Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2711101 Date:17/05/2016

Subject Name: Advanced Thermodynamics & 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)** An iron cube at a temperature of 400°C is dropped into an insulated bath containing 10 kg water at 25°C. The water finally reaches a temperature of 50°C at steady state. Given that the specific heat of water is equal to 4186 J/kg K. Find the entropy changes for the iron cube and the water. Is the process reversible ? If so why ? **07**

(b) 5 kg of air at 550 K and 4 bar is enclosed in a closed system. (i) Determine the availability of the system if the surrounding pressure and temperature are 1 bar and 290 K respectively. (ii) If the air is cooled at constant pressure to the atmospheric temperature, determine the availability and effectiveness. **07**

Q.2 **(a)** The temperature distribution across a wall 1m thick at a certain instant of time is given as $T(x) = a + bx + cx^2$ where T is in degree Celsius, x is in meters, while a = 900 ^oC, b= -300 $^oC/m$ and c = -50 $^oC/m^2$. A uniform heat generation of 1000 W/m^3 in wall of area 10 m^2 is present, having properties ρ = 1600 kg/m^3, k = 40 W/m.K, C_p = 4 kJ/kg.K. Determine (i) Rate of rate of heat transfer entering the wall and leaving the wall (ii) Rate of change of energy storage in the wall. **07**

(b) Explain exergy balance for closed processes. **07**

OR

(b) Explain entropy generation in open and closed system. **07**

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

(b) Explain numerical analysis for two dimensional heat conduction. **07**

OR

Q.3 **(a)** Derive temperature profile equation and heat transfer from triangular fin. **07**

(b) Explain lumped parameter analysis and derive it's governing equation. **07**

Q.4 **(a)** Explain the following term in relation with natural convection heat transfer including its physical significance : 1) Buoyancy force 2) Rayleigh number 3) Grashof number 4) Nusselt number **07**

(b) 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**

OR

Q.4 **(a)** Explain the fluid flow along a flat plate **07**
1) Temperature distribution in thermal boundary layer
2) Velocity distribution in hydrodynamic boundary layer
3) Variation of local heat coefficient along the flow

(b) Derive necessary Von-Karman's expression for convection heat transfer. **07**

Q.5 **(a)** What is shape factor? Discuss the salient features of the shape factor for analysis of radiant heat exchange between surfaces. **07**

(b) Two parallel vertical plates each 80 mm high and at 85 ^{o}C are placed in a tank of water at 15 ^{o}C. Calculate the minimum spacing which will prevent interference of the free convection boundary layer. Take (properties of water at 50 ^{o}C) as k = 0.659 W/m.K, ρ = 988.1 kg/m^3, μ = 549.2 x 10^{-6} kg/m.s, Pr = 3.54, $\beta = 4.574 \; x \; 10^{-4}$ **07**

OR

Q.5 **(a)** State and explain any three laws of radiation **07**

(b) A gray, diffuse opaque surface (α = 0.8) is at 100 ^{o}C and receives an irradiation 1000 W/m^2. If the surface area is 0.1 m^2, Calculate 1) Radiosity of the surface, 2) Net radiative heat transfer rate from the surface and 3) Above quantities, if surface is black. **07**

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