[Total No. of Questions - 9] [Total No. of Printed Pages - 4] (2064)

14699

B. Tech 6th Semester Examination

Heat Transfer

ME-6006

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Candidates are required to attempt five questions selecting one from each section A, B, C, D and all question of Section E.

SECTION - A

1. (a) A furnace is insulated with 230 mm thick fire brick ,115 mm of insulating brick, 230 mm thickness of building brick. The convective heat transfer coefficient from the outer surface of building brick = 12 W/m^2C .The inside temperature of furnace is 1213°K and outside temperature of air is 318°K. The thermal conductivities of fire brick, insulating brick, building bricks are 6.047, 0.581 and 2.33 W/m.°K. Find out:

   (1) Heat loss per unit area.

   (2) Temperatures at interfaces (10)

   (b) Derive an expression for heat conduction through a spherical wall with r_1 and r_2 inner and outer radii. (10)

2. (a) Draw the diagram and describe the concept of optimum thickness of insulation with a neat diagram. (10)

2. (b) An aluminum rod (k =204 W/m°K) 2 cm in diameter and 20 cm long protrudes from a wall which is maintained at 300°C. The end of the rod is insulated and the surface of the rod is exposed to air at 30°C. The heat transfer coefficient between the rod's surface and air is 10 W/m^2 K. Calculate the heat lost by the rod and the temperature of the rod at a distance of 10 cm from the wall. (10)

SECTION - B

3. (a) A large iron plate of 10 cm thickness and originally at 800°C is suddenly exposed to an environment at 30°C where the convection coefficient is 50 W/m^2K. Calculate the temperature at a depth of 4 cm from one of the faces 100 seconds after the plate is exposed to the environment. How much energy has been lost per unit area of the plate during this time? (10)

   (b) (i) Define the Biot and Fourier numbers. (3)

   (ii) What is meant by lumped capacity? Derive the expression for the same. What are the physical assumptions necessary for a lumped capacity unsteady state analysis to apply? (7)

4. (a) A large vertical plate 5 m high is maintained at 100°C and exposed to air at 30°C. Calculate the convection heat transfer coefficient. (7)

   (b) What is Reynolds's analogy? Describe the relation between fluid friction and heat transfer. (3)

   (c) Atmospheric air at 275 K and a free stream velocity of 20 m/s flows over a flat plate 1.5 m long that is maintained at a uniform temperature of 325 K. Calculate the average heat transfer coefficient over the region where the boundary layer is laminar, the average heat transfer coefficient over the entire length of the plate and the total

heat transfer rate from the plate to the air over the length 1.5 m and width 1 m. Assume transition occurs at $Re_c = 2 \times 10^5$. (10)

SECTION - C

5. (a) State and prove the following laws; (i) Kirchoffs law of radiation (ii) Stefan - Boltzmann law (10)

   (b) Two large parallel plates having emissivities of 0.4 and 0.6 are maintained at 1000°Cand 500°C respectively. The radiation shield having an emissivity of 0.03 on both sides is placed between two plates.

   Determine (i) heat transfer rate /unit area before and after placing the shield

   (ii) Temperature of shield when placed. (10)

6. (a) Define emissivity, absorptivity and reflectivity (3)

   (b) Define Radiosity and Irradiation.What is the relation between them. (4)

   (c) What is monochromatic emissive power and spectral emissive power? (3)

   (d) Describe the phenomenon of radiation from real surfaces. (6)

   (e) What are the radiation view factors and why they are used? (4)

SECTION - D

7. (a) In a double pipe counter flow heat exchanger 10000 kg/h of an oil having a specific heat of 2095 J/kg°K is cooled from 80°C to 50°C by 8000 kg/h of water entering at 25°C. Determine the heat exchanger area for an overall heat transfer coefficient of 300 W/m^2K.
   Take C_p for water as 4180 J/kg°K. (10)

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(b). Derive the expression for LMTD of a parallel flow heat exchanger. (10)

8. (a) With a neat and labeled sketch explain the various regimes in boiling heat transfer. (10)

(b) A vertical plate 0.5 m^2 in area at temperature of 92°C is exposed to steam at atmospheric pressure. If the steam is dry and saturated estimate the heat transfer rate and condensate mass per hour. The vertical length of the plate is 0.5 m. (10)

SECTION - E

9. (i) What is Poisson's equation for heat flow?

(ii) Define effectiveness of the fin.

(iii) Differentiate between Natural & Forced convection.

(iv) What is Colburn analogy?

(v) Define thermal boundary layer thickness.

(vi) Sketch temperature and velocity profiles in free convection on a vertical wall.

(vii) What is meant by sub cooled or local boiling?

(viii) What is nucleate boiling?

(ix) Sketch temperature distribution graph for condensers & evaporators.

(x) How is the Reynolds number in condensation defined? (2×10=20)