**King Fahd University of Petroleum & Minerals**
**Chemical Engineering Department**
**CHE 303 – Chemical Engineering Thermodynamics II**
**2008 - 2009 (082)**

**HW#7**
Due: Sat. 2-May-2009

## Q1. (10 points)

Solve problem 10.6 of your textbook.

## Q2. (20 points)

Assuming Raoult's law is applicable for a benzene(1)/toluene(2) binary system, calculate:

(a) The bubble point pressure and the composition of vapor for a liquid at 100 $^oC$ with composition $x_1 = 0.33$. (5 points)
(b) The dew point pressure and the composition of liquid for a vapor at 100 $^oC$ with composition $y_1 = 0.33$. (5 points)
(c) The bubble point temperature and the composition of vapor for a liquid at 120 kPa with composition $x_1 = 0.33$. (10 points)

## Q3. (20 points)

For a binary system of species 1 and 2 at 70 $^oC$,

- $\ln(\gamma_1) = 0.95\, x_2^2$ $\quad$ $\ln(\gamma_2) = 0.95\, x_1^2$
- $P_1^{sat} = 79.80\ \text{kPa}$ $\quad$ $P_2^{sat} = 40.50\ \text{kPa}$

Assuming the validity of the modified Raoult's law VLE model, calculate:

(a) The bubble point pressure and the composition of vapor for a liquid at 70 $^oC$ with composition $x_1 = 0.05$. (5 points)
(b) The dew point pressure and the composition of liquid for a vapor at 70 $^oC$ with composition $y_1 = 0.05$. (15 points)

## Q4. (15 points)

By referring to example 10.3 of your textbook, the system of methanol(1) and methyl acetate(2) forms a non-ideal liquid solution and at low pressures the modified Raoult's law is appropriate. Non-ideal liquid solutions, at certain conditions, form an azeotrope at VLE calculations. At the azeotropic conditions the composition of the vapor and liquid are equal:

$$y_1 = x_1 \text{ and } y_2 = x_2$$

and the relative volatility is equal to unity:

$$\alpha \equiv \frac{y_1/x_1}{y_2/x_2} = 1$$

Calculate the azeotropic composition and azeotropic pressure at $T$ = 320 K. Please note in this case you still have two degrees of freedom for the binary system:

Known variables: $T$ = 320 K and $y_1 = x_1$.
Unknown variable: $P$ and $x_1$ (or $P$ and $y_1$).