Name: **Enrolment No:**	

UPES
End Semester Examination, December 2023

Course: Thermodynamics of materials **Semester: V**
Programme: Int-BSc-MSc-PHYSICS **Time: 03 hrs**
Course Code: PHYS3039 **Max. Marks: 100**
Nos. of page(s) : 3

Instructions: Read all the below mentioned instructions carefully and follow them strictly

1) Write your name and enrollment no. at the top of the question paper.
2) Do not write anything else on the question paper except your name and roll number.
3) Attempt all the parts of a question at one place only.
4) Internal choices are given for question number 9 and 11.
5) CO1, CO2, CO3 & CO4 in the last column stand for course outcomes and are for official use only.

SECTION A
(Attempt all Five Questions) (5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	A system consists of gaseous H_2, O_2, H_2O and CO_2 where amount of CO_2 is specified and equilibrium constant for the reaction $2H_2(g)+O_2(g) \rightleftharpoons 2H_2O(g)$ is known. Find the number of degrees of freedom.	**4**	**CO1**
Q 2	Suppose we know that $\Delta G^0 = +200$ J/mol for the reaction $A(g) + B(s) \rightarrow C(g)$ at 25°C. ΔH and ΔS of the reaction are 20 kJ/mol and 66.44 J/K/mol respectively. Calculate the temperature at which the reaction will be spontaneous.	**4**	**CO1**
Q 3	Explain the Fick's law.	**4**	**CO2**
Q 4	Draw and compare the phase diagram of water and CO_2.	**4**	**CO2**
Q 5	A liquid has vapour pressure of 1200 mmHg at 293 K and heat of vaporization is 41 kJ/mole. Calculate the boiling point of the liquid. Given: R = 8.314 J/K/mol.	**4**	**CO3**

SECTION B
(Attempt all Questions; internal choice is given for question number 9) (4Qx10M= 40 Marks)

Q 6	(a) Draw and discuss the phase diagram of one component system which exist in two polymorphs. (b) Derive all the Maxwell's thermodynamic equation using Euler's reciprocity theorem.	**6+4**	**CO2**
Q 7	(a) Draw and label the phase diagram of $FeCl_3$-H_2O system.	**5+5**	**CO2**

	(b) Check whether the following reaction is spontaneous at 25℃ and 1000 ℃ $C(s) + H_2O(l) \rightarrow CO(s) + H_2(g)$. Given that ΔH and ΔS are 31400 Cal/mol and 32 Cal/deg at 25℃.		
Q 8	(a) Explain Hume Rothery rules with suitable examples. (b) What are the advantages and experimental evidences of two metals forming a solid solution?	**10**	**CO3**
Q 9	(a) Define peritectic temperature with a suitable example. Draw and label a phase diagram of a two-component system which undergoes peritectic reaction. **OR** Draw and discuss the phase (T-C) diagram of a liquid vapour system. (b) State Raoult's law and Henry's law. Under what conditions the two laws behave similar? Draw a P-C diagram for an ideal liquid-vapour system. **OR** Derive the Gibbs-Duhem equation.	**5+5**	**CO3**
SECTION-C (**Attempt all Questions; internal choice is given for question number 11**) **(2Qx20M=40 Marks)**			
Q10	(a) What is simple eutectic system? Draw a phase diagram for a simple eutectic system. Show how to use the Lever rule to find the ratio of number of moles of solid and liquid present in a two-component solid-liquid equilibrium system. (b) Derive Clausius - Clapeyron Equation.	**8+12**	**CO4**
Q 11	(a) Explain Kirkendall effect and kinetics of defect diffusion. **OR** Calculate the entropy change for transformation $I_2(s, 1\,atm, 298\,K) \rightarrow I_2(v, 1\,atm, 457\,K)$, Given that: $\Delta H_{fus,m}$ =15.68 kJ/mole at the melting point 113.6°C, $\Delta H_{vap,m}$ = 25.52 kJ/mol at the boiling point 184°C. $C_{p,m}(I_2,s) = 54.6+13.4\times10^{-4}$ T Joule/mole/K, $C_{p,m}(I_2, l) = 81.5$ Joule/mol/K (b) Draw a well labelled triangular phase diagram of water-chloroform-acetic acid system and explain the various regions in it. **OR** Draw the phase diagram for a solid solution. Using Lever rule derive an expression for the relative amount of solid and liquid phases.	**10+10**	**CO4**