Q.P. Code: 25737

(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) Why are the finned surfaces called as heat sinks? Why are heat sinks with closely packed fins not suitable for natural convection heat transfer? 5

   (b) How heat transfer coefficient is enhanced in coiled tube? Define Dean Number. 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) = $0.45 + 8.1\times10^{-4}T + bT^2$, 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 565°C. Also calculate its average thermal conductivity over the temperature range 150°C to 565°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 $\alpha = 0.14\times10^{-6}$ m²/s. The egg is initially at a uniform temperature of 8°C and is dropped into boiling water at 97°C. Taking the convection heat transfer coefficient to be $h = 1400$ W/m²K, determine how long it will take for the center of the egg to reach 70°C. Take $\lambda_1 = 3.0754$ & $A_1 = 1.9958$ 5

   (c) What is conduction shape factor and how it is related to thermal resistance? 5

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

3. (a) Describe in brief any five active heat transfer enhancement techniques. 5

   (b) A 15 cm wide and 18 cm high vertical hot surface in 20 °C air is to be cooled by a heat sink with equally spaced fins of rectangular profile. The fins are 0.1 cm thick, 4 cm wide, and 18 cm long in the vertical direction. Determine the optimum fin spacing and the rate of heat transfer by natural convection from the heat sink if the base temperature is 85°C. 10

   (c) What does the effective conductivity of an enclosure represent? How is the ratio of the effective conductivity to thermal conductivity related to the Nusselt number? 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 $\sigma = 5.67\times10^{-8} W/m^2K^4$ 10

(b) Explain examples of conduction in porous media. 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) Write Beer's law with reference to radiation in participating medium. Explain the terms involved. 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·K. Considering six equally spaced nodes with a nodal spacing of 1 cm, obtain the finite difference formulation of this problem. 10

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

(c) How is an insulated boundary handled in finite difference formulation of a problem? How does a symmetry line differ from an insulated boundary in the finite difference formulation? 5