Roll No. | | | | | | | | | | |

B.E / B.Tech (Full Time) END SEMESTER EXAMINATIONS, April / May 2019

MECHANICAL ENGINEERING

VI SEMESTER

ME 8651 Heat & Mass Transfer
(Regulation 2012)

(Use of standard HMT data book is permitted)

Time: 3 Hours | Answer ALL Questions | Max. Marks 100

ADDITIONAL CONTROLLER OF EXAMINATIONS * AU CHENNAI 600 025

PART - A (10 x 2 = 20 Marks)

1. What do you understand by 'critical radius of insulation'?
2. Write the general two dimensional heat conduction equation for a system under unsteady state with internal heat generation.
3. What are Heisler charts? Write its significance in solving transient conduction problems.
4. What is Reynolds colburn analogy?
5. Write any two major effects of non-condensable gases during condensation.
6. Define the term 'effectiveness of a heat exchanger'.
7. State Kirchhoff's law of radiation.
8. What is Radiosity?
9. State Fick's law of diffusion.
10. Write the physical significance of Sherwood number. What is its counterpart in heat transfer?

Part – B (5 x 16 = 80 Marks)

11. 4 kg/s of product stream from a distillation column is to be cooled by a 3 kg/s water stream in a counterflow heat exchanger. The hot and cold stream inlet temperatures are 400 K and 300 K respectively, and the area of the exchanger is 30 m^2. If the overall heat transfer coefficient is estimated to be 820 W/ m^2 K, determine the product stream outlet temperature, if its specific heat is 2500 J/kg K and the coolant outlet temperature. (16)

12. a) A 1 m long, 5 cm diameter, cylinder placed in an atmosphere of 40 °C is provided with 12 longitudinal straight fins (k= 75 W / m K), 0.75 mm thick. The fins protrude 2.5 cm from the cylinder surface. The heat transfer coefficient is 23.3 W / m^2 K. Calculated the rate of heat transfer, if the surface temperature of cylinder is at 150 °C. (16)

(OR)

b) Steel ball bearings (k = 55 W / m K & $\alpha = 1.4 \times 10^{-5}$ m^2/s) having a diameter of 45 mm

are heated to a temperature of 650°C and then quenched into a tank of oil at 50°C. If the heat transfer coefficient between the ball bearings and oil is 320 W / m^2 K, determine (i) time during which the ball bearings must remain in the oil to reach a temperature of 200°C and (ii) the total amount of heat removed from each bearing during this time. (16)

13. a) Air at 27°C and 1 bar flows over a flat plate at a speed of 2 m/s. Calculate the boundary layer thickness at distances of 20 cm and 40 cm from the leading edge of the plate. Calculate the mass flow which enters the boundary layer between x = 20 cm and x = 40 cm by assuming unit depth in the z – direction. (16)

(OR)

b) A flat plate solar collector is placed horizontally on a roof and it is a long strip 0.3 m wide. The surface temperature of the collector is 60. If a wind at 16 °C is blowing over the collector at a velocity of 3 m/s. calculate the boundary layer thickness and Local friction coefficient at x=0.3 m and $x = x_c$. (16)

14. a) (i) Define absorptivity, reflectivity and transmissivity. (6)

(ii) Two large parallel planes with emissivity of 0.3 and 0.8 exchange radiative heat energy between them. Determine the percentage reduction in radiative energy transfer when a polished aluminium radiation shield with the emissivity of 0.04 is placed between them. (10)

(OR)

b) (ii) Two parallel plates 2 m × 1 m are spaced 1 m apart. The plates are at temperatures of 727 °C and 227 °C and their emissivities are 0.3 and 0.5 respectively. The plates are located in a large room, the wall of which is at 27 °C. Determine the rate of radiation heat loss from each plate and the heat gain by the walls. (16)

15. a) A mixture of O_2 and N_2 with their partial pressures in the ratio 0.21 to 0.79 is in a container at 25 ^{o}C. Calculate the molar concentration, the mass density, the mole fraction and the mass fraction of each species for a total pressure of 1 bar. What would be the average molecular weight of the mixture? (16)

(OR)

b) (i) Discuss briefly the analogy between heat transfer and mass transfer. (6)

(ii) Calculate the mass transfer coefficient of water vapor in air under turbulent flow at 60 m/s, 1 atm & 300 K over a flat plate of 0.3 m long. Assume the concentration of vapor in air is sufficiently dilute so that $p_{bm}/p = 1$. Assume $D = 0.26 \times 10^{-4}$ m^2/s. (10)