Q.P. Code: 25738

(3 Hours) **[Total Marks: 80**

Note:

1. Solve any **FOUR** questions.
2. Assume suitable data if necessary and mention it clearly.
3. Draw sketches wherever required.

1. (a) Explain natural convection inside enclosures. **5**

   (b) What do you mean by heat transfer in common configuration? Define conduction shape factor? **5**

   (c) Why it is necessary to consider the concept of variable thermal conductivity? **5**

   (d) How does radiation transfer through a participating medium differ from that through a nonparticipating medium? **5**

2. (a) A substance has a temperature dependent thermal conductivity given by: k (W/m°C) = $0.5 + 8\times10^{-4}T + bT^2$, where $b = 6.2\times10^{-4}$ and T is in °C. What is the unit of the coefficient b? Find the thermal conductivity of the material at 560°C. Also calculate its average thermal conductivity over the temperature range 150°C to 560°C. **5**

   (b) An ordinary egg can be approximated as a 5.5 cm diameter sphere whose properties are k = 0.6 W/mK and $\alpha = 0.14\times10^{-6}$ m^2/s. The egg is initially at a uniform temperature of 8°C and is dropped into boiling water at 100°C. Convection heat transfer coefficient to be 800 W/m^2K. If the egg is considered cooked when its center temperature reaches 60°C, determine how long the egg should be kept in the boiling water. Take λ_1=3.0754 & A_1=1.9958 **5**

   (c) Explain examples of conduction in porous media. **5**

   (d) Explain the concept of thermal contact resistance? **5**

3. (a) What is Dittus-Boelter equation? When does it apply? **5**

   (b) A 150 mm wide and 200 mm in height vertical hot surface in 25°C air is to be cooled by a heat sink with equally spaced fins of rectangular profile. The fins are 2 mm thick and 200 mm long in the vertical direction and have a height of 30 mm from the base. Determine the optimum fin spacing and the rate of heat transfer by natural convection from the heat sink if the base temperature is 80°C. **10**

   (c) Write the correlation for calculating Reynolds number for transition flow in coiled tube. Write the criteria for validity also. **5**

4. (a) Two large parallel planes are at $T_1 = 800K$, $\varepsilon_1 = 0.3$, $T_2 = 400K$, $\varepsilon_2 = 0.7$ and are separated by gas having $\varepsilon_g = 0.2$, $\tau_g = 0.8$. Calculate heat transfer rate between the two planes and the temperature of the gas using a radiation network. Compare with the heat transfer without presence of the gas. Assume $\sigma = 5.67\times10^{-8} W/m^2 K^4$ **10**

   (b) How heat transfer coefficient is enhanced in coiled tube? Define Dean Number. **5**

   (c) Write the applications of laminar flow forced convection heat transfer. **5**

5. (a) Derive the equation for average condensation heat transfer coefficient. Write assumptions also. **10**

   (b) Differentiate between external and internal flow boiling. **5**

   (c) Explain the concept of mean beam length. **5**

6. (a) Consider a large uranium plate of thickness 5 cm and thermal conductivity $k = 28$ W/m·K in which heat is generated uniformly at a constant rate of 600 kW/m^3. One side of the plate is insulated while the other side is subjected to convection to an environment at 30°C with a heat transfer coefficient of $h = 60$ $W/m^2 \cdot K$. Considering six equally spaced nodes with a nodal spacing of 1 cm, obtain the finite difference formulation of this problem. **10**

   (b) How can a node on an insulated boundary be treated as an interior node in the finite difference formulation of a plane wall? Explain. **5**

   (c) What is the basis of the energy balance method? How does it differ from the formal finite difference method? **5**