Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, July 2020

Course: Thermodynamics-II **Semester: IV**
Program: B. Tech CE+RP **Max. Marks: 100**
Course Code: CHCE-2016

Instructions:
1. Attempt all questions. Marks are shown against each question.
2. Take any missing data with proper justification.

SECTION A
(60 marks)

S. No.		Marks	CO
Q 1	A binary mixture of acetone (1) and acetonitrile (2) is flashed at temperature 340 K and 115 kPa. The overall mole fraction of acetone in the feed was 0.75. Determine the equilibrium mole fraction of liquid and vapor phase formed. Assume that Raoult's law applies. Antoine equation for acetone and acetonitrile are given below (saturation pressure is in kPa and temperature is in K) $\ln P_1^{sat} = 14.3916 - \frac{2795.82}{T - 43.15}$ $\ln P_2^{sat} = 14.7258 - \frac{3271.24}{T - 31.30}$	**10**	**CO1**
Q 2	The excess Gibbs energy for the system chloroform/ethanol at 328.15 K is represented by the Margules equation, $\frac{G^E}{RT} = (1.42\, x_1 + 0.59\, x_2) x_1 x_2$ Find the expression for activity coefficient for each species at this temperature.	**10**	**CO2**
Q 3	Estimate the fugacity of liquid water at normal boiling point and 80 bar. Data: $T_c = 647.1\ K$; $P_c = 220.55\ bar$; $\omega = 0.345$; $V_c = 55.9\ X\ 10^{-6}\ m^3/mol$	**10**	**CO2**
Q.4	Estimate the change in entropy when 2 m^3 of carbon dioxide and 4 m^3 of carbon monoxide, each at 1 bar and 500 K are blend to form a gas mixture at the same conditions. Assume ideal gases.	**10**	**CO3**
Q 5	A binary liquid system exhibits LLE at 298.15 K. Derive the expressions to estimate Margules's constant and van Laar constants for	**10**	**CO4**

	$x_1^{\alpha} = 0.2, \qquad x_1^{\beta} = 0.9$		
Q.6	A system initially containing 4 mol C_2H_4 and 6 mol of O_2 undergoes the reaction: $$C_2H_4\,(g) + \frac{1}{2}O_2(g) \;=\; C_2H_4O\,(g)$$ $$C_2H_4(g) + 3O_2(g) = 2CO_2(g) + 2H_2O(g)$$ Develop expressions for the mole fraction of the reacting species as function of reaction coordinates for the two reaction.	**10**	**CO5**
	SECTION B **(40 marks)**		
Q 7	At 298.15 K and atmospheric pressure the volume change of mixing of binary liquid mixtures of species 1 and 2 is given by the equation: $$\Delta V = x_1 x_2\,(45\,x_1 + 25\,x_2)$$ Where ΔV is in cm^3/mol. At these conditions, *V_1 = 110 and V_2 = 90 cm^3/mol*. Determine the partial molar volumes of each species containing 30 mol-% of species 1 at the given conditions.	**20**	**CO3**
Q 8	For the cracking reaction, the equilibrium conversion is negligible at 300 K, but becomes appreciable at temperature above 500 K. For a pressure of 1 bar, determine $$C_3H_8\,(g) = C_2H_4\,(g) + CH_4\,(g)$$ (a) The fractional conversion of propane at 700 K (b) The temperature at which fractional conversion is 80 % The values for ΔH^0_{298} *and* ΔG^0_{298} are 82670 and 42290 J/mol respectively. Heat capacities of gases are: $$\frac{C_p^{ig}}{R} = A + BT + CT^2$$	**20**	**CO5**

component	A	10^3 B	10^6 C
C_3H_8	1.213	28.785	-8.824
C_2H_4	1.424	14.394	-4.392
CH_4	1.702	9.081	-2.164