Code No: R7212302 **R7**

II B.Tech I Semester(R07) Supplementary Examinations, May/June 2010
THERMODYNAMICS FOR BIOTECHNOLOGISTS
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) What are different forms of energy . Explain about them.
   (b) Derive the equations used for solution of energy balance problems. What is the basis for this derivation? Explain. [16]

2. (a) Klebsiella aerogenes is produced in aerobic culture with NH3 as nitrogen source. The biomass contains 8% ash, 0.40 gm biomass is produced for each gm glycerol consumed and no major metabolic products are formed. What is the oxygen requirement for this culture in mass terms? Y_s for glycerol is 4.7 $Y_{xs,\ max} = 0.9$ C_{max}/w = 1.1.
   (b) Explain about product stiochiometry and theoretical oxygen demand. [8+8]

3. With a neat sketch explain the P,T behavior of the pure substances? [16]

4. A 1:3 N_2 - H_2 mixture is fed in to the reactor where a 21 % conversion to NH_3 is achieved. NH_3 formed is separated and unconverted gases are recycled to the reactor with a fraction continuously purged off. The feed contains 0.2 parts of Argon to 100 parts of N_2-H_2 mixture by volume. The tolerance limit for argon entering the reactor is assumed to be 5 parts per 100 parts of N_2-H_2 mixture by volume. Calculate the
   (a) the fraction recycle that must be continuously purged off.
   (b) the overall yield of NH_3 per 100 kmol of feed. [16]

5. Show that Gibb's energy is the generating function for other thermodynamic properties. [16]

6. (a) Show that $\ln \phi_i = \int_0^p (Z_i - 1)\frac{dP}{p}$
   (b) For nitrogen it has been found that Z= 1 - 0.36$\times 10^{-2}$P (P is pressure) Calculate the fugacity of nitrogen at 10 atm. [8+8]

7. (a) A binary system in equilibrium is represented by the equation $\frac{\Delta G}{RT} = x_1 \ln x_1 + x_2 + \frac{G^E}{RT}$. Show that the solubility of the system requires that $\frac{d^2(G^E/RT)}{d\,x_1^2} > -\frac{1}{x_1\,x_2}$(at constant T,P).
   (b) The excess Gibbs energy function for a binary system is represented by $\frac{G^E}{RT} = x_1 \ln \gamma_1 + x_2 \ln \gamma_2$. Show that the condition for stability is $\frac{d \ln \gamma_1}{d\,x_1} > -\frac{1}{x_1}$. (at constant T,P). [8+8]

8. Acetic acid is esterified in the liquid phase with ethanol at 100^0C and atmospheric pressure to produce ethyl acetate and water according to the reaction
   CH_3COOH (l)+C_2H_5OH (l)- - - - ->$CH_3COOC_2H_5$ (l)+H_2O (l)
   (a) Equilibrium constant at 298K is 6.5266.Calculate the equilibrium constant value at 373K.
   (b) If initially there is one mole each of acetic acid and ethanol, estimate the mole fraction of ethyl acetate in the reacting mixture at equilibrium. [8+8]

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