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**SIR ISSAC NEWTON COLLEGE OF ENGINEERING & TECHNOLOGY**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**MODEL EXAM**

**SUB. CODE & NAME: ME-6502 HEAT AND MASS TRANSFER**

**YEAR :** III **DATE :**

**SEM :** V **MARKS :** 100

**PART- A ( 10 × 2 = 20 )**

1. What is Fourier's Law of heat conduction?

2. Give examples of use of fins in various engineering applications.

3. Differentiate between Natural & Forced convection.

4. Distinguish between laminar & turbulent flow.

5. Discuss the advantage of NTU method over the LMTD method.

6. In what way Boiling & Condensation differs from other types of heat exchange?

7. Define Wien's distribution law.

8. Distinguish between Reflectivity & Transmittivity.

9. What is Convective mass transfer?

10. What is the Molar Diffusion velocity?

**PART- B (5 × 13 = 65 )**

11(A). A pipe consists of 100 mm internal diameter and 8mm thickness carries steam at 170°C. The convective heat transfer coefficient on the inner surface of pipe is 75 W/m2C. The pipe isinsulated by two layers of insulation. The first layer of insulation is 46 mm in thickness having thermal conductivity of 0.14 W/m°C. The second layer of insulation is also 46 mm in thickness having thermal conductivity of 0.46 W/m°C. Ambient air temperature = 33°C. The convective heat transfer coefficient from the outer surface of pipe = 12 W/m2C. Thermal conductivity of steam pipe = 46 W/m°C. Calculate the heat loss per unit length of pipe and determine the interface temperatures. Suggest the materials used for insulation. (13)

(or)

11(B). Circumferential aluminium fins of rectangular profile (1.5cm wide and 1mm thick) are fitted on to a 90 mm engine cylinder with a pitch of 10 mm. The height of the cylinder is 120 mm. The cylinder base temperature before and after fitting the fins are 200°C and 150°C respectively. Take ambient at 30°C and h(average) =100 W/m2K. Estimate the heat dissipated from the finned and the unfinned surface areas of cylinder body. (13)

12(A) (i) Sketch the boundary layer development of a flow over a flat plate and explain the significance of the boundary layer. (4)

(ii) Atmospheric air at 275 K and a free stream velocity of 20 m/s flows over a flat plate 1.5 m long that is maintained at a uniform temperature of 325 K. Calculate the average heat transfer coefficient over the region where the boundary layer is laminar, the average heat transfer coefficient over the entire length of the plate and the total heat transfer rate from the plate to the air over the length 1.5 m and width 1 m. Assume transition occurs at Re = 2xl05  (9)

(or)

12(B). Air at 400 K and 1 atm pressure flows at a speed of 1.5 m/s over a flat plate of 2 m long.

The plate is maintained at a uniform temperature of 300 K. If the plate has a width of 0.5 m, estimate the heat transfer coefficient and the rate of heat transfer from the air stream to the plate. Also estimate the drag force acting on the plate. (13)

13(A)(i). Compare LMTD and NTU method of heat exchanger analysis. (4)

(ii). Hot exhaust gases which enters a finned tube cross flow heat exchanger at 300°C and leave at 100°c, are used to heat pressurized water at a flow rate of 1 kg/s from 35 to 125°C. The exhaust gas specific heat is approximately 1000 J/kg.K, and the overall heat transfer co-efficient based on the gas side surface area is Uh = 100W/m2K. Determine the required gas side surface area Ah using the NTU method. Take Cp,c at Tc = 80°C is 4197 J/kg.K and Cp,h = 1000 J/kg.K . (9)

(or)

13(B)(i). Give the classification of heat exchangers. (4)

(ii)It is desired to use a double pipe counter flow heat exchanger to cool 3 kg/s of oil (Cp = 2.1 kJ/kgK) from 120°C. Cooling water at 20°C enters the heat exchanger at a rate of 10 kg/so The overall heat transfer coefficient of the heat exchanger is 600 W/m2Kand the heat transfer area is 6 m2.Calculate the exit temperatures of oil and water. (9)

14(A). Two parallel, infinite grey surface are maintained at temperature of 127°C and 227°C

respectively. If the temperature of the hot surface is increased to 327°C, by what factor is the net radiation exchange per unit area increased? Assume the emissivity’s of cold and hot surface to be 0.9 and 0.7 respectively. (6)

(ii). Two equal and parallel discs of diameter 25 cm are separated by a distance of 50 cm. If the discs are maintained at 600°C and 250°C. Calculate the radiation heat exchange between them. (7)

(or)

14(B). A thin aluminium sheet with an emissivity of 0.1 on both sides is placed between two very large parallel plates that are maintained at uniform temperatures Tl = 800 K and T2 = 500 K and have emissivities £"1 = 0.2 and £"2 = 0.7 respectively. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result to that without shield. (13)

15(A)(i). Dry air at 20°C (p = 1.2 kg/m3, v = 15 x l0-6 m2/s, D = 4.2 x l0-5 m2/s) flows over a flat plate of length 50 cm which is covered with a thin layer of water at a velocity of 1 m/s. Estimate the local mass transfer coefficient at a distance of 10 cm from the leading edge and the average mass transfer coefficient. (6)

(ii). A mixture of O2 and N2 with their partial pressures in the ratio 0.21 to 0.79 is in a container at 25°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? (7)

(or)

15(B). The tire tube of a vehicle has a surface area 0.62 m2 and wall thickness 12 mm. The tube has air filled in it at a pressure 2.4 x 105 N/m2. The air pressure drops to 2.3 x 105 N/m2 in 10 days. The volume of air in the tube is 0.034 m3. Calculate the diffusion coefficient of air in rubber at the temperature of 315K. Gas constant value = 287. Solubility of air in rubber tube = 0.075m3 of air/m3 of rubber tube at one atmosphere (13)

**PART- C ( 1 × 15 = 15 )**

16. (A) A furnace wall consists of three layers. The inner layer of 10 cm thickness is made of firebrick (k =1.04 W/mK). The intermediate layer of 25 cm thickness is made of masonry brick (k = 0.69 W/mK) followed by a 5 cm thick concrete wall (k = 1.37 W/mK). When the furnace is in continuous operation the inner surface of the furnace is at 800°C while the outer concrete surface is at 50°C. Calculate the rate of heat loss per unit area of the wall, the temperature at the interface of the firebrick and masonry brick and the temperature at the interface of the masonry brick and concrete. (15)

(or)

16(B) Define effectiveness of a heat exchanger. Derive an expression for the effectiveness of a double pipe parallel flow heat exchanger. State the assumptions made. (15)