OR

8. A well is 40 m deep and 9m in diameter is exposed to atmosphere at 25°C. The air at the top has relative humidity of 50%. Calculate the rate of diffusion of water vapour through the well Take $D_{AB} = 2.58 \times 10^{-5}$ m²/s. 14

M_W = 18kg/kg mol.

9. A gray, diffuse opaque surface ($\alpha = 0.8$) is at 100°C and receives an irradiation 1000W/m². If the surface area is 0.1 m² calculate 14

   i) Radiosity of the surface and

   ii) Net radiative heat transfer rate from the surface.

   iii) Calculate the above quantities, if surface is Black.

OR

10. a) Discuss the various regimes of pool boiling? 7

    b) Using Nusselt's theory of laminar film condensation show that $\delta \propto x^{1/4}$ for a flat vertical surface, where x is the distance from the leading edge of the film and δ is the film thickness. 7

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Roll No .....

ME - 605

B.E. VI Semester

Examination, December 2014

Heat and Mass Transfer

Time : Three Hours

Maximum Marks : 70

Note: i) Solve five questions.

ii) Heat and mass transfer data book is permitted in examination hall.

1. a) Establish analogy between flow of heat and electricity. Find out values of thermal resistances in conduction, radiation and convection by Fourier's law, Newton's law and Stifan Boltzmann's law. Discuss a system where conduction, convection and radiation heat transfer takes place in series combination? 1+2+2+2

   b) A Black metal plate (k = 25 W/mK) at 300°C is exposed to surrounding air at 30°C. It convects and radiates heat to surroundings. If the convective heat transfer coefficient is 25W/m²K. What is the temperature gradient in the plate? 7

OR

2. The temperature of the inner side of a furnace wall is 640°C and that of on other side is 240°C and it is exposed to atmosphere at 40°C, in order to reduce the heat loss from furnace, its wall thickness is increased by 100%, calculate the percentage decrease in heat loss due to increase in wall thickness, Assume no change in properties except temperature. 14

3. A still fin having 8mm diameter and 100mm long is exposed to boiling water having convective heat transfer coefficient of 4000 W/m²K. The thermal conductivity of steel can be taken as 17 W/mK show by calculations how much heat dissipation is achieved and is it advisable to use the fin? How the heat dissipation performance change, if a material with thermal conductivity of 45 W/mK is used? All conditions are same. 14

OR

4. A person is found dead at 5pm in a room whose temperature is 20°C. The temperature of the body is measured to be 25°C when found, and the heat transfer coefficient is estimated to be 8W/m²K. Modelling the body of human as a 30 cm diameter, 1.70m long cylinder, calculate actual time of death of the person, take thermophysical properties of the body as below:

   K = 6.08 W/mK, ρ = 900 kg/m³ and C = 4000 J/kg k. (sp. heat) 14

5. A flat plate 1m wide and 1.5 m long is maintained at 90°C in air with free stream temperature of 10°C flowing along 1.5 m side of the plate. Determine the velocity of the air required to have a rate of energy dissipation as 3.75 kW. 14

Use correlations:

$N_{u4} = 0.664\,Re^{1/2}\,Pr^{1/3}$ for laminar flow

$N_{u4} = \left[0.036\,Re^{0.8} - 836\right]Pr^{1/3}$ for turbulent flow.

Take properties of air

ρ = 1.0877 kg/m³, $\mu = 2.029 \times 10^{-5}$ kg/ms,

k_f = 0.028 W/mK, P_r = 0.703, C_p = 1.007 kJ/kg k

OR

6. Vertical door of a hot oven is 0.5m high and is maintained at 200°C, It is exposed to atmospheric air at 20°C. Find 14

   a) Local heat transfer coefficient half way up the door.

   b) Average heat transfer coefficient for entire door.

   c) Thickness of free convection boundary layer at the top of the door.

   Take properties of air at 110°C

   ρ = 0.922 kg/m³, C_p = 1000 J/kg k, $\mu = 2.2410^{-5}$ kg/m-s

   $\nu = 2.429 \times 10^{-5}$ m²/s, k_f = 0.0332 W/mk and P_r = 0.687

7. A heat exchanger is required to cool 55000 kg/hr of alcohol from 66°C to 40°C using 40,000 kg/hr of water entering at 5°C. Calculate 14

   i) Exit temperature of water

   ii) Heat transfer rate

   iii) Surface area required for

      a) Parallel flow type

      b) Counter flow type