

Birla Institute of Technology and Science, Pilani
First Semester, 2016-17
CHE G622, Advanced Chemical Engineering Thermodynamics

Mid Semester Examination

4th October, 2016 (9:00 -10:30 AM)

Max Time: 90 min

Total Max Marks:75

- Concept is only important, not the answer
- Refer the equations, table and book which you have used.
- Box the final and intermediate answers
- Don't skip any mathematical steps-otherwise you will lose marks
- Mention unit for the intermediate and final answers-otherwise you will lose marks

Q1: Estimate specific volume, H^R , and S^R for 1,3-Butadiene at 500 K and 20 bar by using by the Soave/Redlich/Kwong equation. [10+5+5]

Q2: A liquid containing 60 mol% benzene and 40 mol% Toluene is continuously fed to a flash vaporizer which is maintained at 90 C and 760 Torr. Determine the compositions of the liquid and vapor streams leaving the flash unit and the fraction of feed which leaves as liquid. [15]

Q3: It is desired to store 100 kmol mixture of 70:30 mole ratio propane and n-pentane at 500 K and 150 bar. Determine the size of the tank using the pseudocritical properties estimated through Prausnitz-Gunn rule. [10]

Q4: From the following vapor pressure data, construct the temperature - composition diagram at 1 atm, for the system benzene-toluene, assuming ideal solution behavior. [10]

Temperature °C	Vapor pressure, mm Hg	
	Benzene	Toluene
80	760	300
92	1078	432
100	1344	559
110.4	1748	760

Q5: Fill in the Blanks with right word(s). No marks will be awarded if you write one right one wrong, or leave one blank. [1x5]

- a) For an ideal incompressible fluid, both , _____ expansivity and _____ compressibility are zero
- b) The unit for virial coefficient B is _____ and for C is _____.
- c) For N2 virial coefficient C reaches a maximum at a temperature _____ and B shows negative value till the temperature _____.
- d) For a pure species coexisting liquid and vapor phases are in equilibrium when they have the same _____, _____, and fugacity.
- e) For a mechanically reversible, constant-volume, closed-system process, the heat transferred is equal to the _____ of the system.

Q6: Conceptual/Short Questions. Answer to the point. Concept is only important

- a) Explain the physical significance of the 4th virial coefficient term. Arrange the 1st to 4th virial coefficient terms in order of increasing contribution. [2]
- b) Show the trends of the P-v plot for water at a temperature $T < T_c$, experimentally and by following SRK equation of state. Which plot follows the criteria of thermodynamic stability? Explain at least three points with proper schematic and logic. Not more than 3 lines per point will be allowed. [5]
- c) A thermodynamic system has the following equation of state.
 $2U/T=3NR$ and $PV/T=NR$
Obtain the Gibbs-Duhem relation for the system in terms of R, specific internal energy (u) and specific volume (v). [2.5]
- d) When we mix two unknown liquids X and Y in the amount of 100 mL of X and 50 mL of Y, we get 148 mL of solution. What can we say about the relative magnitudes of V_X , V_Y , \bar{V}_X , and \bar{V}_Y ? [2.5]
- e) Consider that you want to estimate the actual fugacity of 'i' from the following graphs. Would you like to use Lewis-Randall rule and/or Henry's law? Explain by using 2-3 lines maximum. [3]

