Department of Chemical Engineering, Indian Institute of Technology Delhi
CHL721: Advance Chemical Engineering Thermodynamics
Semester II, 2009-2010

Closed Book & Closed Notes | **Major Examination** | Marks: 35
Date: 04/05/10 | Time: 2 Hrs.

Note:

1. Do not answer a question in more than one place. If the answer to a question is given at different places, only the first continuous attempt will be evaluated.
2. Show all the intermediate steps of the methods employed for the solution of the problems.
3. Supplementary answer-sheets will not be provided.

1. Derive the following

   a. [7 Marks] Show that for grand canonical ensemble $\sigma_N{}^2 = \left(\frac{\partial\langle N\rangle}{\partial\beta\mu}\right)_{\beta,V}$

   b. [7 Marks] Show that for a system of uncorrelated particles $\sigma_N{}^2 = \langle N\rangle$.

   c. [4 Marks] Using the above two results derive ideal gas EOS.

2. [6 Marks] Derive the expression for partition function of a canonical ensemble (in terms of E_j, and β) using method of maximum probable distribution and Lagrange multiplier.

3. [6 Marks] Derive the Gibbs entropy formula: $dS = -k_B \sum_j P_j \ln P_j$

4. [5 Marks] The following isomerization reaction occurs in liquid phase:

$$A \rightarrow B$$

where A and B are miscible liquids for which:

$$\frac{G^E}{RT} = 0.1 x_A x_B$$

if $\Delta G^0_{298} = -1000 J$, what is the equilibrium composition of the mixture at 25 °C? How much error is introduced if one assumes that A and B form an ideal solution? [The reaction is at low enough pressure that pointing factor correction can be ignored].