Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER– III (NEW) EXAMINATION – SUMMER 2015

Subject Code:2130405 **Date: 27/05/2015**
Subject Name: Thermodynamics
Time:02.30pm-05.00pm **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)** State first law of thermodynamics? Derive the expressions for 1st law of thermodynamics for non-flow process. **07**

(b) For an ideal gas undergoing adiabatic process, show that **07**

a. $(T_2/ T_1)=(V_1/V_2)^{Y-1}$

b. PV^{Y} = constant

Q.2 **(a)** Derive: $P= RT/(V-b) – a/V^2$ **07**

(b) Define: Molal heat capacity, Zeroth law of thermodynamics, Metastable system, Kinetic Energy, Isolated system, Enthalpy, Thermodynamics **07**

OR

(b) One mole of a gas which obeys the relation PV=RT, where R=8.314 J/mol K is initially at 300K and 0.1MPa. The gas is heated at constant volume till the pressure rises to 0.5MPa and then allowed to expand at constant temperature till the pressure reduces to 0.1MPa. Finally the gas is returned to its original state by compressing at constant pressure. Calculate the work done by the gas in each of the processes and also estimate the net work done by the gas. **07**

Q.3 **(a)** Explain effect of temperature on standard enthalpy change of a reaction. **07**

(b) What does the Kelvin- Plank statement and Clausius statement of the second law of thermodynamics say? **07**

OR

Q.3 **(a)** In the northern states of India, the ambient atmosphere temperature greatly varies from season to season leading to uncomfortable conditions for living. In summer the temperature rises to as high as 42°C and in winter it drops to as low as 0°C. An engineer designs a device which can be used as a refrigerating unit in summer and as a heat pump in winter to maintain a comfortable temperature of 25°C inside the house in all seasons. The rate of energy losses as heat from the windows, walls and roof is estimated as 0.5 kW per degree Celsius temperature difference between the ambient atmosphere and the conditions inside the room. Estimate the minimum power required to operate the device in winter and in summer. **07**

(b) What is state of equilibrium? Classified equilibrium states of system. **07**

Q.4 **(a)** Derive Maxwell equations using fundamental property relations for a homogeneous fluid of constant composition. **07**

(b) Write about different types of thermodynamic diagrams used in the study of thermodynamic properties of fluids. **07**

OR

Q.4 **(a)** For the two-phase systems, derive the Clausius / Clapeyron equation relating latent heat of vapourization directly to the vapour-pressure curve. **07**

(b) Prove that heat absorbed during a process is approximately equal to the change in entropy **07**

Q.5 **(a)** One method for the manufacture of "synthesis gas" (a mixture of CO and H_2) is the catalytic reforming of CH_4 with steam at high temperature and atmospheric pressure: **07**

$$CH_4\ (g) + H_2O\ (g) \rightarrow CO\ (g) + 3H_2\ (g) \qquad \Delta H°_{298} = 205813J$$

The only other reaction to be considered is the water gas shift reaction:

$$CO\ (g) + H_2O\ (g) \rightarrow CO_2\ (g) + H_2\ (g) \qquad \Delta H°_{298} = -41166J$$

If the reactants are supplied in to ratio, 2 mol steam to 1 mol CH_4, and if heat is supplied to the reactor so that the products reach a temperature of 1300K, the CH_4 is completely converted and the product stream contains 17.4 mole %CO. assuming the reactants to be preheated to 600K, calculate the heat requirement for the reactor

Component	**A**	**B*10^3**	**C*10^6**	**D*10^{-5}**
CH_4	1.702	9.081	-2.164	-
H_2O	3.470	1.450	-	0.121
CO	3.376	0.557	-	-0.031
H_2	3.249	0.422	-	0.083
CO_2	5.457	1.045	-	-1.157

(b) For a vapour compression refrigeration machine, explain the effect of undercooling and superheating on the COP with neat sketch **07**

OR

Q.5 **(a)** Derive Carnot equations for a Carnot cycle using an ideal gas **07**

(b) Show that COP of a heat pump is greater than COP of a refrigerator by unity **07**

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