Registration No. : | | | | | | | | | | |

Total number of printed pages – 2

B. Tech

PCCH 4401

Seventh Semester (Special) Examination – 2013

CHEMICAL ENGINEERING THERMODYNAMICS

BRANCH : CHEM

QUESTION CODE : D 380

Full Marks – 70

Time : 3 Hours

*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.
Answer all parts of a question at a place..

1. Answer the following questions : 2×10

   (a) What are intensive and extensive properties ?

   (b) State and explain First law of thermodynamics.

   (c) State PVT equation of state and Virial equation of state.

   (d) Differentiate between isobaric and isochoric process.

   (e) What is acentric factor ? Mention its use.

   (f) State Duhem's theorem.

   (g) State Raoult's law and Henry's law.

   (h) What do you understand by partial molar properties ? State and explain.

   (i) State and explain fugacity and fugacity coefficient.

   (j) State third law of thermodynamics.

2. Water flows over a waterfall 200 m in height. Take 1 kg of the water as the system and assume that it does not exchange energy with its surroundings. 10

   (a) What is the potential energy of the water at the top of the falls with respect to the base of the falls ?

(b) What is the kinetic energy of the water just before it strikes bottom ?

(c) After the 1 kg of water enters the stream below the falls, what change has occurred in its state ?

3. Air at 1 bar and 298.15 K is compressed to 5 bar and 298.15 K by two different mechanically reversible processes :

(a) Cooling at constant pressure followed by heating at constant volume

(b) Heating at constant volume followed by cooling at constant pressure

Calculate the heat and work requirements and ΔU and ΔH of the air for each path. The following heat capacities for air may be assumed independent of temperature :

$C_V = 20.78$ and $C_P = 29.10$ J mol^{-1} K^{-1}

Assume also for air that PV/T is a constant, regardless of the changes it undergoes. At 298.15 K and 1 bar the molar volume of air is 0.02479 m^3 mol^{-1}. 10

4. (a) Draw a PT diagram for a pure substance and explain various curves in it. 6

(b) Define volume expansivity and isothermal compressibility. 4

5. Draw a PV diagram showing Carnot cycle for an ideal gas and derive the Carnot's equations. 10

6. Neatly draw a PTxy diagram for VLE and explain in detail. 10

7. (a) Derive the equation relating to mole fraction and reaction coordinate. 5

(b) Develop an expression for the mole fractions of reacting species as functions of the reaction coordinate for a system initially containing 3 mol NO_2, 4 mol NH_3, and 1 mol N_2 and undergoing the reaction:

$6NO_2\ (g) + 8NH_3\ (g) \rightarrow 7N_2\ (g) + 12\ H_2O\ (g)$ 5

8. Write short notes on any **two** of the following : 5×2

(a) Phase rule

(b) Entropy changes of an ideal gas

(c) Gibbs's theorem

(d) Multireaction stoichiometry