

Time: 3 Hours

Marks: 80

- Note: - (1) Question No. 1 is compulsory
(2) Answer any Three out of remaining Five
(3) Make suitable assumption, if necessary

Q1. Solve any Five

(5*4)

- A steam pipe is insulated to reduce the heat loss. However, the measurement reveal that the rate of heat lost has increased instead of decreasing. Can you comment why?
- Two pin fins are identical except that the diameter of one is twice that of other. For which fin will (i) Fin Effectiveness (ii) Fin Efficiency be higher?
- What is lump system analysis? What are the assumptions made in the lumped system analysis and when is it applicable?
- When heat transfer through a fluid layers is by conduction and when it is by convection? For what case, the rate of heat transfer is higher?
- What are the limitations of LMTD method? How is Effective – NTU method superior to LMTD method?
- Explain Thermal Contact Resistance.

Q.2 a) Derive Fourier's differential equation in the Cartesian Co-ordinate. (10)

- b) A vertical plate 2.2m high and 1.4m wide has been designed on free convection heating of liquid. The temperature of plate surface is maintained at 960 °C while the temperature of liquid is 340 °C. Calculate the heat dissipation from both side of plate. (10)

For convection coefficient, Use correlation $Nu = 0.13(Gr.Pr)^{0.33}$.

Properties of liquid at 650°C are $\rho = 10^4 kg/m^3$; $C_p = 150.7 kJ/kg.K$; $k = 13.02 W/mK$; $\mu = 3.12 kg/mh$

Q.3 a) Starting from basic derive an expression for effectiveness of parallel flow heat exchanger in terms of NTU and Capacity ratio. (10)

- b) A longitudinal copper fin ($k=380 W/m^{\circ}C$) 600 mm long and 5 mm diameter is exposed to air stream at 20°C. The convective heat transfer coefficient h is 20 $W/m^2^{\circ}C$. If the fin base temperature is 150°C, determine (i) the heat transferred in kJ/h and (ii) the efficiency of the fin. Assume that fin is insulated at the tip. (10)

Q.4 a) An exterior wall of a house may be approximated by 10 cm layer of common brick ($k = 0.75 W/m-deg$) followed by 4 cm layer of gypsum plaster ($k = 0.5 W/m-deg$). What thickness of loosely packed rock wool insulation ($k = 0.065 W/m-deg$) should be added to reduce the heat loss or gain through the wall by 75%? (10)

- b) A ceramic block is of 0.3 m × 0.2 m section and is 0.3 m in height. Surface temperature of the block is 380 °C. if it is exposed to air at 20 °C, (10)

Determine the rate of convective heat loss.

Properties of air $\nu = 34.57 \times 10^{-6} \text{ m}^2/\text{s}$, $k = 37.81 \times 10^{-3} \text{ W/mK}$, $\text{Pr} = 0.699$.

The following empirical relation can be used

$$\text{Nu}_L = 0.55(\text{Gr} \times \text{Pr})^{0.25}$$

- Q.5 a) Define Shape factor and discuss its properties. Derive an expression for shape factor for (i) Hemispherical shape of radius R (ii) Two concentric cylinders. (10)
- b) In a shell and tube heat exchanger, tubes are 4 m long, 3.1 cm OD, 2.7 cm ID. Water is heated from 22 °C to 45 °C by considering steam at 100 °C on the outside of tubes. Water flow rate through the tubes is 10 kg/s. Heat transfer coefficient on steam side is 5500 W/m²K and waterside, 850 W/m²K. Neglecting all other resistances, find the number of tubes. (10)
- Q.6 a) For transit conduction, with negligible internal resistance, with usual notations, show that: (10)
- $$\frac{\theta}{\theta_0} = \exp(-B_i \cdot F_o)$$
- Also state the significations of 'B_i' and 'F_o'.
- b) Write short note on any two of the following (10)
- Heisler Charts.
 - Boiling curves and various regimes of boiling.
 - Heat Pipe.