Q. P. Code: 27944

[3 Hours] **[Total Marks: 80**

N.B Question no.1 is compulsory.
Attempt any **THREE** from question no.2 to 6.
Use illustrative diagrams wherever possible.

Q1. Solve any Four **(5*4)**

(a) Define Thermal conductivity. Explain variation of thermal conductivity with respect to temperature of solid, liquid and gases.

(b) Explain Hydrodynamic and Thermal Boundary Layer.

(c) Define: Emissive power, Emissivity, Radiosity, Irradiation, Opaque body.

(d) Derive the equation of critical thickness of insulation.

(e) The radiation shape factor of the circular surface of thin hollow cylinder of 10cm diameter and 10 cm length is 0.1716. What is the shape factor of curved surface of cylinder with respect to itself?

Q.2 (a) A wall of a furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperature at inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If thermal conductivity of silica and magnesite bricks are 1.7 W/m°C and 5.8 W/m°C, calculate **(08)**

(i) The rate of heat loss per unit area of wall
(ii) The temperature drop at interface.

(b) Derive the expression for log mean temperature difference in a parallel flow heat exchanger. State your assumption. **(08)**

(c) Explain Lumped heat capacity method with its assumption. **(04)**

Q.3 (a) Derive a relation of heat transfer through infinitely long fin. **(08)**

(b) In a counter flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500 kg/h. The steam enters the heat exchanger at 180^0 C and Leaves at 130^0 C. The inlet and exit temperature of water are 30^0 C and 80^0 C respectively. If U = 814 W/m^2 ^{0}C, calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel? **(08)**

(c) Explain the physical significance of Nusselt number and Prandtl number. **(04)**

Q.4 (a) Show that the radiant heat transfer between two infinitely large parallel plates separated by n shields is **(10)**

$$Q_{n-shields} = \frac{A\,\sigma\,(T_1^4 - T_2^4)}{(n+1)[\frac{2}{\epsilon} - 1]}$$

(b) Air at 20°C is flowing over a flat plate which is 20 cm wide and 50 cm long. The plate is maintained at 100°C. Find heat loss from the plate if air is flowing parallel to 50 cm side with a velocity of 2 m/s. What will be the effect on heat transfer if the flow is parallel to 20 cm side? Take the following properties of air at 60°C **(10)**

k = 0.025 W/m^{0}C, Pr = 0.7, ν = 18.97 x 10^{-6} m^2/s,

$Nu_x = 0.664\,(Re_x)^{0.5}\,(Pr_x)^{0.33}$

Q.5 (a) Show by dimensional analysis for forced convection, Nu = ϕ(Re,Pr) **(10)**

(b) Calculate the net radiant heat exchange per m^2 area for two large parallel plates of temperature 427°C and 27°C respectively ε (hot plate)=0.9 and ε (cold plate) = 0.6.If a polished aluminum shield is placed between them, find the % reduction in heat transfer : ε (shield)=0.4 **(07)**

(c) Explain geometrical or shape factor. **(03)**

Q.6 (a) Write short note on(any **Two**) **(08)**

(i) Heat pipe
(ii) Various regimes in boiling heat transfer
(iii)Numerical methods and its application

(b) An egg with mean diameter of 4cm and initially at 20^{0}C is placed in a boiling water pan for 4 min and found to be boiled to the consumers taste. For how long should a similar egg for same consumer be boiled when taken from refrigerator at 5^{0}C? Take the following properties for egg: k = 10 W/mK, ρ = 1200 kg /m^3, C_p = 2 kJ/kg K and h = 100 W/m^2 ^{0}C. Use lump theory. **(08)**

(c) Explain the physical significance of Nusselt number and Prandtl number. **(04)**

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