UNIVERSITY OF GHANA

B.Sc ENGINEERING FIRST SEMESTER EXAMINATION: 2016/2017
SCHOOL OF ENGINEERING SCIENCES
FPEN 303: THERMODYNAMICS (2 Credits)

Answer FOUR questions: **TIME: TWO (2) HOURS**

Question 1

a) State the two main practical engineering problems that this course sought to address. Briefly discuss the basis for the solution of these problems in the context of equilibrium thermodynamics.

(b) A ternary gas mixture contains 20 mol % A, 40 mol % B, and 40 mol % C. At a pressure of 80 atm and a temperature of 75°C, the fugacity coefficient of components A, B and C in this mixture are 0.4, 0.6 and 0.8 respectively. What is the fugacity of the mixture?

c) Explain the basis of the equation you use in (b).

Question 2

A mixture of the following composition:

	mol %
Ethane	25
Propane	35
n-butane	40

is brought to a condition of 40°F at a pressure P. If the molar fraction of liquid in the system is 0.45, what is pressure P (in bar) and what are the compositions of the liquid and vapour phases? Use the k-value (*DePriester*) chart given.

Question 3

For the cracking reaction

$$C_3H_8\ (g) \Rightarrow C_2H_4\ (g) + CH_4\ (g)$$

The equilibrium conversion is negligible at 300 K, but becomes appreciable at temperatures above 500 K. For a pressure of 1 bar, determine the fractional conversion of propane at 600 K.

Compd.	$\Delta H^o_{f,298}$ (J/mol)	$\Delta G^o_{f,298}$ (J/mol)
C_3H_8 (g)	-104,680	-24,290
C_2H_4 (g)	52,510	68,460
CH_4 (g)	- 74,520	-50,460

R=8.314 J/mol.K

Question 4

For the system ethyl ethanoate (1)/n-heptane (2) at 450 K, assuming the validity of the modified Raoult's law

a) Make a BUBL P calculation for T=450 K, x_1=0.06
b) Make a DEW P calculation for T=450 K, y_1=0.06
c) Determine if the system forms an azeotrope

Given the following data:

$ln\gamma_1 = 0.95x_2^2$; $ln\gamma_2 = 0.95x_1^2$; $P_1^{sat} = 80.0\ kPa$; $P_2^{sat} = 41.0\ kPa$

Question 5

The following data was collected for ethanol-water mixture at 40°C.

Weight % Ethanol	Density (g/mL)
0	0.99220
10	0.97060
20	0.96130
30	0.94164
40	0.92070
50	0.89863
60	0.87070
70	0.85213
80	0.82622
90	0.80074
100	0.77240

Molar mass of ethanol and water are 46 g/mol and 18 g/mol, respectively.

a) Plot the data above and determine the partial molar volumes from the graph at a mole fraction of 0.4.

b) Using this values obtained from (a), confirm the additivity rule of partial molar quantities