

Roll No.

Total No. of Pages : 03

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B.Tech. (Mechanical Engg.) (Sem.-5)

HEAT TRANSFER

Subject Code : BTME-501-18

M.Code : 78247

Date of Examination : 25-06-2024

Time : 3 Hrs.

Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.
3. SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.

SECTION-A

1. Write briefly :

- a) **Distinguish between :** (i) Steady state (ii) Unsteady state and (iii) Transient state of heat transfer.
- b) How thermal conductivity is affected by the nature of solid state (amorphous or crystalline)?
- c) List the assumptions made while analyzing the heat flow from a finned surface.
- d) What are drawbacks of lumped capacity analysis?
- e) Define Nusselt number. How it is related to temperature gradient in the fluid immediately in contact with the solid surface.
- f) Draw the temperature profile for parallel flow and counter flow heat exchangers.
- g) Differentiate specular and diffused reflection.
- h) Explain Newton's law of cooling.
- i) Define emissive power and intensity of radiation.
- j) What do you mean by drop wise condensation and film wise condensation?

SECTION-B

- The walls of a house, 4m high, 5m wide and 0.3m thick are made from brick with thermal conductivity of 0.9 W/m.K. The temperature of air inside the house is 20°C and outside air is at -10°C. There is a heat transfer coefficient of 10 W/m².K on the inside wall and 30 W/m².K on the outside wall. Calculate the inside and outside wall temperatures, heat flux and total heat transfer rate through the wall.
- One end of a long rod 3 cm in diameter is inserted into a furnace with the outer end projecting into the outside air. Once the steady state is reached the temperature of the rod is measured at two points, 15 cm apart and found to be 140°C and 100°C, when the atmospheric air is at 30°C with convection coefficient of 20 W/m².K. Calculate the thermal conductivity of the rod material.
- Experimental results for local heat transfer coefficient h_x for flow over a flat plate with an extremely rough surface were found as

$$h_x = ax^{-0.1}$$

where a is constant and x is a distance from the leading edge of the plate. Develop, an expression for ratio of average heat transfer coefficient h for a plate of length x to the local heat transfer coefficient h_x at x .

- Discuss any theory accounting for increased heat transfer during nucleate phase of boiling.
- 1 cm O.D. horizontal copper tube carries liquid freon at -30°C. If 2 m length of this tube must pass uninsulated through the still air at 40°C, determine the heat leakage when outside tube surface emissivity is 0.8. Use the following properties and correlations for determination of convection coefficient ; Air properties : $\beta = 3.597 \times 10^{-3} \text{ K}^{-1}$, $Pr = 0.69$, $\nu = 1.66 \times 10^{-5} \text{ m}^2/\text{s}$, $k_f = 0.028 \text{ W/m.K}$ Correlation for free convection:

$$h = 1.32 (\Delta T/D)^{1/4} \text{ for } 10^3 < Ra < 10^9$$

$$h = 1.24 (\Delta T/D)^{1/3} \text{ for } 10^9 < Ra < 10^{12}$$

SECTION-C

- Two large parallel planes with emissivity 0.6 are at 900 K and 300 K. A radiation shield with one side polished and having emissivity of 0.05, while the emissivity of other side is 0.4 is proposed to be used. Which side of the shield to face the hotter plane, if the temperature of shield is to be kept minimum? Justify your answer.

8. Consider the following parallel flow heat exchanger specification :

cold flow enters at 40°C : $C_c = 20,000 \text{ W/K}$ hot flow enters at 150°C : $C_h = 10,000 \text{ W/K}$,
 $A = 30 \text{ m}^2$ $U = 500 \text{ W/m}^2\cdot\text{K}$. Determine the heat transfer rate and the exit temperatures.

9. Write short notes on the following :

- a) Electrical network analysis for radiation exchange
- b) Hydrodynamic and thermal entry length
- c) Stefan Boltzmann's Law
- d) Heat Transfer from Piston Crown.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.