R17

Code No:5421AB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech I Semester Examinations, December – 2018/ January - 2019

ADVANCED HEAT TRANSFER

(Thermal Engineering)

Time: 3hrs Max.Marks:75

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) Show that the radial heat conduction through a hollow cylinder depends on the logarithmic mean area of the inside and outside surfaces. [5]

b) Explain in detail, the differences between implicit and explicit methods. [5]

c) Explain the principle of dimensional homogeneity. How is it utilized in deriving the dimensionless groups? [5]

d) Explain the significance of combined forced and natural convection. [5]

e) Discuss the assumptions made in the Nusselts theory of film condensation on a vertical plate. [5]

PART - B

5 × 10 Marks = 50

2.a) Can fins prove not only not effective but also counterproductive? Discuss.

b) Derive the 1D steady state heat conduction equation for a slab with internal heat generation. [5+5]

OR

3. Determine the current in amperes that is passed through a stainless steel wire (k = 15.1 W/m K), 3 mm in diameter. The electrical resistivity of the steel is 70 micro ohm cm and the maximum temperature of the wire is 236^{0}C. The wire is submerged in a liquid at 110^{0}C with a convection heat-transfer coefficient of 400 W/m^2 K. [10]

4. a) Define and explain the physical significance of Biot and Fourier numbers.

b) A short iron cylinder (k = 60 W/m K, $\alpha = 1.6 \times 10^{-5}$ m^2/s) of diameter 5 cm and height 4 cm is initially at a uniform temperature of 225^{0}C. Suddenly the boundary surfaces are exposed to an ambient fluid at 25^{0}C with a heat transfer coefficient of 500 W/m^2 K. Calculate the center temperature at 2 min after the start of cooling. [5+5]

OR

5. a) In what medium is the lumped system analysis more likely to be applicable: in water or air? Why?

b) A solid copper ball of 100 mm diameter and ρ = 8954 kg/m^3, C_p = 383 J/kg K, k = 386 W/mK is at a uniform temperature of 250^{0}C. It is suddenly immersed in a well-stirred fluid which is maintained at a uniform temperature of 50^{0}C. The heat transfer coefficient between the ball and the fluid is h = 200 W/m^2 K. Estimate the temperature of the copper ball after a lapse of 5 minutes of immersion. [5+5]

6. Air at a pressure of 6 kN/m^2 and a temperature of 300^{0}C flows with a velocity of 10 m/s over a flat plate 0.5 m long. Estimate the cooling rate per unit width of the plate needed to maintain it at a surface temperature of 27^{0}C. [10]

OR

7. An air stream at 0^{0}C is flowing along a heated plate at 90^{0}C at a speed of 75 m/s. The plate is 45 cm long and 60 cm wide. Assuming the transition of boundary layer takes plate at $Re_{cr} = 5 \times 10^5$. Calculate the average value of friction coefficient and heat transfer coefficient for full length of the plate. Also calculate the heat dissipation from the plate. [10]

8. a) What do you mean by Boussinesque approximation?
   b) A 15 cm diameter steel shaft is heated to 350^{0}C for heat treatment. The shaft is then allowed to cool in air (at 20^{0}C) while rotating about its own horizontal axis at 4 rpm. Compute the rate of convection heat transfer from the shaft when it has cooled to 100^{0}C. [5+5]

OR

9. A water heater is fabricated by a resistance wire wound uniformly over a 10 min diameter and 4 m long tube. The resistance element maintains a uniform heat flux of 1000 W/m^2. The mass flow rate of water is 12 kg/h, and its inlet temperature is 10^{0}C. Estimate the surface temperature of the tube at exit. [10]

10. Derive an expression for Nusselt number for laminar film condensation on a vertical surface. [10]

OR

11. What is a gray body? Derive the expression for radiation heat exchange between two gray surfaces connected by single refractory surface. [10]

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