V-Ex-1-09-E-Scan-50

ME (M) THERMAL I
ADVANCE HEAT TRANSFER

Con. 3256-09. BB-5619

(4 Hours) [Total Marks : 100

N.B : (1) Question No.**1** is **compulsory**.
(2) Answer any **four** questions out of remaining **six** questions.
(3) Answers to **all** parts of a question should be written **together** and **one** below the **other**.
(4) Assume any **suitable data** wherever **required** but **justify** the **same**.

1. (a) Derive the following equation— 10

$$\frac{\partial^2 T}{dx^2} + \frac{q_g}{k} = \frac{1}{\alpha}\frac{\partial T}{dt}.$$

(b) What are the practical examples where there is internal heat generation ? 4

(c) The thermal conductivity of a plane wall of thickness L varies as $k(T) = k_0(1 + \beta T^2)$ where k_o and β are constants. The wall temperature varies from T_1 at $x = 0$ to T_2 at $x = L$. Assuming steady state, derive a relation for the heat transfer rate through the wall. 6

2. A wire of radius 1 mm and 10m long is wrapped with a plastic coating 1 mm thick (k = 0.15 W /mK). A current of 5 A passes through the wire, with a voltage drop of 8 V. If the insulated wire is exposed to an ambient at 35°C with h = 24 W/m^{2}K, determine the temperature at the interface of the wire and plastic layer. Derive any equations used. 20

3. (a) By deriving the equation governing heat transfer from a pin fin find the heat transferred from the fin. Assume insulated fin tip boundary condition. 10

(b) Explain fin efficiency and fin effectiveness. With respect to a pin fin, discuss the effects of the following on these two parameters :— 10
(i) Length (ii) Diameter (iii) Convection heat transfer coefficient.

4. (a) A square plate of side 'a' is bounded by the lines x = 0, x = a, y = 0, y = a. The edges x = 0, x = a, y = 0, are kept at zero temperature while the edge y = a is kept at 50°C. Find the steady state temperature distribution in the plate. 10

(b) Explain the energy balance method to derive the finite difference formulation of the above mentioned plate if the surface at x = 0 is insulated and edge x = a is subject to convective heat transfer (h) to an environment at T_a. 10

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5. (a) Under what conditions can lumped parameter analysis can be used in a transient heat transfer problem ? 8

(b) Discuss factors affecting Biot No. 4

(c) Explain the use of Heisler and Grober charts. 8

6. Two large (infinite) parallel plates are separated by an air film of 4 mm thickness. The lower plate is stationary and maintained at 10°C, while the other plate is at 20°C and is moving at a speed of 200 m/s. 20

(a) Beginning with differential form of conservation equation, determine the velocity and temperature distribution between plates. Clearly specify the assumption made and the boundary condition used for simplification.

(b) Find the location and magnitude of the maximum velocity.

(c) Calculate the temperature at a distance 2.5 mm from lower plate.

(d) Which plate has higher rate of heat flux ?

7. Write short notes on the following :— 20

(a) Implicit and Explicit solution to transient heat conduction problem

(b) Hydrodynamic and thermal boundary layer

(c) Heat transfer enhancement

(d) ε-NTU method for heat exchanger analysis.

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