Q. Code: 302495

M.E. / M.TECH. DEGREE EXAMINATIONS, DEC 2020 (Held during April, 2021)

First Semester

CL18101- Advanced Thermodynamics for Chemical Engineers

(Chemical Engineering)

(Regulation 2018)

Time: Three Hours **Maximum : 80 Marks**

Answer **ALL** questions

PART A - (8 X 2 = 16 Marks)

1. Pick out the correct statement.
   A. Entropy and enthalpy are path functions
   B. In a closed system, the energy can be exchanged with the surrounding, while matter cannot be exchanged
   C. All the natural processes are reversible in nature
   D. Work is a state function
2. __________ does not change during phase transformation when substance changes directly from solid to a gas phase without going through the liquid phase.
   A.Entropy B. Gibbs free energy C. Internal energy D. All (a), (b) & (c)
3. Locate degree of freedom for the point on a phase diagram at which gas, liquid and solid coexists
   A. 0 B. 1 C. 2 D. 3
4. Entropy of an ideal gas depends upon its
   A. Pressure B. temperature C. both (1) & (2) D. neither (1) nor (2)
5. Why does the boiling point diagram at a higher pressure lie above that at a lower pressure?
6. At the constant values of pressure and temperature of interest, which property will define the stable state of the system.
7. According to van der Waals, write the principle of corresponding states.
8. Give the expression for the total energy of a multicomponent stream.

PART B - (4 X16 = 64 Marks)

9. (a) The molal heat capacity of nitrogen at 1 bar is given as $C_P= 23.4X10^{-3}T$ Where T is in K and C_P is in J/mol.K. For one mole of nitrogen at 733K and 100 bar assuming that nitrogen acts as an ideal gas and enthalpy of nitrogen is zero at 273 K and 1 bar. The entropy of nitrogen is 192.4 J/mol.K at 298K and 1 bar. Find the internal energy, enthalpy, entropy and free energy of the system . **(16)**

(OR)

(b) (i) An ideal gas law obeys by one mole of gas, Where R is 8.314 J/mole.k is initially at 350K and 0.2 mega Pascal. The gas is heated at a constant volume till the pressure rises to 0.6 mega Pascal and it is allowed to expand at constant temperature till the pressure reduces to 0.1 mega Pascal. Finally, the gas is **(10)** returned to its original state by compressing at constant pressure. Calculate the work done by the gas.

(ii) Examine about Legendre transformation and write its applications. **(6)**

10 (a) (i) Verify whether the following data are consistence **(12)**

x_1	0	0.2	0.4	0.6	0.8	1
γ_1	0.576	0.655	0.748	0.856	0.950	1.000
γ_2	1.000	0.985	0.930	0.814	0.626	0.379

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(ii) Indicate few applications of Le-Chatliers principle. **(4)**

(OR)

(b) One mole steam undergoes the water-gas shift reaction at a temperature of 1100K and pressure of 1 bar **(16)**

$CO (g) + H_2O (g) \longrightarrow CO_2 (g) + H_2 (g)$

The equilibrium constant for the reaction is K=1. Assuming ideal gas behaviour, calculate the fractional dissociation of steam in the following cases and discuss the effect of the presence of excess reactant on the extent of reaction

i) CO supplied is 80% in excess of the stoichiometric requirement

ii) CO supplied is only 30 % of the theoretical requirement

11. (a) (i) Discuss the Gibbs–Duhem equation and its various forms. What are the major fields of application of the Gibb's Duhem equations? **(8)**

(ii) The partial molar volume of ethanol in a 70 mole %, ethanol-water solution is 67.5 x 10^{-6} m^3. The density of the mixture is 849.4 kg/m^3. Calculate the partial molar volume of water in the mixture. **(8)**

(OR)

(b) For the binary system methanol (1) and benzene (2), the recommended values of the Wilson parameters at 341 K are L12 = 0.1751 and L21 = 0.3456. The vapour pressures of pure species are 68.75 kPa and 115.89 kPa respectively. Show that the given system can form an azeotrope at 341 K. Assume that the vapour behaves like an ideal gas. **(16)**

12. (a) With the help of proper phase diagrams, discuss and distinguish between minimum and maximum boiling azeotropes and specify the effect of pressure on the azeotropic composition? **(16)**

(OR)

(b) (i) Analyse the procedure with neat diagrams to estimate the composition of the vapour phase in equilibrium with two immiscible liquid phases. **(10)**

(ii) Gibbs–Duhem equations are helpful in testing the consistency of the VLE data. Justify. **(6)**