B.E. / B.TECH. DEGREE EXAMINATIONS, DECEMBER 2020

Fifth Semester

ME18504-Heat and Mass transfer

(Regulation 2018)

Use of Heat and Mass transfer data book is permitted

Time: Three Hours | Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 Marks)

1. An increase in convection coefficient over a fin will
   (a) increase effectiveness (b) decrease effectiveness
   (c) does not influence effectiveness (d) influences only the fin efficiency
2. Flow transition is generally judged by
   (a) Reynolds number (b) Prandtl Number
   (c) Nusslet number (d) Rayleigh number
3 In an parallel flow heat exchangers the value of NTU is 2.0. the capacity ration is 0.5, The value of effectiveness is (a) 0.5 (b) 0.3 (c) 0.2 (d) 0.1

4 The unit of mass transfer coefficient hm is (a) m2/s (b) m/s (c) W/m2 K (d) W/m K

5 Distinguish Transient Heat conduction?

6 State the characteristics of a boundary layer

7 Describe dropwise condensation?

8 State equimolar counter diffusion?

PART B - (4 X16 = 64 Marks)

9. (a) (i) A pipe carrying steam at 230°C has an internal diameter of 12 cm and the pipe thickness is 7.5 mm. The conductivity of the pipe material is 49 W/m K the convective heat transfer coefficient on the inside is 85 W/m^{2}K. The pipe is insulated by two layers of insulation one of 5 cm thickness of conductivity 0.15 W/m K and over it another 5 cm thickness of conductivity 0.48 W/m K. The outside is exposed to air at 35°C with a convection coefficient of 18 W/m^{2}K.Determine the heat loss for 5 m length. **(8)**

(ii) A cylinder 1 m long and 5 cm in diameter is placed in an atmosphere at 45^{0}C. It is provided with 10 longitudinal straight fins of material having K = 120 W/m K. The height of 0.76 mm thick fins is 1.27 cm from the cylinder surface. The heat transfer coefficient between cylinder and atmospheric air is 17 W/m^{2}K. Calculate then rate of heat transfer and temperature at the end of the fins if surface temperature of cylinder is 150^{0}C. **(8)**

(OR)

(b) A 60 mm thick large steel plate (K = 42.6 W/m K) (α = 0.043m^2/hr), initially at 440^{o}C is suddenly exposed on both sides to an environment with h =235 W/m^2 K and temperature 50^{o}C. Determine the centre line temperature and temperature inside the plate 15 mm from the midplane after 4.3 min. Also calculate the total thermal energy removed per unit area of the slab during this period. **(16)**

10. (a) (i) Engine oil at 25°C flows over a 30 cm long 20 cm wide flat plate at 1.5 m/s, which is heated to a uniform temperature of 55°C. Determine the rate of heat transfer to the oil from the plate. **(8)**

(ii) Water flows at a velocity of 12 m/s in a straight tube of 60 mm diameter. The tube surface temperature is maintained at 70°C and the flowing water is heated from the inlet temperature of 15°C to outlet temperatures of 45°C. Calculate the heat transfer coefficient and heat transferred from the tube surface to the water. **(8)**

(OR)

(b) (i) A 6 m long section of an 8 cm diameter horizontal hot water pipe passes Through a large room whose temperature is 20°C. If the outer surface temperature of the pipe is 70° C. Determine the rate of heat loss from the pipe by natural convection. **(8)**

(ii) Consider a 0.6 m x 0.6 m thin square plate in a room at 30°C. One side of the plate is maintained at a temperature of 90°C, while the other side is insulated. Determine the rate of heat transfer from the plate by natural convection if the plate is (a) horizontal with the hot surfaces facing up.(b) horizontal with the hot surfaces facing down **(8)**

11. (a) (i) Sketch the pool boiling curve. **(6)**

(ii) Water at atmospheric pressure (saturation temperature = 100°C) is boiling on a brass surface heated from below. If the surface is at 108°C, determine the heat flux and compare the same with critical heat flux. **(10)**

(OR)

(b) (i) Saturated steam at 120°C is condensing on the outer tube surface of a single pass heat exchanger. The transfer coefficient is1800 W/m^{2}K. Determine the surface area of a heat exchanger capable of 1000 kg/hr of water from 20°C to 90°C. Also compute the rate of condensation of steam. **(8)**

(ii) Water enters a counter flow, double pipe heat exchanger at 15°C, flowing at the rate of 1300 kg/hr. it is heated by oil (C_p = 2.0 kJ/kg K) flowing at the rate of 550 kg/hr from the inlet temperature of 94°C, for an area of 1m^2 and an overall heat transfer coefficient of 1075 W/m^{2}K, determine the total heat transfer and the outlet temperature of water and oil. Take C_p of water as 4.18 kJ/kg/K (8) **(8)**

12. (a) (i) Hydrogen stored in a vessel diffuses through the steel wall of 20 mm thickness. The molar concentration at the inner surface is 2 kg mol/m^3. At the other surface it is zero. Assuming plane wall condition and $D_{ab} = 0.26 \times 10^{-12}$ m^2/s. determine the mass of hydrogen diffused per 1 m^2. **(8)**

(ii) Estimate the diffusion rate of water at 27°C from the bottom of a test tube 20 mm in diameter and 4 cm long into dry air at 27°C. **(8)**

(OR)

(b) (i) Dry air at 27°C and 1 bar flows over a wet plate of 50 cm at 50 m/s. Evaluate the mass transfer coefficient of water vapour in air at the end of the plate. **(8)**

(ii) Air at 25°C and atmospheric pressure, containing small quantities of iodine flows with a velocity of 5 m/s inside a 3 cm inner diameter tube. Determine the mass transfer coefficient from the air stream to the wall surface. **(8)**
Assume D_{AB} (Iodine- air) = 0.82 x10^{-5} m^2/s.