Karunya University
(Karunya Institute of Technology and Sciences)
(Declared as Deemed to be University under Sec.3 of the UGC Act, 1965)

End Semester Examinations - 2015-16 Even Semester - May 2016

14ME2019 Heat and Mass Transfer

Set B

Time : 3 hrs
Total Marks: 100

1. a.Explain in brief the concept of Thermal Contact Resistance. **(4)**

   b. An external wall of a house is made up of 10 cm common brick of thermal conductivity 0.7 W/mK followed by a 4 cm of zibsum plaster of thermal conductivity 0.48 W/mK. What thickness of loosely packed insulation of thermal conductivity 0.065 W/mK should be added to reduce the heat loss through the wall by 80%. **(16)**

OR

2. a. Briefly explain the concept of critical radius of Insulation **(4)**

   b. A hollow cylinder 5 cm inner diameter and 10 cm outer diameter has inner surface temperature of 200^{o}C and outer surface temperature of 100^{o}C. Determine heat flow through the cylinder per meter length. Also determine the temperature of the point half way between the inner and outer surfaces. Take thermal conductivity as 1.2 W/mK. **(16)**

3. a. Briefly explain the concept of Lumped Heat Capacity System. **(4)**

   b. An aluminium sphere mass 5.5 kg and initially at a temperature of 290^{o}C is suddenly immersed in a fluid at 15^{o}C with heat transfer co-efficient of 58 W/m^{2}K. Find the Biot number and verify that lumped heat capacity analysis is applicable. Also find the time required to cool the aluminium sphere to 95^{o}C and time constant. **(16)**

OR

4. a. A horizontal pipe 15 cm in diameter and 4 m long is buried in the earth at a depth of 20 cm. The pipe wall temperature is 75^{0}C, and the earth surface temperature is 5^{0}C. Assuming that the thermal conductivity of the earth is 0.8 W/m.^{0}C, Calculate the heat lost by the pipe. **(6)**

   b. An apple, which can be considered as a sphere of 8 cm diameter, is initially at a uniform temperature of 25^{o}C.It is put into a freezer at – 75^{o}C and the heat transfer coefficient between the surface of the apple and surrounding in the freezer is 15 W/ m^{2} ^{o}C.If the properties of apple are given to be ρ = 840 kg/m^{3}, C_p = 3.6 kJ/kg^{o}C, k = 0.513 W/m^{o}C and α = 1.3 x 10^{-7} m^{2}/s, Calculate (i) centre temperature of the apple after 1 hour (ii) surface temperature of apple at that time and (iii) draw the temperature profile along the radius for different times. **(14)**

5. a. Differentiate Forced and Free Convection with examples. **(4)**

   b. Sodium – Potassium alloy, at 300^{o}C, flows with a velocity of 0.4 m/s over a flat plate size 0.3 m X 0.1 m, maintained at 500^{o}C. Calculate (i) the hydrodynamic and thermal boundary layer thickness (ii) local and average value of friction coefficient (iii) heat transfer coefficient and (iv) total heat transfer rate. **(16)**

OR

6. State Buckingham's pi-theorem. Explain the various parameters used in free convection. Using dimensional analysis obtain an expression for Nusselt number in terms of Grashof and Prandtl numbers. **(20)**

7. a. Draw temperature Vs length profiles for i) Condenser ii) Evaporator iii) Counter flow Heat exchanger with C_h = Cc. **(6)**

   b. A parallel flow heat exchanger is used to cool 4.2 kg/min of hot liquid of specific heat 3.5 kJ/kg K at 130^{o}C. A cooling water of specific heat 4.18 kJ/kg K is used for cooling purpose at a temperature of 15^{o}C. The mass flow rate of cooling water is 17 kg/min. Calculate (i) Outlet temperature of liquid (ii) Outlet

temperature of water (iii) Effectiveness of heat exchanger. **(14)**

OR

8. a) Explain Fick's law of diffusion. What is mass diffusivity? What is its dimension **(4)**

b) A vessel contains a binary mixture of oxygen and nitrogen with partial pressure in the ratio 0.21 and 0.79 at $27^{o}C$. The total pressure of the mixture is 1 bar. Determine (a) Molar fractions (b) Mass densities (c) Mass fractions. **(16)**

9. a. Explain the reciprocity theorem. **(4)**

b. Emissivities of two large parallel plates maintained at $800^{o}C$ and $300^{o}C$ are 0.3 and 0.5 respectively. Find net radiant heat exchange per square meter for these plates. Find the percentage reduction in heat transfer when a polished aluminum radiation shield of emissivity 0.05 is placed between them. Also find the temperature of the shield. **(16)**

Wishing you All the Best
