08 Marks)**

3 a. State the first law, (i) for a closed system undergoing a cycle (ii) for a closed system undergoing a change of state. **(04 Marks)**

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

c. The properties of a certain fluid are related as follows :
$u = 196 + 0.718t$
$PV = 0.287(t + 273)$
where u is the specific internal energy (kJ/kg), t is in ˚C, P is pressure (kN/m^2) and V is specific volume (m^3/kg). For this fluid find C_p and C_V. **(10 Marks)**

4 a. Explain PMM I and PMM II with diagrams. **(04 Marks)**

b. Sketch P-V and T-S diagrams indicating all processes for Carnot cycle. **(06 Marks)**

c. A house hold refrigerator is maintained at a temperature of 2˚C. Every time the door is opened, warm material is placed inside, introducing an average of 420 kJ, but making only a small change in the temperature of the refrigerator. The door is opened 20 times a day, and the refrigerator operates at 15% of the ideal COP. The cost of work is 32 paise per kWh. What is the monthly bill for this refrigerator? The atmosphere is at 30˚C (consider 30 days in a month). **(10 Marks)**

PART – B

5 a. State and prove Inequality of Clausius. Mention its significance. **(08 Marks)**

b. One kg of water at 273 K is brought into contact with a heat reservoir at 373 K. When the water has reached 373 K, find the entropy change of the water, of the reservoir and of the universe. **(08 Marks)**

c. Explain principle of increase of entropy. **(04 Marks)**

6 a. Define the following:
   (i) Subcooled liquid.
   (ii) Triple point.
   (iii) Critical point. **(06 Marks)**

b. Explain Throttling calorimeter. **(06 Marks)**

c. A vessel of 0.045 m^3 contains a mixture of saturated water and saturated steam at a temperature of 280˚C. The mass of the liquid present is 8 kg. Find the mass the specific volume, the enthalpy, the entropy and the internal energy. Properties at 280˚ are as below:
P_{sat} = 64.202 bar, V_f = 0.0013324 m^3/kg V_g = 0.030126 m^3/kg ,
h_f= 1236.8 kJ/kg, h_{fg} = 1543.6 kJ/kg, S_f= 3.0683 kJ/kg K
S_{fg} = 2.7903 kJ/kgK **(08 Marks)**

7 a. Express the changes in internal energy and enthalpy of an ideal gas in a reversible adiabatic process in terms of the pressure ratio. **(12 Marks)**

b. A certain gas has C_p = 1.9 and C_V = 1.5 kJ/kgK. Find its molecular weight and the gas constant. A constant volume chamber of 0.3 m^3 capacity contains 2 kg of this gas at 8˚C. Heat is transferred to the gas until the temperature is 108˚C. Find the work done, the heat transferred and the changes in internal energy, enthalpy and entropy. **(08 Marks)**

8 a. State the following and write mathematical expressions :
   (i) Dalton's law of partial pressures.
   (ii) Amagat law of additive volumes.
   (iii) Law of corresponding states. **(12 Marks)**

b. Write short notes on:
   (i) Real gases.
   (ii) Compressibility chart. **(08 Marks)**

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