Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV (New) EXAMINATION – WINTER 2019

Subject Code: 2140502 **Date: 13/12/2019**

Subject Name: Chemical Engineering Thermodynamics - I

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.**

			MARKS
Q.1	**(a)**	State and explain the Zeroth Law of thermodynamics.	**03**
	(b)	Discuss briefly: (1) State and path functions (2) Closed and open systems.	**04**
	(c)	Derive equation for first law of thermodynamics for a steady state flow process.	**07**
Q.2	**(a)**	Explain the principle of corresponding states.	**03**
	(b)	Explain in brief : Clausius Inequality.	**04**
	(c)	Show that for a van der Waals gas, $\left[P_r + \frac{3}{V_r^2}\right]\left[V_r - \frac{1}{3}\right] = \frac{8}{3}T_r$	**07**
		OR	
	(c)	Explain PVT behavior for a pure liquid with neat diagram.	**07**
Q.3	**(a)**	State whether the following properties are extensive or intensive: (1) temperature, (2)pressure, (3) potential energy,(4) volume, (5) specific volume (6) heat capacity.	**03**
	(b)	Starting from basic principles, obtain various forms of Virial equation. Explain physical significance of Virial coefficients.	**04**
	(c)	15 kg of water is kept at temperature of 35˚ C on one side of partitioned insulated vessel while on the other side 30 kg of water at 75˚ C is kept. When the partition is removed, the two masses are mixed and uniform conditions are attained. Find (a) The overall entropy change of 45 kg of water. If 10% of total heat is lost to the atmosphere which is at 30˚ C. (b) The total change in entropy as a result of this process. Data: Average heat capacity of water = 1 kCal/kg K.	**07**
		OR	
Q.3	**(a)**	Using Maxwell's equation prove that : dH = Cp dT + V(1 – β T) dP where β = Volume expansivity.	**03**
	(b)	Distinguish between steady state and equilibrium state.	**04**
	(c)	Show that the maximum fluid velocity attainable for flow through a pipe of uniform cross-section is equal to the sonic velocity.	**07**
Q.4	**(a)**	State the third law of thermodynamics.	**03**
	(b)	Explain relation between sonic velocity, nozzle and Mach no.	**04**

(c) For the following reaction, standard heat of reaction at 298 K is 164.987 kJ. **07**

CO_2 (g) +4 H_2 (g) → 2H_2O (g) + CH_4 (g)

Calculate standard heat of reaction at 773 K. $C_p = \alpha+\beta T+\gamma T^2$, Value of constants α, β and γ are given below (J/mol K).

	α	β	γ
CO_2	26.75	42.26×10^{-3}	-14.25×10^{-6}
H_2	26.88	4.35×10^{-3}	-0.33×10^{-6}
H_2O	29.16	14.49×10^{-3}	-2.02×10^{-6}
CH_4	13.41	77.03×10^{-3}	-18.74×10^{-6}

OR

Q.4 **(a)** Write a short note on Ejector **03**

(b) Explain residual properties in brief. **04**

(c) Discuss about thermodynamic diagrams. **07**

Q.5 **(a)** Write a short note on throttling process or Joule – Thomson expansion **03**

(b) Why work required in multistage compression with inter cooling is less than that in single stage compression for same compression ratio? **04**

(c) Explain vapour compression refrigerant cycle with neat flow diagram and T-S diagram. **07**

OR

Q.5 **(a)** Explain working principle of Linde liquefaction process in brief. **03**

(b) Discuss properties of a suitable refrigerant. **04**

(c) A vapour compression refrigeration system with ammonia as the working fluid is to operate between 266 K and 300 K. Determine following: **07**

(a) COP, given that the enthalpy of saturated vapour at 266 K = 656 kJ/kg and enthalpy of superheated vapour leaving the compressor = 724 kJ/kg, enthalpy of saturated liquid at 300 K = 144 kJ/kg

(b) COP of an ideal Carnot refrigerator.

****