B.TECH SEM - IV (2007 COURSE) (CHEMICAL ENGG.) :
SUMMER - 2018
SUBJECT: CHEMICAL ENGINEERING THERMODYNAMICS-I

Day : **Tuesday** | **S-2018-2604** | Time **10.00 AM TO 01.00 PM**
Date : **12/06/2018** | Max. Marks : 80

N. B. :

1) **Q. No. 1 and Q. No. 5** are **COMPULSORY**. Out remaining questions attempt **any TWO** questions from each sections.
2) Answers to both the sections should be written in the **SEPARATE** answer books
3) Use of non programmable **CALCULATOR** is allowed.
4) Figures to the right indicate **FULL** marks.
5) Assume suitable data if necessary.

SECTION-I

Q.1 **a)** State first law of thermodynamics and derive equation for closed system. **(04)**

b) Define the terms: **(06)**
i) State function ii) Path function
iii) Reversible process iv) irreversible process

c) Define and explain thermodynamic equilibrium. **(04)**

Q.2 **a)** Derive an expression for first law applied to steady flow process with one entrance and one exit. **(08)**

b) A balloon which was originally empty is being filled with hydrogen from a cylinder at constant temp of 300 K. The atmospheric pressure is 1.01325 bar. What is work done by balloon – cylinder system when the balloon attains a spherical shape 4 m in diameter? **(05)**

Q.3 The equation of state for a certain pure fluid is given by $v = \frac{RT}{P} - \frac{C}{T^3}$ *and* specific heat is given by the relation $Cp = A + BT$ **(13)**
Where A, B & C are constant.
Derive the expressions for change in internal energy, enthalpy and entropy for
i) Isothermal process
ii) Isobaric process

Q.4 **a)** Explain PVT behavior of pure substance with PT and PV diagrams. **(08)**

b) Derive for adiabatic process $P_1V_1^{\gamma} = P_1V_2^{\gamma} = PV^{\gamma} = \text{Constant}$ **(05)**

SECTION-II

Q.5 **a)** State the statements of second law of thermodynamics. **(04)**

b) Derive: $dG = VdP - SdT$ *and* $dH = TdS + VdP$ **(04)**

c) Define the terms **(06)**
i) Chemical Potential
ii) Fugacity
iii) Residual Property

Q.6 **a)** Prove the following relation for a gas obeying Van der Waals equations of state: $Cp - Cv = \dfrac{R}{1 - 2a\left[\dfrac{(V-b)^2}{(RTV^3)}\right]}$ **(08)**

Where a & b are Van der Waals constant.

b) State and explain Roult's law and Henry's law. **(05)**

Q.7 **a)** Derive the expression for an ideal gas **(06)**
$\dfrac{\Delta S}{R} = \int_{T_1}^{T_2} \dfrac{Cp}{R}\dfrac{dT}{T} - \ln\dfrac{P_2}{P_1}$

b) Derive Clausius-Clapeyron equation. **(07)**

Q.8 **a)** For a binary liquid system of species 1 and 2 at fixed T and P, the enthalpy is given by $H = 400x_1 + 550x_2 + x_1x_2(40x_1 + 20x_2)$ Where H is in J/mol. Determine expressions for $\overline{H_1}$ and $\overline{H_2}$ as functions of x_1 **(08)**

b) Derive following expression for phase *equilbrium* **(05)**
$\mu_i^{\alpha} = \mu_i^{\beta} = \mu_i^{\gamma} = ----- \mu_i^{\pi}$.

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