Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2018

Subject Code:2140502 **Date:05/12/2018**

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.**

			MARKS
Q.1	**(a)**	State whether the following properties are extensive or intensive: (a) temperature, (b) volume, (c) specific volume (d) heat capacity, (e) potential energy, (f) pressure.	**03**
	(b)	Mention various statements of second law of thermodynamics.	**04**
	(c)	Starting from fundamentals, Derive a mathematical expression of the first law of thermodynamics for a steady state flow process.	**07**
Q.2	**(a)**	Discuss strength and limitations of thermodynamics in chemical engineering.	**03**
	(b)	Explain concept of entropy in brief.	**04**
	(c)	Nitrogen gas is confined in a cylinder and the pressure of the gas is maintained by a weight placed on the piston. The mass of the piston and the weight together is 50 kg. The acceleration due to gravity is 9.81 m/s^2 and the atmospheric pressure is 1.01325 bar. Assume frictionless piston. Determine: i) The force exerted by the atmosphere, the piston and the weight on the gas if the piston is 100 mm in diameter. ii) The pressure on the gas. iii) If the gas is allowed to expand pushing up the piston and the weight by 400 mm, what is the work done by the gas in kJ?	**07**
		OR	
	(c)	Starting from basic principles, obtain various forms of Virial equation. Explain physical significance of Virial coefficients.	**07**
Q.3	**(a)**	Explain the principle of corresponding states and discuss the generalized compressibility chart.	**03**
	(b)	Explain in brief : Clausius Inequality.	**04**
	(c)	An ideal gas initially at 1 bar and 298.15 K is compressed to 5 bar and 298.15 K by a two-step process: first isobaric cooling and then isochoric heating. Calculate ΔU, ΔH, Q, and W for each step considering that heat capacities are independent of temperature, CV = 20.78 J/(mol K) and	**07**

C_P = 29.10 J/(mol K). At 298.15 K and 1 bar, the molar volume of the gas is 0.02479 m^3/mol.

OR

Q.3 **(a)** Using Maxwell's equation prove that : **03**

$dH = Cp\ dT + V(1 - \beta T)\ dP$ where β = Volume expansivity

(b) Define and explain the reversible process. Describe reversible expansion of a gas with necessary diagram. **04**

(c) Oil at 500 K is to be cooled at a 5000 kg/h in a counter-current exchanger using cold water available at 295 K. A temperature approach of 10 K is to be maintained at both ends of the exchanger. The specific heats of oil and water are 3.2 and 4.2 kJ/kg K. **07**

Calculate total entropy change in the process.

Q.4 **(a)** Define: (a) The standard heat of reaction (b) The standard heat of formation (c) The standard heat of combustion. **03**

(b) Distinguish between steady state and equilibrium state. **04**

(c) Discuss about latent heat of pure substance and derive Clapeyron equation of phase transition. **07**

OR

Q.4 **(a)** Write a note on 3rd law of thermodynamics. **03**

(b) Differentiate between reference properties, energy properties and derived properties. **04**

(c) Reported values for the Virial coefficients of Isopropanol vapor at 200 ^oC are: B = -388 cm^3/mol and C = -26000 cm^6 / mol^2. Calculate V and Z for iso-proponal vapor at 200 ^oC and 10 bar by the following equations. (i) Ideal gas equation (ii) $Z = 1 + (B/V) + (C/V^2)$ **07**

Q.5 **(a)** What are the major modifications in "Vapour absorption refrigeration cycle" as compared to "Vapour compression refrigeration cycle"? **03**

(b) Write a Short note on Ejector **04**

(c) Explain factors affecting choice of refrigerant with examples. **07**

OR

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

(b) Differentiate between Heat pump and Heat engine. **04**

(c) Discuss the Linde process for gas liquefaction. **07**

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