Total number of printed pages – 4 **B. Tech**

CPME 6307

Sixth Semester Examination – 2008

HEAT TRANSFER

Full Marks – 70

Time : 3 Hours

Answer Question No. ***1*** *which is compulsory and any* ***five*** *from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10

   (i) What is log mean area ? Find the log mean area of a hollow cylinder if A_1 and A_2 are the inside and outside surface areas of the cylinder.

   (ii) Difference between thermal conductivity and thermal conductance. Mention their units.

   (iii) Show that the temperature profile for the conduction through a plane wall (with isothermal surfaces) of constant thermal conductivity is linear.

   (iv) Why are triangular or parabolic fins generally preferred over the rectangular fins ?

   (v) What is critical Reynolds number ? State their approximate values for flow over a flat plate and through a circular tube.

   (vi) Explain Reynolds analogy with regard to turbulent fluid flow and heat transfer.

   (vii) What do you mean by entrance region and fully-developed region ? Draw the velocity and temperature profiles in both the regions.

   (viii) What is Rayleigh number ? State its importance in Natural convection.

   (ix) What are the radiation surface and space resistances ? How are they expressed ? For what kind of surfaces, is radiation surface resistance zero ?

(x) Differentiate between regenerators and recuperators, and list their industrial applications.

2. Heat is generated uniformly in a stainless-steel plate (k = 20 W/m-K) at ths rate of 500 MW/m^3. The thickness of the plate is 2.0 cm. If the two sides of the plate are maintained at 100° C and 200 °C respectively, calculate the temperature at the center of the plane. 10

3. Obtain an expression for heat transfer with a straight rectangular fin for a given profile area, assuming the insulated-tip condition. 10

4. Assuming linear temperature profile, derive an expression for the local heat transfer coefficient in laminar boundary layer on a flat plate, under the condition $u = U_\infty = \text{constant}$. 10

5. Define the Grashof number. What is its physical significance ? What functional form of equation is normally used for correlation of free convection boundary layer ? How is a modified Grashof number defined for a constant heat flux condition on a vertical plate ? 10

6. Two large parallel planes having emissivities 0.3 and 0.5 are maintained at temperatures of 900 K and 400 K respectively. A radiation shield having an emissivity of 0.05 on both sides is placed between the two planes. Determine the steady-state temperature of the shield. 10

7. Develop an expression for average heat transfer coefficient for laminar film condensation on a vertical plate clearly stating the assumptions made. 10

8. A double-pipe counter-flow heat exchanger having an area of 100 m^2 is used to heat 5 kg/s of water which enters the heat exchanger at 50 °C. The heating fluid is oil (specific heat = 2.1 kJ/kg-K) and its flow rate is 8 kg/s. The oil enters the heat exchanger at 100 °C and the overall heat transfer coefficient is 120 W/m^2–K. Calculate the exit temperature of the oil and the heat transfer rate. 10