

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 **07**
 Maxwell's equations.
- Q.2 (a)** Determine expression to estimate van der Waals EOS parameters *a* and *b* in **07**
 terms of critical properties.
- (b)** An ideal gas initially at 1 bar and 298.15 K is compressed to 5 bar and 298.15 K **07**
 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, $C_V = 20.78 \text{ J/(mol K)}$ and $C_P = 29.10 \text{ J/(mol K)}$. At 298.15 K
 and 1 bar the molar volume of the gas is $0.02479 \text{ m}^3/\text{mol}$.
- 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 **07**
 combustion with appropriate examples.
- (b)** Calculate Z and V for ethylene at 298.15 K (25°C) and 12 bar by the three-term **07**
 virial equation with the following experimental values of virial coefficients:
 $B = -140 \text{ cm}^3 \text{ mol}^{-1}$ and $C = 7200 \text{ cm}^6 \text{ mol}^{-2}$.
- OR**
- Q.3 (a)** Discuss four different correlations to estimate latent heat of vaporization of pure **07**
 substances.
- (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**
 $\text{CO (g)} + 2 \text{H}_2 \text{(g)} \rightarrow \text{CH}_3\text{OH (g)}$, consider standard heat of reaction at 298.15
 K is -90135 J .

Species	A	$B \times 10^3$	$C \times 10^6$	$D \times 10^{-5}$
CH ₃ OH	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, $C_p / R = A + B T + C T^2 + D T^{-2}$, 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**
