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Name of the Program - B.tech (IT & MI)

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Unique Paper Code - 911710

Title of Paper - Fluidity in Nature :
Computational Interpretations

Q.3 $T_5 = 35^\circ C$ $T_o = 100^\circ C$

We need to find the temperatures
T_i $(i = 1, 2, \dots 4)$

T_o & T_5 are known
B_o & B_5 are known

There is no internal heat generation and the heat flow is one-dimensional

$$\left(\frac{\partial T}{\partial y} = 0\right)$$

The conductivies are k_1, k_2, k_3
& $h_1 = 0.05m$ $h_2 = 0.035m$ $h_3 = 0.025m$

The Eq^{ns} are

$$\begin{bmatrix} k_1/h_1 & -k_1/h_1 & 0 & 0 \\ -k_1/h_1 & \frac{k_1}{h_1} + \frac{k_2}{h_2} & -k_2/h_2 & 0 \\ 0 & -k_2/h_2 & \frac{k_2}{h_2} + \frac{k_3}{h_3} & -k_3/h_3 \\ 0 & 0 & -k_3/h_3 & k_3/h_3 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} = \begin{bmatrix} q_1^1 \\ q_2^1 + q_1^2 \\ q_2^2 + q_1^3 \\ q_2^3 \end{bmatrix}$$

Now keeping the values

$$Q_1^1 = -10(T_1 - 100)$$

$$Q_2^1 + Q_1^2 = 0$$

$$Q_2^2 + Q_1^3 = 0$$

$$Q_2^3 = -15(T_4 - 35)$$

$k_1 = 50$

$k_2 = 30$

$k_3 = 70$

$h_1 = 0.05\ m$

$h_2 = 0.035\ m$

$h_3 = 0.025\ m$

∴ After Simplifying, we have

$$\begin{bmatrix} \frac{k_1}{h_1} + 10 & -k_1/h_1 & 0 & 0 \\ -k_1/h_1 & k_1/h_1 + \frac{k_2}{h_2} & -k_2/h_2 & 0 \\ 0 & -k_2/h_2 & \frac{k_2}{h_2} + \frac{k_3}{h_3} & -k_3/h_3 \\ 0 & 0 & -k_3/h_3 & \frac{k_3}{h_3} + 15 \end{bmatrix} \begin{bmatrix} 100 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} =$$

$$\begin{bmatrix} 10 \times 100 \\ 0 \\ 0 \\ 15 \times 35 \end{bmatrix}$$

Substituting all the numerical values we get

$$\begin{bmatrix} 20 & -10 & 0 & 0 \\ -10 & 18.57 & -8.57 & 0 \\ 0 & -8.57 & 36.57 & -28 \\ 0 & 0 & -28 & 43 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix}$$

$$= \begin{bmatrix} 1000 \\ 0 \\ 0 \\ 525 \end{bmatrix}$$

$T_1 = 84.4886\,^\circ C$

$T_2 = 68.9773\,^\circ C$

$T_3 = 50.8807\,^\circ C$

$T_4 = 45.3409\,^\circ C$