Seat No.: _____ Enrolment No._____

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 W/m · °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 $T_Ð$ = 25°C, with a combined heat transfer coefficient of h = 60 W/m2 · °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 з = Ŭ	**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 Tf = 45°C and 1 atm are : k = 0.02699 W/m °C; Pr = 0.7241; ɜ= 1.749× 10^{-5} m2/s; ɓ= $1/T_f$ = 1/ 318K **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: ɟ = 997 kg/m^3, C_p= 4180 J/kgK, µ = 910 ×10^{-6}, and k = 0.608 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 Hottelôs 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**

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