Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) • EXAMINATION – WINTER 2016

Subject Code:2171911 Date:18/11/2016

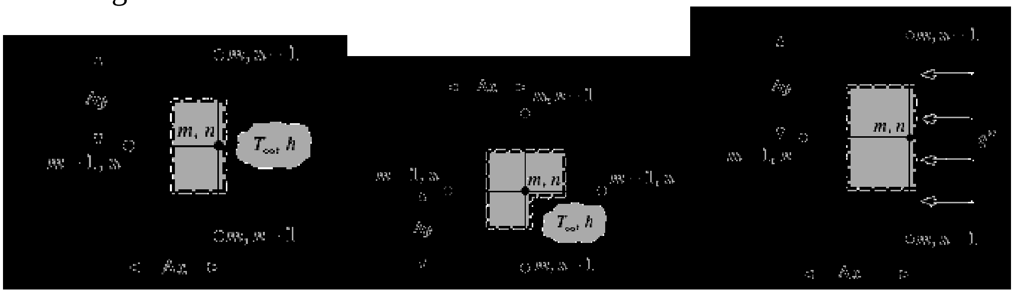
Subject Name: Advance Heat Transfer(Department Elective - I)

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.**
4. **Tables for properties of air and water are permitted.**

Q.1 **(a)** Write the finite-difference equations under steady-state conditions for the following situations: **07**



(i) (ii) (iii)

(b) In a wind tunnel, air at 5 m/s flows over a flat plate and 15^{o}C, 1 m x 0.8 m in size. The surface temperature of plate is 35^{o}C. One of the side of the plate is arranged parallel to the flow direction, such that the heat transfer is lesser, estimate: **07**

(i) Rate of heat transfer from the one side of plate

(ii) Initial rate of cooling per hour of the plate, if mass of the plate is 5 kg and specific heat is 875 J/kg.K.

(iii)If the flow is turned off, compute the heat flow rate from the upper surface of the plate in still air at 15^{o}C.

(iv)What is the percentage change in heat flow rate?

The thermo-physical properties of air are as follows:

ρ= 1.1707 kg/m^3 , ν = 15.172 x 10^{-6} m^2/s , k= 0.02614 W/mK, C_p=1007 J/KgK, Pr = 0.7075

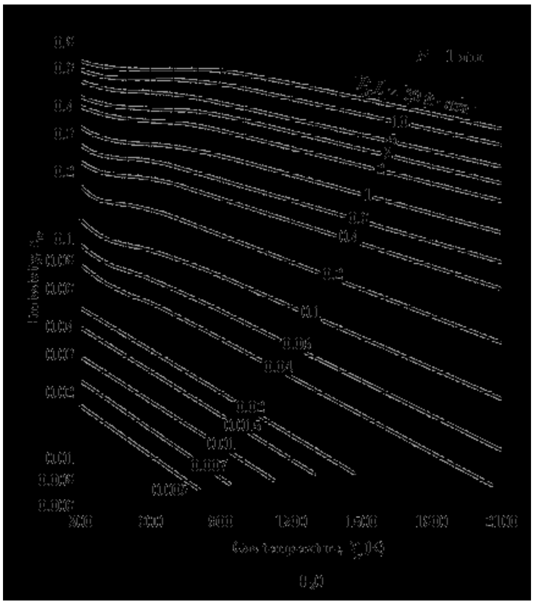
Use the following correlations:

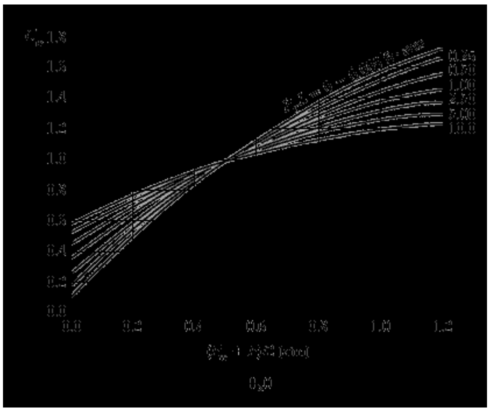
For free convection: Nu= 0.27 (Gr. Pr)$^{0.25}$

For forced convection: Nu= 0.664 (Re)$^{0.5}$ (Pr)$^{0.33}$

Q.2 **(a)** A cylindrical furnace whose height and diameter are 5 m contains gases at 1200 K and a total pressure of 2 atm. The composition of the gases is determined by volumetric analysis to be 85 percent N_2, 8 percent H_2O, 7 percent O_2. Determine the effective emissivity of the gases. Consider L = 0.6D **07**

Make use of following charts





(b) Consider three consecutive nodes n - 1, n, and n + 1 in a plane wall. Using the finite difference form of the first derivative at the midpoints, show that the finite difference form of the second derivative can be expressed as **07**

$$\frac{T_{m-1} - 2T_m + T_{m+1}}{\Delta x^2} = 0$$

OR

(b) Define these terms used in the finite difference formulation: node, nodal network, volume element, nodal spacing, and difference equation. **07**

Q.3 **(a)** What is an irregular boundary? What is a practical way of handling irregular boundary surfaces with the finite difference method? **07**

(b) In a production facility, large brass plates of 4 cm thickness that are initially at a uniform temperature of 20°C are heated by passing them through an oven that is maintained at 500°C. The plates remain in the oven for a period of 7 min. Taking the combined convection and radiation heat transfer coefficient to be h = 120 $W/m^2.°C$, determine the surface temperature of the plates when they come out of the oven using Heisler charts (given at end of paper). **07**
The properties of brass at room temperature are k = 110 W/m·°C, ρ = 8530 kg/m^3, C_p = 380 J/kg · °C, and α = 33.9 10^{-6} m^2/s

OR

Q.3 **(a)** Define fin efficiency and fin effectiveness. Why is the insulated-tip solution important for the fin problems? **07**

(b) Explain radial fins of rectangular and parabolic profiles. **07**

Q.4 **(a)** Explain the mechanism of laminar film condensation on a vertical plate. **07**

(b) The water flows at 20°C enters a 2 cm diameter tube with a velocity of 1.5 m/s. The tube is maintained at 100°C. Find the tube length required to heat the water to a temperature of 60°C. **07**
The properties of water are:
ρ = 992.2 kg/m^3 , ν = 0.659 x 10^{-6} m^2/s , k= 0.634 W/mK ,C_p= 4.174 kJ/KgK, Pr= 4.31

OR

Q.4 **(a)** Discuss the various regimes of pool boiling with neat sketch. **07**

(b) Explain heat transfer in high velocity flow with neat sketch. **07**

Q.5 **(a)** What is Beer's law? **07**
Why do surfaces absorb differently for solar or earthbound radiation?

(b) How is the insulating effect of clothing expressed? How does clothing affect heat loss from the body by convection, radiation, and evaporation? How does clothing affect heat gain from the sun? **07**

OR

Q.5 **(a)** What is latent heat? How is the latent heat loss from the human body affected by (a) skin wettedness and (b) relative humidity of the environment? How is the rate of evaporation from the body related to the rate of latent heat loss? **07**

(b) A long, circular aluminum rod is attached at one end to a heated wall and transfers heat by convection to a cold fluid. **07**

(i) If the diameter of the rod is tripled, by how much would the rate of heat removal change?

(ii) If a copper rod of the same diameter is used in place of the aluminum, by how much would the rate of heat removal change?

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