Code No: R09222304 **R09** **Set No. 2**

II B.Tech II Semester Examinations,APRIL 2011
THERMODYNAMICS FOR BIOTECHNOLOGISTS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. What is carnot engine and give the steps involved in the carnot engine. Derive the equation to give the efficiency of the carnot engine? [15]

2. (a) What is ideal gas? Name the two-basic assumptions, which were made use of in deriving the ideal gas equation of state from kinetic theory arguments.
   (b) Define thermodynamic properties, Classify the thermodynamic properties. [7+8]

3. Derive the Maxwell's relations from first principles. [15]

4. Develop a general equation for calculation of lnΦi, values from compressibility-factor data. [15]

5. For a pure species in vapour liquid equilibrium, prove that
   (a) $f_i^l = f_i^v = f_i^{sat} = \varphi_i^{sat} p_i^{sat}$
   (b) $f_i = \varphi_i^{sat} p_i^{sat} \exp \frac{V_i^l}{RT}(P - P_i^{sat})$ [7+8]

6. (a) What is the necessity of classifying properties into intensive or extensive properties?
   (b) Classify the following into intensive or extensive properties with reasons, Total energy, Temperature, Specific heat, Volume, Specific Volume. [5+10]

7. The water gas shift reaction,
   CO (g) + H_2O (g) - - - - - > CO_2 (g) + H_2 (g) is carried out at 1100K and 1bar. Assume the mixture behaves as an ideal gas and the equilibrium constant, k=1.0 and at 1100k and 1bar. Calculate the fractions of steam required if:
   (a) The reactants are 1mol H_2O and 2mol CO.
   (b) The initial mixture consist of 1mol H_2O, 1mol CO and 1mol CO_2. [7+8]

8. Calculate P-x-y values at a temperature of 90^0Cof 1-cholorobutane (1)/cholrobenezene (2) system
   Assume Raoults law to be valid.
   At 90^0C, P_1^{sat} = 142.88kPa
   P_2^{sat} = 26.54kPa. [15]

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Code No: R09222304 **R09** **Set No. 4**

II B.Tech II Semester Examinations,APRIL 2011
THERMODYNAMICS FOR BIOTECHNOLOGISTS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. Show that for multi reaction stoichiometry :

   $y_i = \frac{x_{io}+\sum_j V_{i,j}\varepsilon_j}{x_o+\sum_i V_j\varepsilon_j}$. [15]

2. Draw the phase equilibrium diagram on p-T coordinates for a pure substance. [15]

3. (a) What is the significance of the second law efficiency?
   (b) Define the second law efficiency of a process. [7+8]

4. Derive the relationships between activity coefficients to fugacities and fugacity Coefficients. [15]

5. Discuss the equilibrium and stability criteria in a closed system. [15]

6. (a) Discuss the importance of fugacity in thermodynamics.
   (b) Discuss fugacity and fugacity coefficient for pure species. [7+8]

7. Water flows over a waterfall 100m in height. Take 1 kg of the water as the system, and assume that it does not exchange energy with its surroundings?
   (a) What is the potential energy of the water at the top of the falls with respect to the base of the falls?
   (b) What is the kinetic energy of the water just before it strikes bottom?
   (c) After the 1kg of water enters the stream below the falls, what change has occurred in its state? [15]

8. Consider the steady state, adiabatic, irreversible flow of an incompressible liquid in a horizontal pipe of constant cross sectional area. Show that
   (a) The velocity is constant
   (b) The temperature increases in the direction of flow. [15]

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Code No: R09222304 **R09** **Set No. 1**

II B.Tech II Semester Examinations,APRIL 2011
THERMODYNAMICS FOR BIOTECHNOLOGISTS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. For an ideal solution show that
   (a) $\overline{H_i^{id}} = H_i$
   (b) $\overline{V_i^{id}} = V_i$ [7+8]
2. If one kmol of methane is stored in a 0.3 m^3 tank at 300K, estimate the pressure of the gas using ideal gas law and Van der Waals equation of state.
   Van der Waals equation of state parameters are:
   a = 0.2303 Pa $\left(\frac{m^3}{mol}\right)^2$
   $b = 43.06 \times 10^{-6} \frac{m^3}{mol}$ [15]
3. For chemical reactions show that:
   (a) $K = \exp\left[\frac{-\Delta G^0}{RT}\right]$
   (b) $\Delta H^0 = -RT^v \frac{d\left(\frac{\Delta G^0}{RT}\right)}{dT}$. [7+8]
4. (a) Define gauge pressure and absolute pressure.
   (b) The pressure of a gas in a pipe line is measured with a mercury manometer having one limb open to the atmosphere. If the difference in the height of mercury in the two limbs is 562 mm, calculate the gas pressure. The barometer reads 761 mm Hg, the acceleration due to gravity is 9.79m/s^2, and the density of mercury is 13,640 kg/m^3. [5+10]
5. A particular power plant operates with a heat source reservoir at 623.15 K and a heat sink reservoir at 303.15 K. Calculate the thermal efficiency
   to what temperature must the heat source reservoir be changed to increase the thermal efficiency to 55% of the Carnot engine value? [15]
6. Show that multiple phases at constant T and P are in equilibrium when fugacity of each species is the same in all phases i.e., $\hat{f}_i^{\alpha} = \hat{f}_i^{\beta} = - - - -- = \hat{f}_i^{\eta}$ (i = 1,2,- -,N). [15]
7. (a) Discuss the usefulness of bounded nature of fugacity.
   (b) Define fugacity and fugacity coeffcient for species in solution. [6+9]
8. Discuss the equilibrium and stability criteria in a closed system. [15]

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Code No: R09222304 **R09** **Set No. 3**

II B.Tech II Semester Examinations,APRIL 2011
THERMODYNAMICS FOR BIOTECHNOLOGISTS
Bio-Technology

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. Prove the Following
   (a) $dH = C_p dT + (1 - \beta T)V dP$
   (b) $dS = C_p \frac{dT}{T} - \beta V dP$ [8+7]
2. Explain the formulation of the first law of Thermodynamics and illustrate any two examples. [15]
3. (a) Discuss chemical potential as a criterion for phase equilibrium.
   (b) Define the following partial molar properties :
   Internal energy, Enthalpy, Entropy, Gibbs energy. [7+8]
4. Estimate the fugacity of the Cyclopentane at 110^0C and 275 bar. At 110^0C the vapor pressure of cyclopentane is 5.267 bar. [15]
5. The stability of the system requires that $\frac{d^2(G^E/RT)}{dx_1^2} > -\frac{1}{x_1 x_2}$ (at constant T,P) and hence show that LLE is predicted by the expression $\frac{d^2(G^E/RT)}{dx_1^2} > -\frac{1}{x_1 x_2}$ (A≥2). [15]
6. Hydrogen is to be formed by the steam cracking of methane according to the reaction

   CH_4 (g) + $2H_2O$ (g) - - - - - - - - - > CO_2 (g) + $4H_2$.

   The reaction will be performed at 600^0C where the equilibrium constant is 2.117. If the reaction pressure is one atm, what is the percent conversion of CH_4 to H_2. [15]
7. Effect of temperature on the Equilibrium constant Equilibrium criteria. [15]
8. A reversible engine operating between a reservoir at 605K and the ambient atmosphere at 305 K, drives a refrigerator operating between 245K and the ambient atmosphere. Determine the ratio of energy rejected by both the devices to the ambient atmosphere to the energy absorbed by the engine from the reservoir at 605K. [15]

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