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Total Pages : 06

D-180274

B. Tech. EXAMINATION, 2018

Semester V (CBS)

HEAT TRANSFER (ME, AE)

ME-503

Time : 3 Hours *Maximum Marks : 60*

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt *Five* questions in all, selecting *one* question from each Section A, B, C and D. Section E is compulsory. Assume suitable value of any missing data. Use of heat transfer data book is allowed. Non-programmable calculator is allowed. All questions carry equal marks.

Section A

1. (a) Derive a relation for the critical radius of insulation for a cylinder. **6**

(b) Water flows at 50°C inside a 2.5 cm inside-diameter tube such that h_i = 3200 W/m^2.°C. The tube has a wall thickness of 0.9 mm with a thermal conductivity of 16 W/m^2.°C. The outside of the loses heat by free convention with h_o = 8.6 W/m^2.°C. Calculate the overall heat-transfer coefficient and heat loss per unit length to surrounding air at 20°C.

2. (a) Derive the required expression of heat transfer for an infinitely long fin. **6**

(b) A circumferential fin of rectangular profile having a thickness of 1.0 mm and a length of 2.0 cm is placed on a 2.0 cm-diameter tube. The tube temperature is 140°C, the environment temperature is 20°C, and h = 150 W/m^2.°C. The fin is aluminium. Assume k = 200 W/m^2.°C for aluminium. Calculate the heat lost by the fin. **6**

Section B

3. (a) Obtain a relation for the time required for a lumped system to reach the average temperature $1/2(T_i + T_\infty)$, where T_i is the initial temperature and T_∞ is the temperature of the environment. **6**

(b) A copper sphere (ρ = 8900 kg/m^3, c = 0.38 kJ/kg.°C, and k = 370 W/m.°C.) having a diameter of 3.0 cm is initially at a uniform temperature of 50°C. It is suddenly exposed to an airstream of 15°C with h = 15 W/m^2.°C. How long does it take the sphere temperature to drop to 25°C ? **6**

4. (a) Air at 25°C and 1 atm flows over a flat plate at 45 m/s. The plate is 75 cm long and is maintained at 60°C. Assuming unit depth in the z-direction, calculate the heat transfer from the plate. **6**

(b) Engine oil (ρ = 876 kg/m^3, ν = 0.00024 m^2/s, k = 0.144 W/m.°C, Pr = 2870) at 20°C is forced over a 40-cm-square plate at a velocity of 1.2 m/s. The plate is heated to a uniform temperature of 70°C. Calculate the heat lost by the plate. **6**

Section C

5. Consider a hemispherical furnace of diameter D = 5 m with a flat base. The dome of the furnace is black, and the base has an emissivity of 0.8. The base and the dome of the furnace are maintained at uniform temperatures of 500 and 1100 K, respectively. Determine the net rate of radiation heat transfer from the dome to the base surface during steady operation. **12**

6. (a) A truncated cone has top and bottom diameters of 20 and 40 cm and a height of 20 cm. Calculate the shape factor between the top surface and the side and also the shape factor between the side and itself. **6**

(b) What is the Stefan-Boltzmann Law ? How the heat transfer can be calculated between black surfaces ? **6**

Section D

7. (a) How the heat exchanger classified ? How the fluid arrangements influence heat-exchanger performance ? **4**

(b) A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/s. The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 1.5 cm. If the overall heat transfer coefficient of the heat exchanger is 6400 W/m^2.°C, determine the length of the heat exchanger required to achieve the desired heating. **8**

8. Steam in the condenser of a power plant is to be condensed at a temperature of 30°C with cooling water from a nearby lake, which enters the tubes of the condenser at 14°C and leaves at 22°C. The surface area of the tubes is 50 m^2, and the overall heat transfer coefficient is 2100 W/m^2.°C. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser. **12**

Section E

9. Short answer types questions : **2×6**

(a) What is meant by transient heat conduction ? What is Hiesler chart ?

(b) What is meant by thermal resistance ? What is overall heat transfer co-efficient ?

(c) Define thermal boundary layer thickness. What is energy thickness ?

(d) What is LMTD ? What is significance of LMTD in heat exchanger design ?

(e) What is Radiation Shield ? What is the purpose of radiation shield ?

(f) What is significance of Prandtl Number ? How is it related to boundary layer ?