Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - III EXAMINATION - WINTER 2025

Subject Code: BE03021011 **Date: 15-12-2025**

Subject Name: Metallurgical Thermodynamics

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Identify difference between intensive and extensive properties with suitable examples.	**03**
	(b)	For isothermal reversible expansion of an ideal gas, derive the expression for mechanical work done.	**04**
	(c)	With reference to metallurgical thermodynamics define and explain term "System". Utilizing various criteria, classify different types system with suitable example.	**07**
Q.2	**(a)**	State the Zeroth Law of Thermodynamics and explain its importance.	**03**
	(b)	Differentiate between internal energy and enthalpy.	**04**
	(c)	Derive the relation between Cp and Cv for an ideal gas.	**07**
		OR	
	(c)	(i) Calculate standard enthalpy change for formation of ethane (C_2H_6) at 298 K from following data. $C_{(S)}+O_{2(g)}=CO_{2(g)}$ $\Delta H^0_{f,298K}$ = - 393 kJ/mol $H_{2(g)} + 1/2\ O_{2(g)}= H_2O_{(l)}$ $\Delta H^0_{f,298K}$ = - 286 kJ/mol $C_2H_{6(g)} + 7/2\ H_2O(l) = 2CO_{2(g)} + 3H_2O_{(l)}$ $\Delta H^0_{f,298K}$ = -1561 kJ/mol (ii) Calculate ΔS for melting of ice at 0°C an constant atomospheric pressure, given $dq_{rev} = \Delta H_{fusion}$ = 6.02 kJ/mol.	**07**
Q.3	**(a)**	Define heat capacity (C) and give its unit. Also derive mathematical equations Cp and Cv.	**03**
	(b)	Explain the Law of Thermodynamics that explain heat transfer under temperature gradient. With suitable example give its importance.	**04**
	(c)	Explain the First Law of Thermodynamics with its application in metallurgical processes. Illustrate with a suitable example.	**07**
		OR	
	(a)	Define chemical potential and discuss its role in phase equilibrium.	**03**
	(b)	Explain Gibbs-Helmholtz equation with its applications	**04**

	(c)	Derive Maxwell's relations and explain their importance in metallurgy.	**07**
Q.4	**(a)**	State the Third Law of Thermodynamics.	**03**
	(b)	Differentiate between ideal and non-ideal solutions.	**04**
	(c)	Explain Raoult's law, Henry's law and Sievert's Law.	**07**

OR

	(a)	Draw neat sketch for phase equilibrium of one-component system.	**03**
	(b)	Explain the statistical interpretation of entropy using Boltzmann's relation.	**04**
	(c)	Derive Gibbs-Duhem equation and explain its application in metallurgy	**07**
Q.5	**(a)**	State and explain fugacity and activity.	**03**
	(b)	Draw neat sketch and label binary phase diagram of Cu-Ni system.	**04**
	(c)	Explain Ellingham diagram using suitable example and discuss its importance in metallurgy.	**07**

OR

	(a)	Define the term free energy. Also give equation for Helmhotz's free energy and Gibb's free energy.	**03**
	(b)	Derive combined expression of first and second law of thermodynamics in terms of internal energy, enthalply, Helmhotz's free energy and Gibb's free energy.	**04**
	(c)	State and explain Gibbs Phase Rule. Also, derive expression for degrees of freedom in Gibbs Phase Rule.	**07**

***