Ds Deepak Sharma MSD

1/5/2023 (M) Roll No. _____ 214

National Institute of Technology Hamirpur (H.P.)

B.Tech. End-Semester Examination, May 2023

Branch	:	Physics & Photonic Science	**Course Code**	:	PH-224
Semester	:	4th	**Time**	:	3 Hrs
Course Name	:	Engineering Thermodynamics	**Max. Marks**	:	50

NOTE: Attempt all questions which carry marks as indicated in the [ ]. Assume suitable data if missing.

Q-1. (a) What is Gibbs Phase Rule? Explain the term phase & component with suitable example. **[4]**

(b) Explain phase diagram in detail with various terminology (like critical temperature, critical pressure, saturation state, triple point, sublimation, ablimation etc.) **[4]**

(c) Derive that the Gibbs free energy is thermodynamic potential for isothermal isobaric transformation. **[4]**

Q-2. How real gases differ from ideal gases? Derive the vander wall equation and find out the value of critical constants. Also derive the reduced equation of state. **[2+4+2]**

Q-3. What is Transport phenomena? Explain viscosity and derive the equation for coefficient of viscosity. What is the effect of pressure & temperature on it? **[2+4+2]**

Q-4. Derive all the four thermodynamic Maxwell's relations. **[8]**

Q-5. Two Carnot refrigerators A and B are arranged in series. Workout the following expression for COP of the composite system **[2×4]**

$$COP = \frac{COP_A \times COP_B}{1 + COP_A + COP_B}$$

Where COPA is the coefficient of performance of refrigerator A and COPB is the coefficient of performance of refrigerator B.

A Carnot refrigerator absorbs 250 kJ of heat from a reservoir at 150 K and rejects heat to a reservoir at 450 K. This heat serves as the energy input to a second Carnot refrigerator which operates between 450 K and 1500 K. Determine the coefficient of performance of **(a)** the cold refrigerator **(b)** the hotter refrigerator and **(c)** the composite system. Verify the answer of part (c) with the relation established above.

Q-6. An iron cube at a temperature of 400°C is dropped into an insulated bath containing 10 kg water at 25°C. The water finally reaches a temperature of 50°C at steady state. Given that the specific heat of water is equal to 4186 J/kg K. Find the entropy changes for the iron cube and the water. Is the process reversible? If so why ? **[6]**