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10ME/AU33

Third Semester B.E. Degree Examination, June/July 2016
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 thermodynamic charts and Tables is permitted.

PART – A

1 a. Distinguish between :
   i) Macroscopic and Microscopic approaches
   ii) Diathermic and adiabatic walls
   iii) Intensive and extensive properties
   iv) Thermal equilibrium and Mechanical equilibrium
   v) Quasistatic and actual process
   vi) Point function and path function. **(12 Marks)**

b. The readings t_A and t_B of two Celsius thermometers A and B agree at the ice point (0°C) and steam point (100°C), but else where they are related by the equation $t_A = L + mt_B + nt_B^2$ where ℓ, m and n are constants, when both the thermometers are immersed in a well stirred bath, A registers 51°C whereas B registers 50°C. Determine the reading on B when A registers 25°C. **(08 Marks)**

2 a. Starting from a common stage point, draw the following process on the PV – plane and derive an expression for the work done in each case
   i) Isobaric process
   ii) Isothermal process
   iii) Polytropic process. **(09 Marks)**

b. Distinguish between heat and work in thermodynamics. **(04 Marks)**

c. A spherical balloon has an initial diameter of 25cm and contains air at 1.2 bar. Because of heating the diameter of the balloon increases to 30cm and during the heating process the pressure is found to be proportional to the diameter. Calculate the work done during the process. **(07 Marks)**

3 a. State First Law of Thermodynamics for a process and show that energy is a property of the system. **(06 Marks)**

b. Derive the steady flow energy equation for a single stream of fluid entering and a single stream of fluid leaving the control volume. **(06 Marks)**

c. The following expression gives the specific heat at constant pressure of a gas that undergoes a non flow constant pressure process $c_p = \left[2.5 + \frac{60}{T+40}\right] kJ/kg\ K$, where T is in °C. The pressure during the process is maintained at 2 bar and the volume changes from 0.3 to 0.56 m^3/kg. The corresponding change in temperature is from 25°C to 300°C. Determine
   i) Work done and heat added
   ii) Change in internal energy and enthalpy. **(08 Marks)**

4 a. State and prove that Kelvin Planck and clausius statements of second Law of Thermodynamics are equivalent. **(12 Marks)**

b. A heat engine working on Carnot cycle absorbs heat from three thermal reservoirs at 1000K, 800K and 600K. The engine does 10kW of network and rejects 400kJ/min of heat to a heat sink at 300K. If the heat supplied by the reservoir at 1000K is 60% of the heat supplied by the reservoir at 600K. Make calculations for the quantity of heat absorbed by each reservoir. **(08 Marks)**

PART – B

5 a. State and prove Clausius inequality. **(08 Marks)**

b. Show that entropy of an isolated system either increases or in the limit remains constant. **(06 Marks)**

c. A lump of steel of mass 8kg at 1000K is dropped in 80kg of oil at 300K. Make calculations for the entropy change of steel, the oil and the universe. Take specific heats of steel and oil as 0.5kJ/Kg K and 3.5 kJ/kg K respectively. **(06 Marks)**

6 a. With a neat sketch explain the measurement of dryness fraction of steam by using throttling calorimeter. Also indicate throttling process on TS and HS diagram. **(08 Marks)**

b. A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 240°C. The mass of the liquid present is 8kg. find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy. **(10 Marks)**

c. Define the following :
i) Pure substance ii) Critical point. **(02 Marks)**

7 a. Explain the following :
i) Maxwell's relations
ii) Clausius – Clapeyron equation. **(10 Marks)**

b. 1kg of air undergoes a cyclic process comprising three process 1 – 2 , 2 – 3, and 3 – 1. At state 1, the pressure and temperature are 1MPa and 27°C. 1 – 2 is an constant pressure process, 2 – 3 is adiabatic process and 3 – 1 is a isothermal process. At state 3, P = 100KPa.
i) Sketch the cycle on PV – Coordinates
ii) Find the heat and work interactions in each the three processes and the net work per cycle
iii) Analyse quantitatively whether the cycle is reversible or Irreversible. **(10 Marks)**

8 a. Explain the following :
i) Compressibility Factor
ii) Vander Waals equation of state
iii) Law of corresponding states
iv) Compressibility chart. **(08 Marks)**

b. State Gibb's Dalton Law of partial pressures and hence derive an expression for the gas constant 'R' of a mixture of gases. **(06 Marks)**

c. A mixture of ideal gases consists of 3kg of nitrogen and 54 kg of carbon dioxide at a pressure of 300KPa and a temperature of 20°C Find
i) Mole fraction of each constituent
ii) The equivalent molecular weight of mixture
iii) The equivalent gas constant of the mixture
iv) The partial pressure of each gas. **(06 Marks)**

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