(b) Discuss and explain Nusselt theory for filmwise condensation. 5

Or

10. Write short notes on the following :
    (a) Radiation shields 7
    (b) Shape factor 7
    (c) Planck's distributive law 6

Total No. of Questions : 10] [Total No. of Printed Pages : 4

ME–605(N)

B. E. (Sixth Semester) EXAMINATION, June, 2010

(New Scheme)

(Mechanical Engg. Branch)

HEAT AND MASS TRANSFER

[ME–605(N)]

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Attempt all question, internal choice is given with all the questions.

1. Find the heat flux and temperature distribution in an infinite slab of thickness b whose thermal conductivity varies linearly with temperature in the form $k = k_0 (1 + CT)$, where k_0 and C are constants.
   Sketch the temperature distribution when : 20
   (i) C is positive
   (ii) C is negatie.

Or

2. (a) Derive an expression for critical radius of insulation of a sphere. 8
   (b) Calculate the overall heat transfer coefficient (based on inner diameter) for a steel pipe covered with fibre glass insulation. The following data is given : 12
   ID of the pipe = 2 cm

P. T. O.

Thickness of the pipe = 0·2 cm

Thickness of insulation = 2 cm

Heat transfer coefficient of inside surface = 10 $W/m^2 K$

Heat transfer coefficient of outside surface = 5 $W/m^2 K$

Thermal conductivity of insulation = 0·05 W/m K

3. A solid steel ball 5 cm in diameter is at a uniform temperature of 45°C. It is quenched in a controlled environment which is initially at 90°C and whose temperature increases linearly with time at the rate of 10°C per minute.

Given :

Surface heat transfer coefficient = 58 $W/m^2 K$

Density of steel = 8000 kg/m^3

Specific heat of steel = 0·42 kJ/kg°K

Neglect internal temperature gradient and find the variation of temperature of ball with time; find the value of minimum temperature to which the ball cools and the time taken to attain this temperature. 20

Or

4. The handle of a ladle used for pouring molten lead at 327°C is 30 cm long and is made of 2·5 × 1·5 cm mild steel bar stock (k = 43 W/m°K). In order to reduce the grip temperature, it is proposed to make hollow handle of mild steel plate 1·5 mm thick to the same rectangular shape. If the surface heat transfer coefficient is 14·5 $W/m^2 K$ and ambient air is at 27°C, estimate the reduction in the

temperature of the grip. Neglect the heat transfer from the inner surface of the hollow shape. 20

5. Deduce an equation between dimensionless number for forced connection. Using Buckingham π theorem, state the guidelines for selecting dimensionless groups. 14, 6

Or

6. A steel plate, 20 cm square and 0·5 cm thick, is heated uniformly at 430°C. Afterwards it is kept vertically in still air at a temperature of 20°C. Neglecting radiation and making suitable assumptions, calculate the time required for the plate to cool to 130°C. Take the density of steel = 7900 kg/m^3 and its specific heat to be 0·46 kJ/kg°K. The properties of air at mean film temperature of 200°C are as given below : 20

$\nu = 34{\cdot}85 \times 10^{-6}\ m^2/s$, Pr = 0·680, k = 0·0393 W/mK.

7. Deduce an equation of effectiveness of a parallel flow heat exchanger in terms of number of transfer units (NTU). 20

Or

8. A counter flow tubelar oil cooler is to be designed to cool 1500 kg/hr. of oil from temperature 90°C to 30°C by means of water entering the cooler at 20°C and leaving at 50°C. Calculate the amount of water flow rate required and the heat transfer area. Take C_P of oil 3 kJ/kg°K and overall heat transfer coefficient equal to 1200 $W/m^2 K$. 20

9. (a) Explain regimes of pool boiling with the help of graphical plot and justify the nature of graph by correct logic.