Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER 2012

Subject code: 711101N Date: 08-01-2013

Subject Name: Advanced Thermodynamics & Heat Transfer

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)** Show that the adiabatic mixing of two fluids is irreversible. **07**

(b) Explain the amount of entropy generation quantifies the intrinsic irreversibility of a process. Also show that S_{gen} is not a thermodynamic property. **07**

Q.2 **(a)** Show that the efficiency of all reversible heat engines operating between the same temperature levels is the same. **07**

(b) Deduce the expression for available energy from a finite energy source at temperature T when the environmental temperature is T_0. **07**

OR

(b) Derive expressions for the irreversibility and second law efficiency of a, (1) Steam Turbine. (2) Compressor. (3) Heat Exchanger. (4) mixer. **07**

Q.3 **(a)** Define the second law efficiency. How is it different from the first law efficiency in the case of a simple power plant? **07**

(b) Calculate the decrease in available energy when 25 kg of water at 95 ^{0}C mix with 35 kg of water at 35 ^{0}C, the pressure being taken as constant and the temperature of the surroundings being 15 ^{0}C. Take c_p of water is 4.2 kJ/kg K. **07**

OR

Q.3 **(a)** Derive the Maxwell relations and explain their importance in thermodynamics. **07**

(b) Show that the rate of heat conduction through a hollow sphere is given by, **07**

$$Q_k = -kA_{gm}\frac{T_2 - T_1}{x_w}$$

Where, $A_{gm} = (A_1A_2)^{1/2}$ A_1 and A_2 being the areas of inside and outside surfaces of the sphere and x_w = wall thickness.

Q.4 **(a)** Determine the optimum shape of a fin having the minimum weight for a given heat flow. Explain how the triangular fin is of the best shape. **07**

(b) A short cylinder initially at a uniform temperature T_i is subjected to convection from all of its surfaces to a medium at temperature T_∞. Explain how you can determine the temperature of the midpoint of the cylinder at a specified time. **07**

OR

Q.4 **(a)** The cooling system of an electronic package has to dissipate 0.153 kW from the surface of an aluminum plate 100 mm x 150 mm. It is proposed **07**

to use eight fins, each 150 mm long and 1 mm thick. The temperature difference between the plate and the surroundings is 50 K, the thermal conductivity of plate and fins is 0.15 kW/m K and the heat transfer coefficient is 0.04 kW/m^2 K. Calculate the height of fins required.

(b) Show physical significance of Following non-dimensional numbers: **07**
Nu (Nusselt Number), Gr (Grashof Number) and Pr (Prandtl Number), Re (Reynold Number).

Q.5 **(a)** What do you mean by von Karman's integral method? How is it used in deriving the drag force and heat transfer coefficient for flow over a flat plate? **07**

(b) Show that for laminar flow of air (P_r = 0.714), the local and average values of Nusselt number for natural convection heat transfer from or to a vertical plate are given by, **07**

$$Nu_x = 0.378\, Gr_x^{1/4}$$

OR

Q.5 **(a)** Explain Hottel's crossed string method for estimating shape factor for infinitely long surfaces. Derive the expression for F_{12} in terms of areas and lengths of surfaces. **07**

(b) In a 25 mm diameter tube the pressure drop per meter length is 0.0002 bar at a section where the mean velocity is 24 m/s and the mean specific heat of the gas is 1.13 kJ/kg K. Calculate the heat transfer coefficient. **07**

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