



**K. K. Wagh Institute of Engineering Education & Research, Nashik**  
(An Autonomous Institute From A.Y. 2022-23)

SUMMER-2024	
Exam Seat No.:	
Academic Year: 2023-2024	Semester: IV
Class: SY	Program: B.Tech
Branch Code: CHE	Pattern: 2022
Name of Course: Thermodynamics	Course Code: CHE222014
Max. Marks: 60	Duration: 2.30 Hrs.

**Instructions:** Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 2 page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

**Question No. 1 Attempt following Question**

- 1a) What is First Law of Thermodynamics. Derive the mathematical expression of the First Law of Thermodynamics for a steady state flow process. (6) CO1

**Question No. 2 Attempt following Question**

- 2a) Show that for adiabatic process,  $TV^{\gamma-1} = \text{Constant}$ . (6) CO2

**Question No. 3 Attempt following Question**

- 3a) Derive the following expression for Partial Molar Properties (8) CO3

$$M^t = \sum_i n_i \cdot \bar{M}_i$$

**OR**

- 3b) Derive the Lewis Randall Rule. (8) CO3

- 3c) Discuss the Gibbs-Duhem equation in terms of fugacity. (8) CO3

**OR**

- 3d) The partial molar volume of acetone and chloroform in an acetone-chloroform mixture containing 53.07 mole% acetone are  $74.166 \times 10^{-6} \text{ m}^3/\text{mol}$  and  $80.235 \times 10^{-6} \text{ m}^3/\text{mol}$ , respectively. Find the volume of 1 kg of acetone-chloroform solution. (8) CO3

**Question No. 4 Attempt following Question**

- 4a) How would you state the criteria of thermodynamic equilibrium in terms of entropy and Gibbs free energy? (8) CO4

**OR**

4b) Derive the phase rule for non-reacting system with necessary equation. (8) CO4

4c) Discuss the Boiling point diagram in detail. (8) CO4

**OR**

4d) The composition of the system ether (1) - acetone (2) at 313 K and  $10^5$  Pa is  $x_1 = 0.30$ ,  $y_1 = 0.42$ . (8) CO4  
The vapor pressure of pure ether (1) and acetone (2) at 313 K are  $1.21 \times 10^5$  Pa and  $0.56 \times 10^5$  Pa, respectively. The vapor phase can be assumed ideal.

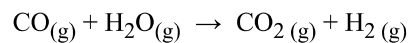
Calculate the liquid phase activity coefficient and excess Gibbs free energy,  $G^E/RT$  for the liquid phase.

**Question No. 5 Attempt following Question**

5a) Derive the expression for reaction equilibrium constant  $K = K_f = K_\phi \cdot K_p$ . (8) CO5

**OR**

5b) A gas mixture containing 1 mol CO, 1 mol steam and 1 mol  $\text{CO}_2$  is undergoing following reaction (8) CO5  
at a temperature of 1100K and a pressure of 1 bar.

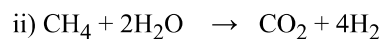
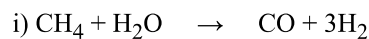


The equilibrium constant for the reaction is  $K = 1$ . Calculate the fractional dissociation of steam assuming that the gas mixture behaves ideally.

5c) Develop the relationship between equilibrium constant, standard free energy change and temperature. (8) CO5

**OR**

5d) The following gas phase reaction occurs in a mixture initially containing 2 mol ethane and 3 mol steam. (8) CO5



Derive expression for the mole fraction of the components present in the reaction mixture in terms of the extent of reaction.

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