**Q. Code: 309266**

**Reg. No.** | | | | | | | | | |

# B.E. / B.TECH. DEGREE EXAMINATIONS, DEC 2019

Fourth Semester

## BT16402 – APPLIED THERMODYNAMICS FOR BIOTECHNOLOGISTS

***(Biotechnology)***

**(Regulation 2016)**

**Time: Three Hours** **Maximum : 100 Marks**

Answer **ALL** questions

**PART A - (10 X 2 = 20 Marks)**

| | | CO | RBT |
|---|---|---|---|
| 1. | What are the limitations of first law of thermodynamics? | 1 | U |
| 2. | What is Joule-Thompson coefficient? | 1 | U |
| 3. | Differentiate between Clapeyron and Clausius-Clapeyron equations. | 1 | U |
| 4. | Define chemical potential. | 1 | U |
| 5. | What is the difference between bubble and dew point? | 3 | U |
| 6. | State Lewis fugacity rule. | 3 | U |
| 7. | State Hess's law. | 2 | U |
| 8. | Define the term "Reaction co-ordinate". | 2 | U |
| 9. | Define apparent growth yield coefficient. | 3 | U |
| 10. | Mention the expression for Gibbs energy for thermodynamics of maintenance. | 3 | U |

**PART B - (5 X16 = 80 Marks)**

| | | | | | | |
|---|---|---|---|---|---|---|
| 11. | (a) | | Derive Maxwell equations and also mention the applications. | (16) | 1 | AN |
| | | | **(OR)** | | | |
| | (b) | | Derive the residual properties from the virial equation of state. | (16) | 1 | AN |
| 12. | (a) | (i) | Derive modified Gibbs Duhem equation and its applications. | (8) | 1 | AN |
| | | (ii) | Derive the expressions for the effect of temperature and pressure on activity coefficient. | (8) | 1 | AN |
| | | | **(OR)** | | | |
| | (b) | (i) | (a) The fugacity of component 1 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:<br>(i) The fugacity of pure component 1<br>(ii) The fugacity coefficient $\Phi_1$ | (8) | 1 | AN |

(iii) The Henry's law constant $K_1$.

(iv) The activity coefficient $Y_1$.

(ii) Explain the tangent-intercept method for determination of partial molar properties. **(8)** **1** **AP**

13. (a) 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)** **3** **AN**

**(OR)**

(b) Explain about the vapor liquid equilibrium behavior. **(16)** **3** **U**

14. (a) (i) Prove that Ka=Kf=Kp with example. **(8)** **2** **AN**

(ii) What is the influence of temperature on equilibrium constant and derive Van't Hoff's equation. **(8)** **2** **AP**

**(OR)**

(b) 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)** **2** **AN**

| 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.

15. (a) Derive Herbert-Pirt relation for electron donor consumption and explain the terms. **(16)** **3** **AN**

**(OR)**

(b) (i) What are non-growth components for microbial maintenance? **(4)** **3** **U**

(ii) Describe briefly about the functions of ATP and NADH in the metabolic pathway. **(12)** **3** **AP**