Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III EXAMINATION – SUMMER 2025

Subject Code:3130507 Date:31-05-2025

Subject Name: Chemical Engineering Thermodynamics I

Time:02:30 PM TO 05:00 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)**	Briefly explain third law of thermodynamics	**03**
	(b)	Write a short on Hess's law of constant heat summation.	**04**
	(c)	Derive equation for the first law of thermodynamics for steady state flow process	**07**
Q.2	**(a)**	Discuss Redlich – Kwong – Soave equation of state.	**03**
	(b)	Discuss different statements of second law of thermodynamics.	**04**
	(c)	Air has volume of 0.02271 m^3/mol at 0℃ and 1 bar. The initial conditions of air are 1 bar and 25 ℃.It is compressed to 5 bar and 25 ℃ by cooling at constant pressure followed by heating at constant volume. Calculate Q, W, ΔU and ΔH. Assume that air is an ideal gas. Cv =5/2×R and Cp = 7/2×R. Take R = 8.314 J/mol K.	**07**
		OR	
	(c)	Reported values for the Virial coefficients of Isopropanol vapor at 200 ℃ are B= − 388 cm^3/mol C= − 26000 cm^6/mol^2.Calculate V and Z at 200 ℃ and 10 bar using i) the ideal gas equation ii) Truncated form of Virial equation.	**07**
Q.3	**(a)**	Define: (a) Closed system (b) Triple Point (c) Path function	**03**
	(b)	Explain in brief: Clausius inequality	**04**
	(c)	A steel casting of mass 10 kg at 800 ℃ is quenched in 100 kg water at 30℃ In an insulated container. The heat capacities of steel and water are 0.461 kJ/kg K and 4.23 kJ/kg K respectively. Calculate change in entropy of steel and water.	**07**
		OR	
Q.3	**(a)**	Discuss briefly limitations of first law of thermodynamics.	**03**
	(b)	Draw a neat sketch of The Principle of Absorption Refrigeration.	**04**
	(c)	Calculate the theoretical flame temperature for CO when burned with 100% excess air when both the reactants are at 373 K. The heat capacities (J/mol K) may be assumed constants i.e. 29.23, 34.83, 33.03, 53.59 for CO, O_2, N_2 and CO_2 respectively. The standard heat of combustion at 298 K is – 283.178 kJ/mol CO.	**07**

Q.4 **(a)** Explain concept of entropy in brief. **03**

(b) Using Maxwell equations prove that $dS = \frac{C_v}{T} dT - \frac{\left(\frac{\partial V}{\partial T}\right)_P}{\left(\frac{\partial V}{\partial P}\right)_T} dV$. **04**

(c) It is required to freeze 1 kg of water at 273 K using refrigeration machine which operates in the surroundings at 300 K. The latent heat of fusion of ice is 334.11 kJ/kg at 273 K. Determine i) minimum amount of work required ii) The heat given up to the surroundings. **07**

OR

Q.4 **(a)** Discuss T-H diagram briefly. **03**

(b) Mercury has a density of 13.69×10^3 kg/m^3 in the liquid state and 14.193×10^3 kg/m^3 in the solid state, both measured at the melting point of 234.33 K at 1 bar. If the heat of fusion of mercury is 9.7876 kJ/kg, what is the melting point of mercury at 10 bar? **04**

(c) For flow through nozzle prove that $\frac{dA}{du} = \frac{A}{u}(M^2\text{-}1)$ **07**

Q.5 **(a)** Explain throttling process. **03**

(b) Write short note on multistage compression. **04**

(c) For an Ideal gas undergoing an adiabatic process Prove that $PV^\gamma = const$ **07**

OR

Q.5 **(a)** Discuss Gibb's Phase Rule. **03**

(b) Discuss Carnot Principle with the help of P-V diagram. **04**

(c) Discuss PVT behavior of pure fluids. **07**

****