B **514B4** **Total pages: 2**

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SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH DEGREE EXAMINATION(R,S), MAY 2024

Chemical Engineering

(2020 SCHEME)

Course Code : 20CHT202

Course Name : Chemical Engineering Thermodynamics

Max. Marks : 100 **Duration:3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Explain Carnot Principle.
2. What is zeroth law of thermodynamics?
3. With the use of a neat P-T diagram, explain the behaviour of a pure material.
4. What is the difference between vapour and gas?
5. Define excess properties in solutions.
6. Write the definition of activity coefficient.
7. Differentiate between a binary solution and an ideal solution. Briefly describe positive and negative deviations from ideal behavior in a vapor-liquid equilibrium (VLE) diagram.
8. What is free energy change of mixing and its partial derivatives in a stable liquid phases?
9. Define the term "extent of reaction" and explain how it relates to the equilibrium constant K.
10. Define the simultaneous equations and its reaction rates.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Define closed system and open system in thermodynamics. 7
    b) Differentiate between intensive and extensive properties of a system with suitable examples. 7

OR

12. a) Define specific heat at constant pressure Cp , specific heat at constant volume Cv. 7
    b) Prove that Cp is greater than Cv. 7

MODULE II

13. a) Relate the internal energy (U) of a system to its heat capacity at constant volume (Cv) using a mathematical equation. 7
    b) Enthalpy (H) is a thermodynamic property. How is it related to internal energy (U) and pressure (P) using an equation? 7

OR

14. a) How does the Joule-Thomson coefficient relate to the change in Gibbs free energy predicted by the Gibbs-Helmholtz equation? 7

b) Can the Joule-Thomson coefficient be used to determine the conditions under which a process will be spontaneous according to the Gibbs-Helmholtz equation? 7

MODULE III

15. a) How does the concept of free energy relate to the stability of a particular phase? 7
b) How can changes in pressure or temperature affect the stability of different phases in a system? 7

OR

16. Derive an equation for the determination of fugacity coefficient. 14

MODULE IV

17. a) Derive an equation for K in terms of pressure and fugacity coefficients. Explain the concept of vaporization equilibrium constant (K) and its relationship to VLE. 10
b) What is meant by bubble point and dew point ? 4

OR

18. a) Compare and contrast the NRTL, UNIQUAC, and UNIFAC models for activity coefficient prediction in non-ideal solutions. 7
b) Sketch phase diagrams for VLE in partially miscible and immiscible binary systems. 7

MODULE V

19. a) Describe two methods for evaluating the equilibrium constant of a reaction. 7
b) In a gas-phase reaction, how does the initial pressure of the reactants affect the equilibrium conversion (percentage of reaction completion)? 7

OR

20. a) Derive the relationship between the equilibrium constant (K) and the standard free energy change (ΔG°) for a chemical reaction. 7
b) A closed system contains an equilibrium mixture of N_2O_4 (g) and NO_2 (g) according to the reaction: N_2O_4 (g) $\rightleftharpoons$ $2NO_2$ (g). How would adding inert Helium gas at constant volume affect the equilibrium? 7

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