6 February 2019
To: ChE 312 Class
From: Professors Koretsky and Goulas
Subject: Homework #5

Below is the fifth homework assignment of the quarter. Please conform to the format described in the class syllabus. This assignment is due on 14 February 2019 by 1 PM on Gradescope. If you have any questions, feel free to see us or one of the other instructors during office hours or by appointment.

1. As accurately as you can, determine the fugacity of pure methane at 220 K and 69 bar.

2. Text 7.25

3. Consider a vapor phase mixture of 2 moles propane (1) and 3 moles nitrogen (2) at 15 °C and 12 bar. You wish to come up with the fugacity and fugacity coefficient for propane. Answer the following questions using the truncated virial equation of state, as follows:

\[
\frac{P_V}{RT} = 1 + B' P \quad \text{with} \quad B' = y_1^2 B'_{11} + 2 y_1 y_2 B'_{12} + y_2^2 B'_{22}
\]

with parameter values:

\[
B'_{11} = 1.9 \times 10^{-7} \quad [\text{Pa}^{-1}]
\]

\[
B'_{12} = 3.6 \times 10^{-8} \quad [\text{Pa}^{-1}]
\]

\[
B'_{22} = 2.0 \times 10^{-9} \quad [\text{Pa}^{-1}]
\]

A. Develop an accurate expression for the fugacity and fugacity coefficient of species 1 in this mixture, using the above equation of state.

B. Determine numerical values for \( \hat{f}_1 \) and \( \hat{\phi}_1 \).

4. Consider a binary mixture of species 1 and 2 in the vapor phase which can be described by the equation of state below:

\[
\frac{P_V}{RT} = 1 + \frac{P}{\sqrt{T}} \left[ Ay_1 + By_2 + Cy_1 y_2 \right]
\]

where \( A, B, \) and \( C \) are constants (parameters).

A. Develop an expression for \( \ln(\phi_1) \) in terms of \( P, T, R, A, B, \) and \( C \). Reduce the expression to the simplest form possible.

B. Develop an expression for \( \ln(\hat{\phi}_1) \) in terms of \( P, T, R, A, B, \) and \( C \). Reduce the expression to the simplest form possible.