Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(New) EXAMINATION – SUMMER 2016

Subject Code:2140502 Date:03/06/2016

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.**

Q.1		**Short Questions**	**14**
	1	Distinguish between system and surroundings.	
	2	What is the difference between steady state and equilibrium state?	
	3	Explain intensive properties and extensive properties.	
	4	What do you mean by saturation pressure and saturation temperature of a substance?	
	5	What are the limitations of first law of thermodynamics?	
	6	Give the Kelvin-Plank statement of second law of thermodynamics.	
	7	Distinguish between enthalpy and entropy.	
	8	Define Helmholtz energy.	
	9	Define Gibb's free energy.	
	10	Which are the significant characteristics of ideal gas?	
	11	Define Co-efficient Of Performance.	
	12	"A good refrigerant should have low latent heat of evaporation." Justify the statement.	
	13	What is Joule-Thomson co-efficient?	
	14	Explain importance of Maxwell's equation in establishing relationship between thermodynamic properties.	
Q.2	**(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)	Discuss briefly: (1) State and path functions (2) Closed and open systems.	**04**
	(c)	Explain PVT behavior for a pure liquid with a neat diagram.	**07**
		OR	
	(c)	Derive equation for first law of thermodynamics for a steady state flow process.	**07**
Q.3	**(a)**	How many degrees of freedom have each of the following system? (1) Liquid water in equilibrium with its vapor. (2) Liquid water in equilibrium with a mixture of water vapor and nitrogen. (3)A liquid solution of alcohol in water in equilibrium with its vapour.	**03**
	(b)	1 mole of water vapour is condensed at 100° C, then cooled to 0°C and then frozen at this temperature. The heat of vapourization at the boiling point and the heat of fusion at freezing point are 539.7 and 79.7 cal/g respectively. Find ΔS for this process. C_p of water = 1 cal/gm K.	**04**
	(c)	Show that for a van der Waals gas, $P_c V_c = (3/8) R T_c$	**07**
		OR	
Q.3	**(a)**	Explain the principle of corresponding states.	**03**
	(b)	Explain in brief : Clausius Inequality.	**04**

(c) With the help of Maxwell relation, prove that $C_P - C_V = \beta^2 VT/k$. **07**
Where, $\beta = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p$, $k = \frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$.

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

(b) Prove that 'A reversible process is never attained in practice. It can only be approached' **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	26.19	14.49×10^{-3}	-2.02×10^{-6}
CH_4	13.41	77.03×10^{-3}	-18.74×10^{-6}

OR

Q.4 **(a)** Explain residual properties in brief. **03**

(b) Write short note on throttling process or Joule – Thomson expansion. **04**

(c) State types of thermodynamic diagrams and discuss any one of them. **07**

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

(b) Explain why multistage compression with inter cooling requires less work as compared to single stage compression for same compression ratio. **04**

(c) A Carnot engine is coupled to a Carnot refrigerator so that all work produced by the engine is used by the refrigerator in extraction of heat from a reservoir at 270 K at the rate of 6 kJ/s. The source of energy for the Carnot engine is heat reservoir at 500 K. If both devices discard heat to the surroundings at 300 K, how much heat does the engine absorb from 500 K heat reservoir? How much heat the engine will absorb if the Carnot engine is replaced with an actual engine with efficiency $\eta_{actual} = \eta_{Carnot}/1.5$ and Carnot refrigerator is replaced with actual refrigerator of COP $\omega_{actual} = \omega_{Carnot}/1.5$? **07**

OR

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

(b) Discuss any major four desirable properties of a good refrigerant. **04**

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

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