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**SIR ISSAC NEWTON COLLEGE OF ENGINEERNG AND TECHNOLOGY**

**PAPPAKOIL, NAGAPATTINAM**

**DEPARTMENT OF MECHANICAL**

**MODEL EXAM**

**SUB CODE/NAME:** ME6502 HEAT AND MASS TRANSFER **DATE : 07-08-18 SEM/YEAR: III / V TIME DURATION** : 3.00 Hrs

**PART- B (10 × 02 = 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 wall is constructed of several layers. The first layer consists of masonry brick 20 cm. thick of thermal conductivity 0.66 W/mK, the second layer consists of 3 cm thick mortar of thermal conductivity 0.6 W/mK, the third layer consists of 8 cm thick lime stone of thermal conductivity 0.58 W/mK and the outer layer consists of 1.2 cm thick plaster of thermal conductivity 0.6 W/mK. The heat transfer coefficient on the interior and exterior of the wall are 5.6 W/m2K and 11 W/m2K respectively. Interior room temperature is 22C and outside air temperature is -5C. Calculate

i)Overall heat transfer coefficient

ii)Overall thermal resistance

iii)The rate of heat transfer

iv)The temperature at the junction between the mortar and the limestone. (13)

(or)

11(B). An aluminium alloy fin of 7 mm thick and 50 mm long protrudes from a wall, which is maintained at 120C. The ambient air temperature is 22C. The heat transfer coefficient and conductivity of the fin material are 140 W/m2K and 55 W/mK respectively. Determine

i) Temperature at the end of the fin

ii) Temperature at the middle of the fin.

iii) Total heat dissipated by the fin. (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)250 Kg/hr of air are cooled from 100C to 30C by flowing through a 3.5 cm inner diameter pipe coil bent in to a helix of 0.6 m diameter. Calculate the value of air side heat transfer coefficient if the properties of air at 65C are

K = 0.0298 W/mK

= 0.003 Kg/hr – m

Pr = 0.7

= 1.044 Kg/m3

(9)

(or)

12(B). Air at 20C, at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. if the plate maintained at 60C, calculate the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2m. (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). Air at 20 °C (ρ = 1.205 kg/m3 , ν = 15.06 × 10-6 m2/s, D = 4.166×10-5 m2/s), flows over a tray (length = 320 mm, width = 420 mm) full of water with a velocity of 2.8 m/s. The total pressure of moving air is 1 atm and the partial pressure of water present in the air is 0.0068 bar. If the temperature of the water surface is 15 °C, Calculate the evaporation rate of water. (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)