B.E/B.TECH. Degree Examination, December 2020

Fourth Semester

BT16402 –Applied Thermodynamics for Biotechnologists

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. What are the limitations of second law of thermodynamics?
2. Ideal gas law is applicable at

   A. Low T, low P B. High T, high P C. Low T, high P D. High T, low P
3. What is Clausius-Clapeyron equation?
4. A gas mixture of three components is brought in contact with a dispersion of an organic phase in water. The degrees of freedom of the system are

   A. 4 B. 3 C. 5 D. 6
5. State Henry's law.
6. For evaluation of heat effects, all thermodynamic equations can be treated as algebraic equations. This is a consequence of

   A. Le Chatlier's principle B. Third law of thermodynamics C. Hess's law

   D. Principle of Corresponding states
7. What is the importance of $\Delta_R G^O$ values?
8. Entropy change of a system is zero in

   A. Reversible process B. Adiabatic process

   C. Reversible adiabatic process D. Isothermal process

PART B - (4 X16 = 64 marks)

09. (a) (i) Show $Cp - Cv = \beta^2 VT/K$, **(12)**

Where $\beta = 1/V\ (dV/dT)p$ and $K = -1/V\ (dV/dP)_T$

(ii) For ideal gas show $Cp - Cv = R$ **(4)**

(OR)

(b) (i) The fugacity of component1 in binary liquid mixture of components 1 and 2 at 298K and 20 bar is given by $f_1 = 50x_1 - 80x_1^2 + 40x_1^3$ where f_1 is in bar and x_1 is the mole fraction of component 1. Determine: **(8)**

(a) The fugacity of pure component1.

(b) The fugacity coefficient Φ_1

(c) The Henry's law constant K_1.

(d) The activity coefficient Y_1.

(ii) Explain about any two methods of determination of partial molar properties. **(8)**

10. (a) (i) Water (i)- hydrazine (ii) system forms an azeotrope containing 58.5% (mol) hydrazine at 393°K and 101.3 Kpa. Calculate the equilibrium vapour composition for a solution containing 20% (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. **(16)**

(OR)

(b) Explain about the boiling point diagrams and distribution diagrams in vapor liquid equilibrium behavior. **(16)**

11. (a) n-Butane is isomerized to i-butane by the action of catalyst at moderate temperatures it is found that the equilibrium is attained at the following compositions. **(16)**

Temperature, K	Mol%, n-Butane
317	31.00
391	43.00

Assuming that activities are equal to the mole fractions, Calculate the standard free energy of the reaction at 317K and 391K and average value of heat of reaction over the temperature range.

(OR)

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

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

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

(a) CO supplied is 100% in excess of the stoichiometric requirement.

(b) CO supplied is only 50% of the theoretical requirement.

12. (a) Derive Maxwell equations and also mention the applications. **(16)**

(OR)

(b) Explain the relationship between the three models for microbial maintenance. **(16)**