Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) – END SEMESTER EXAMINATIONS, NOV / DEC 2024

MATERIALS SCIENCE AND ENGINEERING
Third Semester
MS23302 Metallurgical Thermodynamics
(Regulation 2023)

Time: 3hrs   Max.Marks: 100

CO 1	Identify the nature of the system and properties
CO 2	Explain the concept of internal energy, entropy and criteria for equilibrium.
CO 3	Appraise the importance of auxilliary functions and thermodynamic potentials
CO 4	Apply the concepts of thermodynamics in the behavior of solutions.
CO 5	Perceive the thermodynamic approaches towards electrochemical cells, surfaces and defects

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	Distinguish the intensive and extensive properties with example.	2	1	2
2	What is the work done by or on the closed system which is undergoing a change state by adiabatic process?	2	1	2
3	Why does the work done during an isothermal process exceed that during an adiabatic process?	2	2	2
4	Write down the equation that provides the quantitative relationship between the "entropy of a system" and its "degree of mixed-up-ness".	2	2	1
5	State Plank's heat theorem on entropy.	2	3	1
6	Write the criteria for equilibrium based on Helmholtz free energy.	2	3	2
7	Define liquidus line.	2	4	1
8	What do you understand by the thermodynamic activity of a component?	2	4	1
9	What do you understand by Pourbaix diagram? Mention its applications.	2	5	1
10	What do you meant by Chemisorption?	2	5	1

PART- B (5 x 13 = 65 Marks)
(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a)	Prove that $C_p - C_v = (\partial V/\partial T)_P [P + (\partial U/\partial V)_T]$ and discuss the contribution of internal cohesive forces towards heat capacity at constant pressure.	13	1	4
	OR			
11 (b)	One mole of N_2 gas is contained at 273 K and a pressure of 1 atm. The addition of 3000 joules of heat to the gas at constant pressure causes 832 joules of work to be done during the expansion. Calculate (i) the final state of the gas, (ii) the values of ΔU and ΔH for the change of state, and (iii) the values of C_v and C_p for N_2. Assume that nitrogen behaves as an ideal gas, and that the above change of state is conducted reversibly.	13	1	4
12 (a) (i)	State Thomsen and Clausius principle on cyclic process.	4	2	2

(ii)	Prove that the ideal gas temperature scale is identical with thermodynamic temperature scale.	**9**	2	4
	OR			
12 (b)	One mole of a monatomic ideal gas undergoes a reversible expansion at constant pressure during which the entropy of the gas increases by 14.41 J/K and the gas absorbs 6236 joules of heat. Calculate the initial and final temperatures of the gas. One mole of a second monatomic ideal gas undergoes a reversible isothermal expansion during which it doubles its volume, performs 1729 joules of work and increases its entropy by 5.763 J/K. Calculate the temperature at which the expansion was conducted.	**13**	2	4
13 (a)	Derive the MAXWELL's equation and demonstrate its usefulness in determining the entropy when the system undergoes a change of state.	**13**	3	4
	OR			
13 (b) (i)	Obtain the criteria for equilibrium based on Gibbs free energy for a closed system.	**8**	3	4
(ii)	Derive the Gibb-.Hemholtz equation.	**5**	3	3
14 (a)	Explain Henry's and Raoult's law on the behavior of solutions.	**13**	4	4
	OR			
14 (b)	Derive Gibbs-Duhem equation which describes the relationship between changes in chemical potential and mole fraction for the components in a thermodynamic system	**13**	4	4
15 (a) (i)	Derive the relationship between cell EMF (E) and free energy of the cell reaction (ΔG).	**10**	5	4
(ii)	What is the sign convention that was adopted for EMF of Daniel cell?	3	5	2
	OR			
15 (b)	Obtain a mathematical expression for Langmuir adsorption isotherm.	**13**	5	4

PART- C (1 x 15 = 15 Marks)
(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16.	Derive an expression for the theoretical calculation of specific heat capacity at constant volume using Einstein's approach. Also, compare the assumptions made by Einstein with that of Debye approach.	**15**	2	5