

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.

1. (a) What is enthalpy of a system? How it is related to internal energy? 20
(b) State Carnot principle.
(c) What is the principle of corresponding states?
(d) Explain P-H diagram.
2. One mole of Nitrogen at 3 MPa and 800K follows the following changes: 20
(i) Expand Isothermally to 5 MPa
(ii) Cooled at a constant volume to 600K
(iii) Cooled at constant pressure to 400 K
(iv) Compressed adiabatically to 3 MPa
(v) Heated at constant pressure to 800 K

Calculate the W, Q, ΔH , ΔU for each step, and the entire process.

Data: $C_p = 3.5 R \text{ J}/(\text{mol.K})$ and $C_v = 2.5 R \text{ J}/(\text{mol.K})$

3. (a) An inventor claims to have designed a heat engine which absorbs 260 kJ of energy as heat from a reservoir at 52°C and delivers 72 kJ work. He also states that the engine rejects 100 kJ and 88 kJ of energy to the reservoirs at 27°C and 2°C, respectively. Judge whether the claim is acceptable or not. 10
- (b) A reversible heat engine operates with three reservoirs at 300K, 400K and 1200K. It absorbs 1200kJ energy as heat from the reservoir at 1200K and delivers 400kJ work. Determine the heat interaction with other two reservoirs. 10
4. (a) The coefficients of pressure explicit form & volume explicit form of Virial equation of state are related. Derive the relations between them (upto B and B', C and C'). 10
- (b) Estimate the molar volume of methanol vapor at 500 K and 10 bar using van der Waal equation of state. 10
Data: $T_c = 512.6 \text{ K}$ and $P_c = 81 \text{ bar}$

5. (a) Derive Maxwell Relations. What are its significance? 10
- (b) Calculate the residual enthalpy and residual entropy for n-butane at 800 kPa and 600 K using the van der Waals equation of state. 10
- Data:
 $T_c = 425.2 \text{ K}$, $P_c = 3797 \text{ kPa}$
6. Write short notes on any four of the following: 20
- (a) Cyclic process
 - (b) Exergy
 - (c) Reduced equation of state
 - (d) Fugacity and fugacity coefficient
 - (e) Joule Thomson coefficient
