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Total number of printed pages – 2

B. Tech  
PCCH 4401

**Seventh Semester Back Examination – 2014**  
**CHEMICAL ENGINEERING THERMODYNAMICS**

**BRANCH : CHEM**

**QUESTION CODE : L 143**

**Full Marks – 70**

**Time : 3 Hours**

*Answer Question No. 1 which is compulsory and any **five** from the rest.*

*The figures in the right-hand margin indicate marks.*

*Assume suitable notations and any missing data wherever necessary.*

*Answer all parts of a question at a place.*

1. Answer the following questions : 2×10
- Differentiate between extensive and intensive properties.
  - What do you understand by supercritical fluid ? Give one example.
  - Define volume expansivity and isothermal compressibility.
  - What is a polytropic process ? Draw the paths of polytropic processes.
  - What is an isentropic process ?
  - State and explain chemical potential.
  - Based on the ideal-gas mixture model, write the basis for Gibbs's theorem.
  - Define fugacity and fugacity coefficient.
  - Air is not used for making soda. Explain on the basis of Henry's law.
  - What do you understand by multi-reaction coordinate ?
2. Discuss in detail the PVT behavior of pure substances with suitable diagrams. 10
3. A tank containing 25 kg of water at 295.15 K is fitted with a stirrer that delivers work to the water at the rate of 0.30 kW. How long does it take for the temperature of the water to rise to 305.15 K if no heat is lost from the water ? For water,  $C_p = 4.18 \text{ kJ kg}^{-1}\text{C}^{-1}$ . 10

P.T.O.

4. Write short notes on : 5+5
- (a) Heat engines
- (b) Carnot's equations.
5. With suitable diagrams explain simple models for VLE. 10
6. One mole of an ideal gas with  $C_p = (7/2)R$  and  $C_v = (5/2)R$  expands from  $P_1 = 10$  bar and  $T_1 = 580$  K to  $P_2 = 2$  bar by each of the following paths :
- (i) Constant volume;
- (ii) Constant temperature; and
- (iii) Adiabatically.
- Assuming mechanical reversibility, calculate  $W$ ,  $Q$ ,  $\Delta U$ , and  $\Delta H$  for each process. Sketch each path on a single P-V diagram. 10
7. (a) Write the nature of excess properties. 5
- (b) Develop an expression for the mole fractions of reacting species as functions of the reaction coordinate for a system initially containing 3 mol  $\text{NO}_2$ , 4 mol  $\text{NH}_3$ , and 1 mol  $\text{N}_2$  and undergoing the reaction : 5
- $$6\text{NO}_2(\text{g}) + 8\text{NH}_3(\text{g}) \rightarrow 7\text{N}_2(\text{g}) + 12\text{H}_2\text{O}(\text{g})$$
8. Write short notes on any **two** : 5×2
- (a) Virial equations of state
- (b) Theorem of corresponding states
- (c) The ideal-gas mixture model
- (d) Gibbs's theorem.

