Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End-Semester Examination, Jun. 2021 (ONLINE MODE)

Course: Advanced Thermodynamics **Semester: II**
Program: MTech Chemical (Spl. in Process Design) **Time : 3 hrs**
Course Code: CHPD7003 **Max. Marks: 100**
Instructions: The exam is closed book and closed notes. Use of unfair means will be severely dealt with.

SECTION A

S. No.		Marks	CO
1	Define internal energy and entropy.	**5**	**CO1**
2	State the three parameter theorem of corresponding states	**5**	**CO1**
3	What information do you require in order to completely define a system at equilibrium in the thermodynamic sense?	**5**	**CO2**
4	According to the combined first and second law, what is entropy a function of?	**5**	**CO2**
5	Explain the concept of fugacity in words.	**5**	**CO3**
6	State and explain Duhem's theorem.	**5**	**CO4**

SECTION B

S. No.		Marks	CO
1	Show that $C_P/C_V = \left(\frac{\partial V}{\partial P}\right)_T \left(\frac{\partial P}{\partial V}\right)_S$	**10**	**CO2**
2	Develop a suitable expression of $\left(\frac{\partial T}{\partial P}\right)_H \left(\frac{\partial P}{\partial T}\right)_S$ in term of PVT properties and their derivatives.	**10**	**CO2**
3	Show that if a component *i* in a mixture obeys Lewis-Randall rule, its fugacity is given by, $$\hat{f}_i = y_i P \exp\left[\int_0^P \left[\frac{Z-1}{P}\right] dP\right]_{T_{fixed}}$$	**10**	**CO3**
4	The enthalpy of mixing of a ternary solution containing components 1, 2 and 3 is: $$\Delta H_{123} = \frac{[100x_1x_2 + BD(x_1x_3 + x_2x_3)]}{[x_1 + 2x_2 + 0.5x_3]}$$ Find the partial molar enthalpy of mixing of component 2 at $x_1 = 0.4$ and $x_2 = 0.5$ (*B*,*D* are the last two digits of your SAP ID)	**10**	**CO3**
5	For a liquid mixture of benzene and cyclohexane, experimental data have shown that the activity coefficient of benzene may be expressed as:	**10**	**CO3**

	$RT \ln \gamma_B = (3800 - KT)(1 - x_B)^2$ Calculate the total enthalpy of mixing when one mole of benzene is mixed with three moles of cyclohexane. (K is the last digit of your roll number if non-zero, otherwise take it to be equal to 10)		
SECTION C			
1	Derive from first principles the condition of chemical equilibria for a two-phase system with the reaction occurring in only one of the phases	**20**	**CO4**