Code: 9A03505

R09

B.Tech III Year I Semester (R09) Supplementary Examinations December 2015

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions
All questions carry equal marks
Use of heat transfer data book and steam tables is permitted in the examination hall
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1 (a) Derive 3-D heat conduction equation for cylindrical coordinate system and explain the function of different terms.
(b) A certain building wall consists of 0.15 m of concrete [K = 0.25 W/m.K], 0.18 m of fiber glass insulation and 13 mm of gypsum board [K = 0.17 W/m.K]. The inside and outside convection coefficients are 12 and 42 W/m^2.K respectively. The outside air temperature is -6^{0}C and the inside temperature is 23°C. Calculate the overall heat transfer coefficient for the wall the R value, and the heat loss per area.

2 (a) One side of a plane wall is maintained at 100^{0}C, while the other side is exposed to a convection environment having T = 10^{0}C and h = 11 W/m^2.K. The wall has K = 1.6 W/m.K and is 40 cm thick. Calculate the heat transfer rate through the wall.
(b) Derive the temperature profile in 1-D steady state hallow cylinder and also for the heat transfer rate.

3 (a) Explain the importance of Heisier charts in solving the transient heat conduction problems.
(b) A slab of Aluminum 10 cm thick is originally at a temperature of 500^{0}C. It is suddenly immersed in a liquid at 1000^{0}C resulting it a heat transfer coefficient of 1200 W/m^2.K. Determine the temperature at the centerline and the surface 1 min after the immersion. Also the total thermal energy removal per unit area slab during this period. The properties of aluminum for the given condition are: $\alpha = 8.4 \times 10^{-5}$ m^2/s, K = 215 W/mK, ρ = 2700 kg/m^3, Cp = 0.9 kJ/kg.

4 (a) Water at 10^{0}C flows over a flat plate at 90^{0}C measuring 1 m x 1 m with a velocity of 2 m/s. Then find length of plate over which the flow is laminar and the rate of heat transfer over the entire plate.
(b) Explain the following Dimensionless number and their physical significance:
(i) Reynolds number. (ii) Prandtl number. (iii) Nusselt number.

5 (a) What are the different methods of determining the heat transfer coefficient in forced convection?
(b) Air at 27^{0}C flows across a 30 mm diameter pipe (at 77^{0}C) with a velocity of 1 m/s. Compute the heat transfer rate per unit length of pipe.

6 (a) Differentiate between pool boiling and forced convection boiling.
(b) A condenser is to be designed to condense 2250 kg/h of dry and saturated steam at a pressure of 15 kPa. A square array of 400 tube each of 6 mm in diameter is to be used. If the tube surface temperature is to be maintained at 26^{0}C, calculate the heat transfer coefficient and the length of each tube by assuming single pass.

7 (a) Give a classification of furnaces and explain any one of them with a neat sketch.
(b) Water enters a parallel flow double-pipe heat exchanger at 15^{o}C, flowing at the rate of 1200 kg/hr. It is heated by oil (C_p = 2000 J/kg.K), flowing at the rate of 500 kg/hr from an inlet temperature of 90°C. For an area of 1 m^2 and an overall heat transfer coefficient of 1,200 W/m^2.K, determine the total heat transfer and the outlet temperatures of water and oil.

8 Write short notes on:
(a) Tubular furnaces and their applications.
(b) Radiation from luminous flames.
(c) Concept of black and gray body.
(d) Radiation error in temperature measurement.

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