

GUJARAT TECHNOLOGICAL UNIVERSITY
ME - SEMESTER- I • EXAMINATION – WINTER 2014

Subject Code: 2711101**Date: 13/01/ 2015****Subject Name: Advanced Thermodynamics & Heat Transfer****Time: 02:30 p.m. to 05:00 p.m.****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) Write down the expressions for the physical laws that govern each mode of heat transfer, and identify the variables involved in each relations **07**
- (b) Explain briefly the law of corresponding states **07**
- Q.2** (a) What do you understand by entropy transfer? Why is entropy transfer associated with heat transfer and not with work transfer? **07**
- (b) 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**
- OR**
- (b) Derive the expression for the availability associated with the fluid stream from open system in steady state condition. **07**
- Q.3** (a) Describe different types of boundary conditions applied to heat conduction problem **07**
- (b) Steam in a heating system flows through tubes whose outer diameter is $D_1 = 3$ cm and whose walls are maintained at a temperature of 120°C. Circular aluminum fins ($k = 180 \text{ W/m} \cdot ^\circ\text{C}$) of outer diameter $D_2 = 6$ cm and constant thickness $t = 2$ mm are attached to the tube. The space between the fins is 3 mm, and thus there are 200 fins per meter length of the tube. Heat is transferred to the surrounding air at $T_\infty = 25^\circ\text{C}$, with a combined heat transfer coefficient of $h = 60 \text{ W/m}^2 \cdot ^\circ\text{C}$. Determine the increase in heat transfer from the tube per meter of its length as a result of adding fins. **07**
- OR**
- Q.3** (a) What is the physical significance of Biot Number? Is the Biot number more likely to be large for highly conducting solids or poorly conducting ones? **07**
- (b) Discuss the numerical formulation and solution of two-dimensional steady heat conduction in rectangular coordinates using the finite difference method. **07**
- Q.4** (a) Express the similarity of momentum and energy equation for flow over a flat plate. How are their solutions identical for fluids having $\nu = \alpha$ **07**

- (b) A 6-m-long section of an 8-cm-diameter horizontal hot water pipe passes through a large room whose temperature is 20°C. If the outer surface temperature of the pipe is 70°C, determine the rate of heat loss from the pipe by natural convection. The properties of air at the film temperature of $T_f = 45^\circ\text{C}$ and 1 atm are : $k = 0.02699 \text{ W/m } ^\circ\text{C}$; $\text{Pr} = 0.7241$; $\nu = 1.749 \times 10^{-5} \text{ m}^2/\text{s}$;
 $\beta = 1/T_f = 1/318\text{K}$ 07
- Q.4** (a) What is the physical significance of Grashof number with reference to heat transfer by natural convection? What is Rayleigh number? 07
- (b) Water flows through a 20 mm ID at a rate of 0.01 kg/s entering at 10°C. The tube is wrapped from outside by an electric heating element that produces a uniform flux of 15 kW/m^2 . If the exit temperature of water is 40°C, estimate (a) Reynold number (b) the heat transfer coefficient (c) the length of pipe needed. Properties of water at mean temperature of 25°C are: $\rho = 997 \text{ kg/m}^3$, $C_p = 4180 \text{ J/kgK}$, $\mu = 910 \times 10^{-6}$, and $k = 0.608 \text{ W/mK}$. 07
- Q.5** (a) Define the properties emissivity and absorptivity. When are these two properties equal to each other? 07
- (b) Draw the boiling curve and identify the different boiling regimes. Also, explain the characteristics of each regime. 07
- Q.5** (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) Explain Hottel's crossed string method for estimating shape factor for infinitely long surfaces. Derive the expression for F12 in terms of areas and lengths of surfaces. 07
