**Heat Transfer (ME-3O5E)**

**Time: Three Hours** **Maximum Marks: 100**

**Note: - Attempt any FIVE questions.**

I. (a). Derive the General Heat conduction Equation in spherical co-ordinate system. (10)

(b) A composite wall is made of 3 layers of materials. The central layer is made of brick (K = O.72 W/mC) and has a thickness of 20 cm. The outer layers, on either side of the brick layer, are each 3 cm thick and are made of plaster (K = O.22 W/mc). The exposed faces of plaster are at 45°C and 15°C respectively. Find the steady-state heat flux and interfacial temperatures. (10)

2. (a). Obtain the temperature variation in a spherical shell having uniform internal heat generation. Assume radial conduction and convective boundary condition at the inner and outer surfaces of the shell. (15)

(b). Explain the concept of critical insulation radius. Derive an expression for the same for a cylindrical Surface. (5)

3. (a). A straight fin of uniform circular cross-section of area O.2 $cm^2$, length 15 cm and thermal Conductivity 200 W/mc has its two ends maintained at 100°C and 50°C respectively. The ambient air is at 3O°C and the convective heat transfer coefficient is 15 $W/^{m2c}$. Determine the total heat loss from the fin to the ambient air. What is the minimum temperature of the fin and where does it occur? (16)

(b). Define the terms. Fin Effectiveness and Fin Efficiency. (4)

4. (a) why is it necessary to introduce dimensionless numbers in the study of Heat Transfer by convection? (6)

(b) Air with a velocity of 3 m/s flows parallel to a flat plate 30 cm in length. The plate is maintained at 4OO K and the incoming air is at 300 K and 1 atm pr. Determine the heat flux at the trailing edge of the plate. Also find the total heat transferred to air.

Take $\rho$ = O.995 $Kg/m^3$ , $v = 20.82 \times 10^{-6}$ $m^2$ /s.

K = O.O3 W/mK , Pr = O.7 for air. (14)



5. (a). Explain the concept of Reynolds Analogy. (10)

(b). Derive the relationship between Nusselt number, Prandtl Number and Grashoff number for natural convection from a vertical Plate. (10)

6- (a). what are the limitations of the LMTD method of Heat Exchanger Design ? How can these be overcome by using E-NTU relationships? (10)

(b). Hot gases having Cp = 2500 J/kg°C, T = 600°C flow through a parallel flow heat exchanger at the rate of 3O kg/s. The gases are Cooled by a cold stream of coolant which enters at 1O0°C @ 3O kg/s, with a specific heat of 4200 J/kg°c. The total heat transfer area is 50 $cm^2$ and the overall heat transfer coefficient is 1500 w $/^{m2c}$. Calculate the exit temperatures of both the hot and cold streams. (10)

7 - (a). Explain the concept of shape Factors used in calculating heat exchanger by radiation. (8)

(bl Derive the relationship between Total Emissive Power and Intensity of Emitted Radiation. (12)

8. Write short notes on any TWO:

(a) Integral Momentum Equation

(b) Kirchoffs Law of Radiation

(c) Classification of Heat Exchanger. (20)