Code No: I2103/R16

M. Tech. I Semester Regular/Supple Examinations, Jan/Feb-2018

ADVANCED HEAT AND MASS TRANSFER/ ADVANCED HEAT TRANSFER

Common to Thermal Engineering (21) and Thermal Sciences And Energy Systems (18)

Time: 3 Hours **Max. Marks: 60**

Answer any FIVE Questions
All Questions Carry Equal Marks

1. a What are Heisler charts? Explain its significance. [4]
   b A short cylindrical aluminium bar, having thermal conductivity, 200W/m.K and thermal diffusivity, 8.4 X 10^{-5} m^2/s of diameter 6 cm and height 3 cm is initially at a uniform temperature of 175^0C. Suddenly the surfaces are subjected to convective cooling with a heat transfer coefficient of 250 $W/m^2.K$ into an ambient at 25^0C. Calculate the center temperature of the cylinder one minute after the start of cooling. [8]

2. a Explain Dirichlet and Newmann Boundary conditions as applied to conduction with examples. [4]
   b Write the finite difference form of the two dimensional steady state heat conduction equation with internal heat generation at a constant rate ‘g’ for a region 0.03m X 0.03m by using a mesh size $\Delta x=\Delta y=$ 0.01 m for a material having thermal conductivity 25 W/m.K and heat generation rate, 10^7 W/m^3. All the boundary surfaces are maintained at 10^0C. Express the finite difference equations in matrix form for the unknown node temperatures. [8]

3. a Discuss the assumptions made in the Nussels theory of film condensation on a vertical plate. [4]
   b Prove that by using dimensional analysis Nusselt number is a function of Reynolds number and Prandtl number in forced convection. [8]

4. a Explain in detail, the differences between implicit and explicit methods. [4]
   b By using approximate integral boundary layer analysis, derive the equation for the local heat transfer coefficient for the flow over flat plate in terms of the Reynolds number. [8]

5. a Explain and discuss the significance of (i) Rayleigh number and (ii) Nusselt number in natural convection. [4]
   b Air at 20^0C flowing at 25 m/s passes over a flat plate, the surface of which is maintained at 270^0C. Calculate the rate at which heat is transferred from both the sides of the plate per unit width over a distance of 0.25 m from the leading edge. Properties of air at 145^0C are Prandtl number = 0.687; Viscosity = 2.8 X 10^{-5} m^2/s and thermal conductivity = 3.49 X 10^{-5} kW/m.K. [8]

6. a Write short notes on Gas radiation. [4]
   b A 15 cm outer diameter steel pipe lies 2m vertically and 8 m horizontally in a large room with an ambient temperature of 30^0C. If the pipe surface is at 250^0C, calculate the total rate of heat loss from the pipe to the atmosphere. Properties of air at 140^0C are density = 0.854 kg/m^3; specific heat, c_p= 1.01 kJ/kg.K; thermal conductivity = 0.035 W/m.K; Prandtl number = 0.684 and viscosity = 27.8 X 10^{-6} m^2/s. [8]

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7. Draw the radiation network for a specular diffuse surface losing heat to a large enclosure. Obtain an expression for the heat transfer under these circumstances. How does this heat transfer compared with that which would be lost by a completely diffuse surface with the same emissivity. [12]

8. a Define Schmidt and Lewis numbers. Discuss the significances of each. [4]
   b Assuming laminar film condensation, calculate the ratio of condensing heat transfer coefficient on a vertical tube to that of a horizontal tube of same diameter and length. [8]

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