Registration No.

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PCCH4401

7th Semester Regular / Back Examination 2015-16
CHEMICAL ENGINEERING THERMODYNAMICS
BRANCH : Chemical
Time : 3 Hours
Max Marks : 70
Question Code : T185

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) Isothermal and isobaric changes on a PT diagram are represented which type of lines ?

(b) The values of isothermal compressibility for incompressible and compressible fluids are _____ and _____.

(c) An incompressible fluid is contained in an insulated cylinder fitted with a frictionless piston. Can the energy as work be transferred to the fluid ? Justify.

(d) Write briefly about the applications of Virial equations.

(e) Which is the more effective way to increase the thermal efficiency of a Carnot engine: (i) to increase T_H with T_C constant, or (ii) to decrease T_C with $T_H$constant ? Justify.

(f) An equilibrium liquid/vapour system described by Raoult's law cannot exhibit an azeotrope. Justify.

(g) What are the partial molar temperature and pressure ? Express results in relation to the T and P of the mixture.

(h) State and explain Gibbs's theorem.

(i) Write and explain Lewis/Randall rule.

(j) Mention the common features of excess properties.

2. (a) A closed non-reactive system contains species 1 and 2 in vapour/liquid equilibrium. Species 2 is insoluble in liquid phase. The vapour phase contains both species 1 and 2. Some additional moles of species 2 are added to the system, which is then restored to its initial T and P. As a result of the process, does the total number of moles of liquid increase, decrease, or remain unchanged ? **04**

(b) 1 mole of a gas in a closed system undergoes a four step thermodynamic cycle. For this system, fill the blanks in the given table. **06**

Step	ΔU (J)	Q (J)	W (J)
12	-300	_____	-5000
23	_____	-3700	_____
34	_____	-900	400
41	4800	_____	_____
12341	_____	_____	-1500

3. **(a)** Calculate the reversible work done in compressing 0.03 m^3 of Hg at a constant temperature of 273.15 K from 1 atm to 2800 atm. The isothermal compressibility of mercury at 273.15 K is: **04**

$$\kappa=3.9x10^{-6}-0.1x10^{-9}P$$

where P is in atm and κ is in atm^{-1}.

(b) Discuss in detail the theorem of corresponding states and acentric factor. **06**

4. The LNG is being transported by tankers at atmospheric pressure and 113.7 K and represents a possible heat sink for use as the cold reservoir of a heat engine. Forunloading of LNG from the tanker as a vapor at the rate of 9000 m^3/s, as measured at 298.15 K and 1.0133 bar, and assuming the availability of an adequate heat source at 303.15 K, calculate the maximum possible power obtainable and what is the rate of heattransfer from the heat source? Assume that LNG at 298.15 K and 1.0133 baris an ideal gas with the molar mass of 17. Also assume that the LNG vaporizes only,absorbing only its latent heat of 512 kJ/kg at 113.7 K. **10**

5. Assuming Raoult's law to be valid, prepare a P-x-y diagram for a temperature of 363.15K and a T-x-y diagram for a pressure of 90 kPa for the system 1-Chlorobutane(1)/chlorobenzene(2).Antoine constants are: **10**

A1 = 13.79 B1 = 2723.73 C1 = 218.26
A2 = 13.86 B2 = 3174.78 C2 = 211.70

6. A vessel, divided into two parts by a partition, contains 4 mol of nitrogen gas at 348.15 Kand 30 bar on one side and 2.5 mol of argon gas at 403.15 K and 20 baron the other. If the partition is removed and the gases mix adiabatically and completely,what is the change in entropy? Assume nitrogen to be an ideal gas with Cv = (5/2)Rand argon to be an ideal gas with Cv = (3/2)R. **10**

7. **(a)** A system formed initially of 2 mol CO_2, 5 mol H_2, and 1 mol CO undergoes the reactions: **05**

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

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

(b) Derive the Gibbs/Duhem equation. **05**

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

(a) Carnot's equations
(b) Henry's law
(c) Ideal-Solution model
(d) Reaction coordinate
