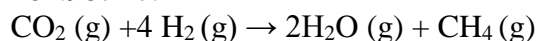


**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER– IV (New) EXAMINATION – WINTER 2019****Subject Code: 2140502****Date: 13/12/2019****Subject Name: Chemical Engineering Thermodynamics - I****Time: 10:30 AM TO 01:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

		MARKS
<b>Q.1</b>	(a) State and explain the Zeroth Law of thermodynamics.	<b>03</b>
	(b) Discuss briefly: (1) State and path functions (2) Closed and open systems.	<b>04</b>
	(c) Derive equation for first law of thermodynamics for a steady state flow process.	<b>07</b>
<b>Q.2</b>	(a) Explain the principle of corresponding states.	<b>03</b>
	(b) Explain in brief : Clausius Inequality.	<b>04</b>
	(c) Show that for a van der Waals gas, $\left[P_r + \frac{3}{V_r^2}\right] \left[V_r - \frac{1}{3}\right] = \frac{8}{3} T_r$	<b>07</b>
	<b>OR</b>	
	(c) Explain PVT behavior for a pure liquid with neat diagram.	<b>07</b>
<b>Q.3</b>	(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.	<b>03</b>
	(b) Starting from basic principles, obtain various forms of Virial equation. Explain physical significance of Virial coefficients.	<b>04</b>
	(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.	<b>07</b>
	<b>OR</b>	
<b>Q.3</b>	(a) Using Maxwell's equation prove that : $dH = C_p dT + V(1 - \beta T) dP$ where $\beta$ = Volume expansivity.	<b>03</b>
	(b) Distinguish between steady state and equilibrium state.	<b>04</b>
	(c) Show that the maximum fluid velocity attainable for flow through a pipe of uniform cross-section is equal to the sonic velocity.	<b>07</b>
<b>Q.4</b>	(a) State the third law of thermodynamics.	<b>03</b>
	(b) Explain relation between sonic velocity, nozzle and Mach no.	<b>04</b>

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



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

	$\alpha$	$\beta$	$\gamma$
CO <sub>2</sub>	26.75	$42.26 \times 10^{-3}$	$-14.25 \times 10^{-6}$
H <sub>2</sub>	26.88	$4.35 \times 10^{-3}$	$-0.33 \times 10^{-6}$
H <sub>2</sub> O	29.16	$14.49 \times 10^{-3}$	$-2.02 \times 10^{-6}$
CH <sub>4</sub>	13.41	$77.03 \times 10^{-3}$	$-18.74 \times 10^{-6}$

**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.

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