14/12/2024 CHEMICAL SEM-III C SCHEME CET-I QP CODE: 10065070

Time: 3 Hours **Total Marks: 80**

N.B.:

(i) Question No.1. is compulsory.
(ii) Attempt any three questions out of remaining five questions.
(iii) Assume suitable data and justify the same.
(iv) Figures to the right indicate full marks.

Q.1] Solve **any four** of the following: **20**

a) Explain the H-S (Mollier) diagram.
b) Write the Carnot Principles. A heat engine operates between a heat source at 700 K and a heat sink at 300 K. What is the maximum efficiency of the engine?
c) Using Van der Waals equation of state derive the relation for the Virial coefficients.
d) Discuss the applications of Exergy.
e) Discuss the applications of Thermodynamics to turbines (expanders).
f) Explain the first law of thermodynamics for non-flow process.

Q.2] a) Derive the relation of joule Thomson coefficient for Van der Waals gas and find the relation for inversion temperature and inversion pressure. **10**

b) Discuss the Heat Engine, Heat Pump and Refrigerator. **10**

Q.3] a) An inventor claims to have designed a heat engine which absorbs 1000 kJ and 400 kJ energy as heat from the reservoirs at 800 K and 400 K respectively, and delivers 1000 kJ energy as work. He also claims that engine uses a reservoir at 300 K as the sink. Judge whether the engine is theoretically possible or not. **10**

b) Derive the relation for enthalpy and entropy departure using Van der Waals equation of state. **10**

Q.4] a) An ideal gas undergoes the following sequence of mechanically reversible processes in a closed system: **10**
(a) From an initial state of 70 °C and 1 bar, it is compressed adiabatically to 150 °C.
(b) It is then cooled from 150 °C to 70 °C at constant pressure.
(c) Finally it is expanded isothermally to its original state.
Calculate the ΔU, ΔH, Q and W for each of the three processes and for the entire cycle.
Given:
$C_v = \frac{3}{2}R$ and $C_p = \frac{5}{2}R$

b) Discuss the thermodynamic properties. Derive the Maxwell equations. **10**

Q.5] a) A 40 kg steel casting (CP = 0.5 $kJ \cdot kg^{-1} \cdot K^{-1}$) at a temperature of 450°C is quenched in 150 kg of oil (CP = 2.5 $kJ \cdot kg^{-1} \cdot K^{-1}$) at 25°C. If there are no heat losses, what is the change in entropy of (a) the casting, (b) the oil, and (c) both considered together? **10**

b) Derive the equation for first Law of Thermodynamics for flow processes. **10**

Q.6] a) Derive the formulae for Van der Waals constants a and b. **10**

b) Air at 1 bar and 25°C enters a compressor at very low velocity, discharges at 3 bar, and enters a nozzle in which it expands to a final velocity of 600 $m \cdot s^{-1}$ at the initial conditions of pressure and temperature. If the work of compression is 240 kJ per kilogram of air, how much heat must be removed during compression? **10**
Assumptions: 1) Negligible initial kinetic energy of the air. 2) Negligible potential-energy change. 3) Overall no change in enthalpy of the air.
