Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH DEGREE EXAMINATION (R), MAY 2023
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. With suitable examples, explain path functions and state functions.
2. Give the limitations of first law of thermodynamics.
3. Write Redlich Kwong equation and give its significance.
4. What is Clausius Clapeyron Equation? What is its importance in thermodynamics?
5. State Lewis Randall rule with relevant equations.
6. Define activity and activity coefficient.
7. Distinguish between bubble point and dew point.
8. Explain Duhem's theorem.
9. Define extent of reaction and conversion.
10. Give the criterion of chemical reaction equilibria.

PART B

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

MODULE I

11. An ideal gas is undergoing a series of three operations: The gas is heated at constant volume from 400 K and 2 bar to a pressure of 4 bar. It is then expanded in a reversible adiabatic process to a pressure of 2 bar. Further it is cooled at a constant pressure of 2 bar to 400K. Determine the heat and work effects for each step. Assume C_P = 29.3 kJ/kmolK (14)

OR

12. a) State third law of thermodynamics. Explain how increase in entropy can be used as measure of irreversibility of the process. (7)

    b) Using the schematic diagram of constant volume thermometer, explain the concept of Ideal gas temperature scale. (7)

MODULE II

13. a) 1 Kmol of CO_2 occupies 0.4 m^3 at 313 K. Compare the pressures given by Ideal gas equation and van der Waals equation. Given van der Waals constants are a = 0.365 Nm^4/mol^2 and b = 4.28 x 10^{-5} m^3/mol. (7)

b) State the principle of corresponding states and give the significance of generalized compressibility chart. (7)

OR

14. a) Define fugacity and show that fugacity and pressure are identical for ideal gases. (6)

b) Explain the phase change curves, triple point and critical point of a pure metal using Pressure-Temperature diagram. (8)

MODULE III

15. Prove that if Raoult's law is valid for one constituent of a binary solution over the entire concentration range, it must also apply to the other constituent. (14)

OR

16. Explain the effect of temperature and pressure on activity coefficient. (14)

MODULE IV

17. Water (Component 1) – Hydrazine (Component 2) system forms an azeotrope containing 60% (mol) hydrazine at 393 K and 101.3 kPa. Calculate the equilibrium vapour composition for a solution containing 30% (mol) hydrazine. The relative volatility of water with reference to hydrazine is 1.6 and may be assumed to remain constant in the temperature range involved. The vapour pressure of hydrazine at 393 K is 124.76 kPa (14)

OR

18. What are azeotropes? With relevant phase diagrams, distinguish between minimum and maximum boiling azeotropes. (14)

MODULE V

19. a) Define equilibrium constant K for a chemical reaction. (4)

b) For a general chemical reaction, derive the expression of standard free energy related to equilibrium constant K. (10)

OR

20. a) The standard heat of formation and standard free energy of formation of ammonia at 298K are - 46,100 J/mol and -16,500 J/mol respectively. Calculate the equilibrium constant for the following reaction at 500 K assuming that the standard heat of the reaction is constant in the temperature range 298K to 500K. (7)

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

b) Derive vant Hoff's equation and give its significance in chemical reaction equilibrium. (7)

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