Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER I (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 711101N **Date:16/05/2016**

Subject Name: Advanced Thermodynamics and Heat Transfer

Time:02:30 pm to 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 transfer of heat through a finite temperature difference is irreversible. **07**

(b) What does conduction refer to? State Fourier's law of heat conduction. Why is the negative sign used? **07**

Q.2 **(a)** Consider a medium in which the heat conduction equation is given in its simplest form as **07**

$$\frac{\partial^2 y}{\partial x^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$$

(i) Is heat transfer steady or transient?
(ii) Is heat transfer one two or three dimensional?
(iii) Is there heat generation in the medium?
(iv) Is the thermal conductivity of the medium constant or variable?

(b) If a fin is thin and long and tip loss is negligible show that the heat transfer from the fin is given by **07**

$Q_{0=}mkA\theta_0 \tanh ml$ where $m = \sqrt{\frac{hP}{kA}}$

OR

(b) An array of 10 rectangular fins of anodized aluminum (k = 180 W/m°C) is used to cool transistor operating at a location where the ambient conditions correspond to temperature 35°C and convective coefficient 12 W/m^2°C. Each fin measures 3 mm wide ×0.4 mm thick × 5 cm length and has its base at 60 °C. Determine the power dissipated by the fin array. **07**

Q.3 **(a)** What are Heisler charts? How these charts are used to obtain temperature distribution when both conduction and convection resistance are almost of equal importance. **07**

(b) Air at atmospheric pressure and 20°C flows past a flat plate with a velocity of 4 m/s. The plate is 30 cm wide is heated uniformly throughout its entire length and is maintained at a surface temperature of 60°C. Make calculation for following parameters at 40 cm distance from the leading edge: **07**
(i) thickness of hydrodynamic and thermal boundary layers
(ii) local and average frictional coefficient
(iii) local and average heat transfer coefficient

OR

Q.3 **(a)** Show physical significance of Following non-dimensional numbers: **07**
Nu (Nusselt Number), Gr (Grashof Number) Pr (Prandtl Number) and Re (Reynold Number).

(b) 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**

Q.4 **(a)** What is Wien's displacement law? Derive an expression for its relation. What is a diffuse body? **07**

(b) Explain Hottel's crossed string method for estimating shape factor for infinitely **07**

long surfaces. Derive the expression for F12 in terms of areas and lengths of surfaces.

OR

Q.4 **(a)** Steam enters a turbine steadily at 3 MPa and 450°C at a rate of 8 kg/s and exits at 0.2 MPa and 150°C. The steam is losing heat to the surrounding air at 100 kPa and 25°C at a rate of 300 kW, and the kinetic and potential energy changes are negligible. Determine (a) the actual power output, (b) the maximum possible power output, (c) the second-law efficiency, (d) the exergy destroyed, and (e) the exergy of the steam at the inlet conditions **07**

(b) What are Helmholtz function and Gibbs function? **07**

Q.5 **(a)** What is Joule Thomson coefficient? Why is it zero for an ideal gas? **07**

(b) Derive the following using first and second Tds equations **07**

$$Cp - Cv = \frac{TV\beta^2}{K_T}$$

Where, β is volume expansivity and K_T is isothermal compressibility

OR

Q.5 **(a)** A system at 500 K receives 7200 kJ/min from a source at 1000 K. The temperature of atmosphere is 300 K. assuming that the temperature of system and source remain constant during heat transfer find out: **07**

(i) The entropy produced during heat transfer

(ii) The decrease in available energy after heat transfer

(b) Derive all the four Maxwell Relations using four perfect differentials given below: **07**

du = Tds – pdv; dh = Tds + vdp; dg = vdp – sdT;and df = - pdv - sdT

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