Name:	
Enrolment No:	

UPES

End Semester Examination, May 2024

Programme Name: B. Tech Chemical Engg. **Semester : IV**
Course Name : Chemical Engineering Thermodynamics 2 **Time : 3 hrs**
Course Code : CHCE2008 **Max. Marks: 100**
Nos. of page(s) : 02
Instructions: (1) **This is an OPEN BOOKS and OPEN NOTES Examination.**
(2) Assume the appropriate value of missing data, if any.
(3) The thermodynamic terms have their usual meanings

(Answer all questions)

S. No.		Marks	CO
1.	A binary mixture of dioxane (1) -steam (2) forms and azeotrope at 345 K during the separation of the mixture by distillation. The activity coefficient of both the components can be calculated as $\overline{G_1^E} = Ax_2^2 = RT \ln \gamma_1$ $\overline{G_2^E} = Ax_1^2 = RT \ln \gamma_2$ The saturation vapor pressures are given as, $P_1^{sat} = 15.6$ kPa and $P_2^{sat} = 12.4$ kPa . Calculate the value of A, if azeotropic composition is $x_1 = 0.51$.	**20**	**CO3**
2.	Three students from the Department of Chemical Engineering at UPES Dehradun working in the research lab conducted experiments on a binary hexane (1)-water (2) system to gather data on activity coefficients. After conducting multiple experiments under consistent temperature and pressure conditions, they obtained values for the activity coefficients of hexane (1)-water (2) as follows $\gamma_1 = \exp\left[x_2^2\left(2x_1 + 0.5\right)\right]$ and $\gamma_2 = \exp\left[x_1^2\left(-2x_2 + 1.5\right)\right]$. As a chemical engineer, could you evaluate the accuracy of their estimations? Calculate the excess Gibbs free energy of the mixture containing 40 mole % of hexane at 335 K.	**20**	**CO4**

3. | **5+20** | **CO1, CO4**

What are some of the most challenging aspects of predicting and controlling chemical reaction equilibria in industrial chemical processes? How can thermodynamic modeling and experimental techniques address these challenges? [Hint: I am providing you 2 challenging aspects, multiple reactions and non-ideal behavior. You are expected to provide 2 more challenging aspects and elaborate how can you address them using theoretical knowledge of thermodynamics and experimental techniques.

4 | **15+20** | **CO2, CO4**

The following experimental VLE data at 760 Torr is obtained for hexane (1)-water (2) system. The system follows van Laar model of activity coefficients. From the given data, obtain VLE data (make a table for the following data $t, x_1, y_1, P_1^s, P_2^s, \ln\gamma_1, \ln\gamma_2, P, RTx_1x_2/G^E$) and plot RTx_1x_2/G^E vs x_1 and find the van Laar constants A and B from the plot. The following data is available for the system,

t(deg C)	x_1	y_1
96.9	0.015	0.133
68.2	0.426	0.747
65.1	0.747	0.838
64.5	0.914	0.921

The van Laar Model is given by,

$$\frac{G^E}{RTx_1x_2} = \frac{A}{\left(\frac{A}{B}\right)x_1 + x_2}$$

The Antoine constants are given as, [$\log_{10} P = A - \frac{B}{t+C}$, P is in Torr and t is in deg C]

	A	B	C
Hexane	8.081	1582.3	239.726
Water	7.2817	1446.9	227.6