Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Examination January 2010

Subject code:711101

Subject Name: Advanced thermodynamics and Heat Transfer

Date: 20 / 01 / 2010 **Time: 12.00 – 2.30 pm**

Total Marks: 60

Instructions:

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

Q.1 **(a)** What do you understand by chemical potential? What are the criteria for thermal equilibrium? What are the different types of equilibrium? **06**

(b) Differentiate between thermal conductivity and thermal diffusivity. Give their units. What are the factors that affect these properties of the material? **06**

Q.2 **(a)** Define entropy and show that it is a property of the system. Give the physical interpretation and significance of it. **06**

(b) Derive the generalized equation for a fin. **06**

OR

(b) Derive the expression for temperature distribution for two dimension conduction in a semi infinite strip of a long rectangular rod. **06**

Q.3 **(a)** Prove that the temperature of a body at any time τ during Newtonian heating or cooling is given by the relation $(t - t_a) / (t_i - t_a) = \exp (- B_i F_o)$ where B_i and F_o are the Biot and Fourier numbers respectively, t_a is the ambient temperature and t_i is the initial temperature of the body. **06**

(b) Derive the expression for the instantaneous and total heat flow rate for transient heat conduction in solids. (lumped parameter analysis) **06**

OR

Q.3 **(a)** Write a short note on Radiation from gases, vapors and flames. **06**

(b) A fluid is passed through a 20cm diameter pipe whose surface is maintained at a constant temperature. At the inlet section, the temperature of the pipe wall exceeds the fluid temperature by 25^oC. How much would the fluid temperature increase over a 2.5 m length of the pipe? The inter relationship between energy and momentum transfer for turbulent flow through a pipe is prescribed by the Reynolds analogy $S_t = h / (\rho c_p V) = f / 8$. The friction factor $f = 0.02$. **06**

Q.4 **(a)** The inner and outer surfaces of a furnace wall, 25 cm thick, are at 300^oC and 30^oC respectively. The thermal conductivity of wall material varies with temperature and is prescribed by the relation : $k = (1.45 + 0.5 \times 10^{-5} t^2)$ kJ / m-hr-deg, where t is the temperature in degree centigrade. Calculate the heat loss per square meter of the wall surface area. **06**

(b) Show that for a plane wall of thickness 2l with a uniformly distributed heat generation q_g per unit volume, the temperature t_0 at the mid plane is given by the relation $t_0 = (q_g l^2 / 2k) + t_w$ where t_w is the temperature on either side of the wall and k is the thermal conductivity of wall material. **06**

OR

Q.4	**(a)**	Show that $(\partial u / \partial p)_T = - T (\partial v / \partial T)_p - p (\partial v / \partial p)_T$	**06**
	(b)	State the Claeyron equation and its practical utility.	**06**
Q.5	**(a)**	Define Helmholtz and Gibbs free energy. Explain the physical significance.	**06**
	(b)	Define and explain "Zeroth Law of Thermodynamics". Give the methods of establishing the " absolute temperature scale".	**06**

OR

Q.5	**(a)**	Write down the four Tds equations.	**06**
	(b)	State third law of thermodynamics and discuss its importance.	**06**

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