ECHE 363 – Thermodynamics of Chemical Systems
Homework #10

100 points total. Complete the following problems and upload your solutions to the Canvas assignment dropbox by the due date/time.

You are strongly encouraged to collaborate with your classmates on the homework, but each student is required to come up with a unique solution to the homework problems. For full credit, you must show all work. This includes showing all steps involving algebra and/or calculus. Your calculator can only be used for the final evaluation of numerical answers and may not be used for solving algebraic equations and/or integrals.

1. Estimate the fugacity of the following pure liquids at their normal boiling point temperatures and P = 200 bar. Justify any assumptions you make.

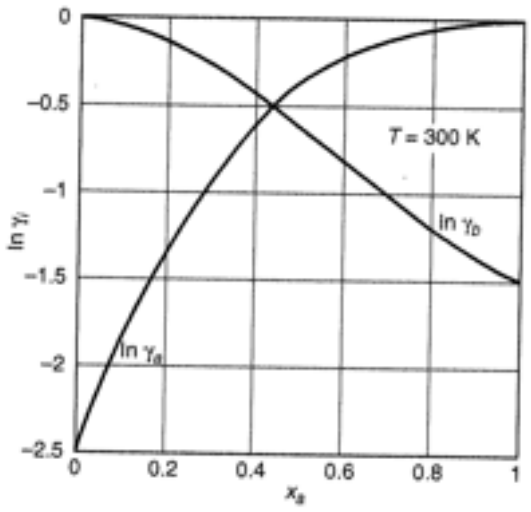
    a. n-pentane

    b. 1-butene

2. Calculate the fugacity of liquid water in a binary liquid mixture with 40 mole % water and 60 mole % ethanol at 70 °C. The following activity coefficient data, at infinite dilution, are available: $\gamma^{\infty}_{H_2O} = 2.62$ and $\gamma^{\infty}_{EtOH} = 7.24$. Use the three-suffix Margules equation:

$$g^{E}_{m} = x_a x_b \left[A + B(x_a - x_b) \right]$$

3. Below is a plot of the natural log of the activity coefficients ($\ln \gamma_i$) for a binary mixture of species *a* and *b* vs. the mole fraction of species *a* (x_a) at 300 K.



   a. What is the reference state for each species (Lewis–Randall or Henry's)?

   b. Show that the Gibbs–Duhem equation is satisfied at a mole fraction $x_a = 0.6$.

   c. Come up with an appropriate model for g_m^E for this system and find the values of the model parameter(s).

   d. Is it possible for species *a* and *b* to separate into two liquid phases? Explain.

4. Cline Black proposed the following model for excess Gibbs energy:

$$g_m^E = \left[\frac{1}{Ax_a} + \frac{1}{Bx_b} \right]^{-1} + Cx_a x_b (x_a - x_b)^2$$

   Develop the corresponding expressions for $\ln \gamma_a$ and $\ln \gamma_b$.

5. Answer the following reflection questions (5 points):

   a. What about the way this class is taught is helping your learning?

   b. What about the way this class is taught is inhibiting your learning?