Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Advanced Thermodynamics CHPD 7003 **Semester: I**
Programme: M.Tech(ChE+PD)
Time: 03 hrs. **Max. Marks: 100**
Instructions: Ask for relevant tables

SECTION A **5 X 4 = 20**

S. No.		Marks	CO
Q 1	A closed system undergoes cyclic process comprised of following three steps. Step-1: The system having internal energy of 210 kJ to which 150 kJ of heat energy is added at constant volume. Step-2: The system rejects 85 kJ of heat and work done on the system is 20kJ at constantpressure. Step-3: The system is brought back to original state by an adiabatic process. Calculate the work done during the adiabatic process in Step-3.	4	CO1
Q 2	Calculate the change in entropy of 100 kg of liquid benzene when it is heated from 25 to 50 ^{o}C isobarically. Specific heat of liquid benzene in this temperature range is 0.5 J/g ^{o}C.	4	CO2
Q 3	Partial molar residual Gibbs free energy of oxygen in air at 300 K and 1 bar is 0.5 J/ mol. Calculate the fugacity of oxygen in air. Mole fraction of oxygen in air is 0.21.	4	CO3
Q 4	What is meant by pseudo component and illustrate the same with suitable examples.	4	CO4
Q 5	State the phase rule for reacting system and apply the same to the system of partial decomposition of $CaCO_3$ into an evacuated space.	4	CO5
	SECTION B **5 X 8 = 40**		
Q 6	Calculate the molar volume of propane gas at 300 ^{o}C and 50 bar while it obeys the Peng-Robinson equation. (Or) Calculate the molar volume of methane gas at 200 ^{o}C and 25 bar using Pitzer correlations for the second Virial Coefficient.	8	CO1
Q 7	Calculate the residual enthalpy of liquid cyclohexane at 45 ^{o}C and 2 bars when it obeys Van der Waals equation.	8	CO2
Q 8	Calculate the fugacity of n-butane vapor at 500 K and 20 bar using the tables of ϕ^0 and ϕ^1. (Or) Calculate the fugacity and residual Gibbs free energy of nitic oxide gas at 300 ^{o}C and 30 bar using generalized correlation for the second virial coefficient.	8	CO3
Q 9	Discuss the correlation between true boiling point and equilibrium flash vaporization curves.	8	CO4

Q 10	Calculate the equilibrium constant of the following reaction at 350 ^{o}C. N_2 (g) + $3H_2$ (g) ↔ $2NH_3$ (g)	**8**	**CO5**
	SECTION-C 2 X 20 = 40		
Q 11	(i) Derive the expression for change in entropy of mixing of ideal gases into ideal gas mixture.	**5**	**CO3**
	(ii) Calculate the G^R of the binary vapor mixture of acetone and 1,3-butadiene at 60 ^{o}C and 170 kPa. The mole fraction of acetone in the mixture is 0.28. Set all k_{ij} = 0	**15**	**CO3**
	(Or)		
	(i) Derive the relation between partial excess Gibbs free energy of a species to its activity coefficient in solution.	**6**	**CO3**
	(ii) Calculate the fugacity of liquid benzene at 150 bar and at its normal boiling point which is 80.1 ^{o}C.	**14**	**CO3**
Q12	(i) Derive the relation between equilibrium constant and Gibbs free energy change.	**5**	**CO5**
	(ii) Propane is dehydrogenated to propylene and hydrogen at 800 K. Calculate the conversion at equilibrium, assuming that all of them behave ideally.	**15**	**CO5**