Q. P. Code: 39556

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) 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?

b) 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?

c) What is lump system analysis? What are the assumptions made in the lumped system analysis and when is it applicable?

d) 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?

e) What are the limitations of LMTD method? How is Effective – NTU method superior to LMTD method?

f) 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 convention 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°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°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 ^{0}C.if it is exposed to air at 20 ^{0}C, **(10)**

Determine the rate of convective heat loss.

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

The following empirical relation can be used

$$\mathbf{Nu_L = 0.55(Gr \times Pr)^{0.25}}$$

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 ^{0}C to 45 ^{0}C by considering steam at 100 ^{0}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/m^{2}K and waterside, 850 W/m^{2}K. 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: $\frac{\theta}{\theta_i} = \exp\left(-B_i . F_o\right)$ Also state the significations of 'B_i' and 'F_o'. **(10)**

b) Write short note on any **two** of the following **(10)**

i) Heisler Charts.

ii) Boiling curves and various regimes of boiling.

iii) Heat Pipe.
