Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV • EXAMINATION – WINTER • 2014

Subject Code: 140502 **Date: 29-12-2014**

Subject Name: Chemical Engineering Thermodynamics -I

Time: 02:30 pm - 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.**

Q.1 **(a)** 1. Which one of the following is not an intensive variable? **07**
a) density b) molar volume c) temperature d) total volume
2. 1 °C rise in the temperature is equal to 1 K rise. State True / False.
3. What is relation between absolute pressure and gauge pressure?
4. Define internal energy.
5. What is a state function?
6. State the phase rule.
7. Which one of the following is incorrect for a reversible process?
a) it is frictionless b) it can be reversed at any point by differential change c) it passes a succession of equilibrium states d) none of the above

(b) Starting from the definition of primary thermodynamics properties, derive Maxwell's equations. **07**

Q.2 **(a)** Determine expression to estimate van der Waals EOS parameters *a* and *b* in terms of critical properties. **07**

(b) 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, W for each step considering heat capacities independent of temperature, C_V = 20.78 J/(mol K) and 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. **07**

OR

(b) Explain PVT behavior of a pure component with a T-V diagram. **07**

Q.3 **(a)** Define standard heat of reaction, standard heat of formation and standard heat of combustion with appropriate examples. **07**

(b) Calculate Z and V for ethylene at 298.15 K (25°C) and 12 bar by the three-term virial equation with the following experimental values of virial coefficients: **07**
B = – 140 cm^3 mol^{-1} and C = 7200 cm^6 mol^{-2}.

OR

Q.3 **(a)** Discuss four different correlations to estimate latent heat of vaporization of pure substances. **07**

(b) Explain how to calculate compressibility factor of a gas using Pitzer correlation. **07**

Q.4 **(a)** Discuss thermodynamic diagrams. **07**

(b) Calculate the standard heat of reaction of the methanol synthesis at 750 °C. **07**
CO (g) + 2 H_2 (g) → CH_3OH (g), consider standard heat of reaction at 298.15 K is – 90 135 J.

Species	A	B × 10^3	C × 10^6	D × 10^{-5}
CH_3OH	2.211	12.216	- 3.450	0.0
CO	3.376	0.557	0.0	- 0.031
H_2	3.249	0.422	0.0	0.083

Consider the correlation, $Cp / R = A + B T + C T^2 + D T^{-2}$, where T is in K.

OR

Q.4	**(a)**	Write a short note on entropy. State the mathematical statement of second law of thermodynamics.	**07**
	(b)	What is residual property? Derive fundamental property relation for residual properties applied to fluids of constant composition.	**07**
Q.5	**(a)**	Write a short note on vapor-compression cycle.	**07**
	(b)	What is mach number? Show that the maximum fluid velocity attainable for flow through a pipe of a uniform cross-section is equal to the sonic velocity.	**07**

OR

Q.5	**(a)**	A refrigeration machine operating at a condenser temperature of 290 K needs 1 kW of power per ton of refrigeration. Determine the coefficient of performance, the heat rejected to the condenser and the lowest temperature that can be maintained.	**07**
	(b)	Explain working principle of a heat pump.	**07**

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