Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III EXAMINATION – WINTER 2015

Subject Code:130405 Date:18/12/2015

Subject Name: Thermodynamics

Time: 2:30pm to 5:00pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Write down the equation for solving a general Vapour-Liquid Equilibrium (VLE) problem. How does this equation simplified for (a) ideal gas phase, ideal liquid phase, (b) low-pressure equilibrium and (c) high-pressure equilibrium **07**

(b) One kg of ice at -5^0C is to be exposed to a atmosphere which is 25^0C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. C_p of ice is 2.093 kJ/kg K and latent heat of fusion of ice is 333.3 kJ/kg. **07**

Q.2 **(a)** Explain ideal vapour compression refrigeration cycle with help of flow, T-S and P-H diagram. Deduce the expression for the COP of it. **07**

(b) In a steam power station, steam flow steadily through a 0.2 m diameter pipeline from the boiler to the turbine. At the boiler end, steam conditions are found to be: pressure = 4 MPa, Temperature = 400^0C, h = 3220 kJ/kg and volume = 0.073 m^3/kg. At the turbine end, the conditions are found to be: pressure = 3.5 MPa, Temperature = 392^0 C, h = 3209 kJ/kg and volume = 0.084 m^3/kg. There is heat loss of 10 kJ/kg from the pipeline. Calculate the steam flow rate. **07**

OR

(b) Define: (i) Thermodynamics (ii) Ideal gas **07**
(iii) Internal energy (iv) Coefficient of compressibility
(v) Helmholtz Function (vi) Heat pump
(vii) Gibbs phase rule

Q.3 **(a)** Define the standard heat of reaction. Explain the effect of temperature on the standard heat of reaction. **07**

(b) Draw the phase equilibrium diagram for a pure substance on P-V, T-s and h-s with relevant constant property lines. **07**

OR

Q.3 **(a)** Define the equilibrium constant K. Explain the effect of temperature on the equilibrium constant. **07**

(b) A piston-cylinder device operates 1 kg of fluid at 10 atm. pressure. The initial volume is 0.04 m^3. The fluid is allowed to expand reversibly following a process $pV^{1.45}$=C so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to the original position. Keeping the piston unaltered heat is added reversibly to restore it to the initial pressure. Calculate the work done in the cycle. **07**

Q.4 **(a)** Draw the phase diagram for binary solution at constant pressure. How the tie line help in determining the amount of liquid and vapour in equilibrium. **07**

(b) Derive the four Maxwell's equations. What is their importance in establishing relationships between the thermodynamic properties? Draw the mnemonic diagram of it. **07**

OR

Q.4 **(a)** Give the Kelvin-Plank statement and the Clausius statement of second law of thermodynamics. Show that they are equivalent. **07**

(b) The standard heat of formation and standard free energy of formation of ammonia at 298 K are -46,200 J/mol and -16,600 J/mol respectively. Calculate the equilibrium constant for the reaction **07**

$$N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)$$

at 400 K assuming that the standard heat of reaction is constant in the temperature range 298 to 400 K.

Q.5 **(a)** Derive the van der Waal's equation for real gases. Calculate the constants in terms of P_c, T_c, and V_c **07**

(b) Derive mathematical equation of first law of thermodynamics for steady flow process. Reduce the same for non-flow process. **07**

OR

Q.5 **(a)** (i) Explain the homogeneous and heterogeneous system. **02**

(ii) Explain the types of system with proper example and neat sketch. **05**

(b) Explain ideal aqua-ammonia absorption refrigeration cycle. How does it differ from a vapour compression cycle. **07**

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