Registration No.										

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B.TECH
PCCH4401

7th Semester Regular / Back Examination 2016 - 17
CHEMICAL ENGINEERING THERMODYNAMICS
BRANCH : Chemical
Time : 3 Hours
Max Marks : 70
Question Code :Y145

Answer Question No. 1 which is compulsory and any FIVE from the rest.
The figures in the right-hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.
Use of Steam Table is permitted.Answer all parts of a question at a place.

1. Answer the following questions : **2 x 10**

(a) For liquid water in equilibrium with a mixture of water vapour and nitrogen, find the number of degrees of freedom.

(b) The volume expansivity values for incompressible fluids and liquids are _____ and _____ respectively.

(c) What do you understand by polytropicprocess ?

(d) What is accentricfactor ? Mention its significance.

(e) State Duhem's theorem.

(f) What do you understand by partial molar properties ?

(g) Write the summability relations.

(h) Write the basis for Gibb's theorem.

(i) What are fugacity and fugacity coefficients ?

(j) State and explain Lewis/Randall rule.

2. **(a)** Calculate ΔU and ΔH for 2 kg of water when it is vaporized at constant temperature of 100^0C and constant pressure of 101.325 kPa. The specific volumes of liquid and water vapour at these conditions are 0.00104 and 1.673 m^3/kg. For this change heat in the amount of 2256.9 kJ/kg is added to the water. **04**

(b) Draw a neat PT diagram and explain the behaviour of pure substances. **06**

3. **(a)** For liquid acetone at 20^0C and 1 bar, $\beta = 1.487 \times 10^{-3}/^0$C, $k = 62 \times 10^{-6}$/bar, and $v = 1.287$ cm^3/g. Find: (i) the value of $\left(\frac{\partial p}{\partial T}\right)_v$ at 20^0C and 1 bar, (ii)pressure generated by heating at constant v from 20^0C and 1 bar to 30^0C, and (iii) change in volume for a change from 20^0C and 1 bar to ^{0}C and 10 bar. **03**

(b) An ideal gas undergoes the following sequence of mechanically reversible process in a closed system. (i) from an initial state of 70^0C and 1 bar, it is compressed adiabatically to 150^0C, (ii) it is then cooled from 150^0C to 70^0C at P = constant, and finally (iii) it is expanded isothermally to its original state. Calculate W, Q, ΔU, and ΔH for each of the three processes and for the entire cycle.
Data: C_V = 3/2 R, C_P = 5/2 R, R = 8.314 J/mol.K, C_V = 12.471 and C_P = 20.785 J/mol.K. **07**

4. A binary system of acetonitrile(1) and nitromethane(2) conforms closely to Raoult's law. Vapour pressures for the pure species are given by the following Antoine equations.
$\ln P_1^{sat} = 14.27 - \frac{2945.47}{T - 49.15}$ and $\ln P_2^{sat} = 14.21 - \frac{2972.64}{T - 64.15}$, where T is in kelvin. Prepare a graph showing T vs. x_1 and T vs. y_1 for a pressure of 70 kPa. **10**

5. Derive the Gibb's/Duhem equation. **10**

6. For H_2O at a temperature of 300^0C and for pressures upto 10,000 kPa calculate values of f_i and Φ_i from data in steam tables and plot them vs. p. **10**

7. **(a)** Discuss briefly about excess property relations. **05**

(b) Develop expressions for the mole fractions of reacting species as functions of the reaction coordinate for a system initially containing 3 mol H_2S and 5 mol O_2 and undergoing the reaction:

$$2\ H_2S\ (g) + 3\ O_2\ (g) \rightarrow 2\ H_2O\ (g) + 2\ SO_2\ (g)$$ **05**

8. Write short notes on any **TWO**: **5 x 2**

(a) Virial equations of state
(b) Partial properties in binary solutions
(c) Ideal solution model
(d) Multireactionstoichiometry
