Registration No.										

Total Number of Pages : 02 **B.Tech.**
PCCH4401

7th Semester Regular / Back Examination 2017-18
Chemical Engineering Thermodynamics
BRANCH : CHEM
Time : 3 Hours
Max Marks : 70
Question Code : B215

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.

Q1 **Answer the following questions :** **(2x10)**

(a) Differentiate between extensive and intensive properties with examples.

(b) For non-reacting systems, define phase rule. Find out the degrees of freedom for a liquid solution of alcohol in water in equilibrium with its vapour.

(c) Write the equation for change in internal energy (ΔU) and change in enthalpy (ΔH) in terms of specific heat and temperature for one mole of ideal gas.

(d) Define polytropic process and mention the empirical equation.

(e) An egg, initially at rest, is dropped onto a concrete; it breaks. Prove that the process is irreversible. In modeling this process, treat the egg as the system and assume the passage of sufficient time for the egg to return to its initial temperature.

(f) What is activity coefficient ? Mention its use.

(g) What is the criterion for the equilibrium of the phases in an ideal mixture in terms of fugacity ?

(h) Write about reaction coordinate.

(i) Define and explain fugacity and fugacity coefficient.

(j) Define third law of thermodynamics.

Q2 A tank containing 20 kg of water at 293.15 K is fitted with a stirrer that delivers work to the water at the rate of 0.25 kW. How long does it take for the temperature of the water to rise to 303.15 K if no heat is lost from the water ? For water, Cp = 4.18 kJ/kg.^{0}C. **(10)**

Q3 One mole of an ideal gas with $C_p = (7/2)R$ and $C_v = (5/2)R$ expands from $P_1 = 8$ bar and $T_1 = 600$ K to $P_2 = 1$ bar by each of the following paths: **(10)**

(a) Constant volume,
(b) Constant temperature, and
(c) Adiabatically.

Assuming mechanically reversibility, calculate W, Q, ΔU, and ΔH for each process. Sketch each path on a single PV diagram.

Q4 For isopropanol vapour at 200^{0}C, B = - 388 cm^3/mol and C = - 26,000 cm^6/mol^2. Calculate V and Z for isopropanol vapour at 200^{0}C and 10 bar by (i) ideal gas law, (ii) Z-equation with two terms, and (iii) Z-equation with three terms. **(10)**

Q5 For water at a temperature of 300^0C and for pressures upto 100 bar calculate fugacity and fugacity coefficient using data from steam table and plot them vs. pressure. **(10)**

Q6 Binary system of acetonitrile(1)/nitromethane(2) conforms closely to Raoult's law. Vapour pressures for the pure species are given by the following Antoine equations: **(10)**

$$\ln P_1^{sat} = 14.3 - \frac{2945.5}{T - 49.2}$$

$$\ln P_2^{sat} = 14.2 - \frac{2972.6}{T - 64.2}$$

Prepare a graph showing P vs. X_1 and P vs. y_1 for atemperature of 70^0C.

Q7 A system formed initially of 2 mol CO_2, 5 mol H_2, and 1 mol CO undergoes the reactions: **(10)**

$$CO_2(g) + 3H_2(g) \rightarrow CH_3OH(g) + H_2O(g)$$
$$CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$$

Develop expressions for the mole fractions of the reacting species as functions of the reaction coordinates for the two reactions.

Q8 **Write short notes on any TWO :** **(5x2)**

(a) Virial equations of state
(b) Acentric factor
(c) Qualitative behavior of VLE
(d) Partial properties in binary solutions
