Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– I (New course)• REMEDIAL EXAMINATION – SUMMER 2015

Subject Code: 2711101 Date:13/05/2015

Subject Name: Advanced Thermodynamics & Heat Transfer

Time: 10:30 am to 1:00 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)** What are the mechanisms of heat transfer? How are they distinguished from each other? **07**

(b) Explain in brief the increase of entropy principle **07**

Q.2 **(a)** Derive an expression for the availability of a closed system. **07**

(b) 5 kg of air at 550K and 4 bar is enclosed in a closed system. Determine the availability of the system is the surrounding pressure and temperature are 1 bar and 290K respectively. **07**

OR

(b) A heat source at 800 K loses 2000 kJ of heat to a sink at (a) 500 K and (b) 750 K. Determine which heat transfer process is more irreversible. **07**

Q.3 **(a)** Derive the general heat conduction equation for Cartesian Co-ordinates **07**

(b) A carbon steel rod (k =55 W/m°C) has been attached to a plane wall which is maintained at a temperature of 350°C. The rod is 8 cm long and has cross section of an equilateral triangle with each side 5 mm. Determine the heat dissipation from the rod if it is exposed to a convection environment at 25°C with value of h = 100 W/m^2°C). Consider end surface loss to be negligible. **07**

OR

Q.3 **(a)** Prove that the temperature of a body at any time τ during Newtonian heating or cooling is given by the relation **07**

$$\frac{t-t_a}{t_i-t_a} = \exp\,[-B_i F_o],$$

Where B_i and F_o are the Biot and Fourier modulus respectively; t_a is ambient temperature and t_i is the initial temperature of the body.

(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)** What do you understand by the hydrodynamic and thermal boundary layers? Illustrate with reference to flow over a flat heated plate. **07**

(b) Engine oil at 60°C flows over the upper surface of a 5-m-long flat plate whose temperature is 20°C with a velocity of 2 m/s. Determine the total drag force and the rate of heat transfer per unit width of the entire plate. The properties of engine oil at the film temperature of T_f = 40°C are ρ = 876 kg/m^3 Pr = 2870 k = 0.144 W/m°C ν = 242×10^{-6} m2/s **07**

Q.4 **(a)** What is natural convection? How does it differ from forced convection? What force causes natural convection currents? **07**

(b) Hot air at atmospheric pressure and 80°C enters an 8ï m-long uninsulated square duct of cross section 0.2 m × 0.2 m that passes through the attic of a house at a rate of 0.15 m^3/s. The duct is observed to be nearly isothermal at 60°C. Determine the exit temperature of the air and the rate of heat loss from the duct to the attic space. Use following properties of air for the calculation. ɟ = 0.9994 kg/m^3, C_p= 1008 J/kgK, μ = 910 ×10^{-6}, k = 0.02953 W/mK, Pr= 0.7154, ν = 2.097 ×10^{-5} m2/s. **07**

Q.5	**(a)**	Explain Kirchhoffôs law. What do you mean by the statement: A perfect absorber of radiant energy is also a perfect emitter?	**07**
	(b)	How does the Nusseltôs equation for condensation on a horizontal tube differ from that on a vertical tube?	**07**
Q.5	**(a)**	Draw the boiling curve and identify the burnout point on the curve. Explain how burnout is caused. Why is the burnout point avoided in the design of boilers?	**07**
	(b)	Explain how Hottelôs curves can help in estimating radiant heat exchange between a gas volume and an enclosure.	**07**

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