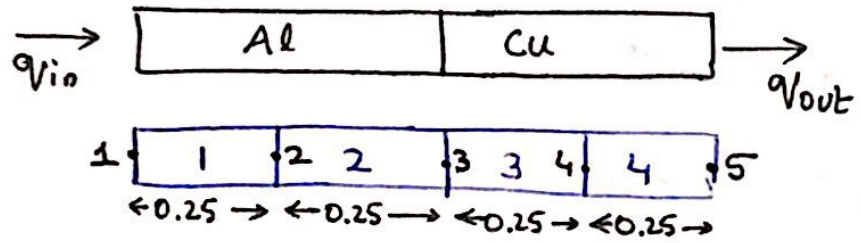
Problem Statement

The Circular rod has an outside Diameter of 60mm, length of 1m, and is properly insulated on its circumference. The left half of cylinder is Aluminum, (k_x(Al) = 200 W/m°c) and Right half of cylinder is Copper, (k_x(cu) = 389 W/m°c). The Left End is subjected to a heat input rate = 4000 W/m². The Right end is subjected to a heat output rate = 4033.6 W/m². Using four equal length elements, Determine the steady state temperature distribution in the cylinder.

Sol:



The elements & Nodes are chosen above.

For Al :- (Elements 1 & 2)

The Conductance Matrixes are :- for elements 1 & 2 :

$$k_{[al]} = \frac{k_x A}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} = 2.26\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} W/°c$$

For copper :-

$$k_{[cu]} = \frac{k_x A}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} = 4.40\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} W/°c$$

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The Assembled Matrix are:-

$$\begin{bmatrix} 2.26 & -2.26 & 0 & 0 & 0 \\ -2.26 & 4.52 & -2.26 & 0 & 0 \\ 0 & -2.26 & 6.66 & -4.40 & 0 \\ 0 & 0 & -4.40 & 8.80 & -4.40 \\ 0 & 0 & 0 & -4.40 & 4.40 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \end{bmatrix} = \begin{bmatrix} 4000 \\ 0 \\ 0 \\ 0 \\ 4038.6 \end{bmatrix}$$

The Exact Values are:-

$T_1 = 95.15^\circ c$

$T_2 = 90.14^\circ c$

$T_3 = 85.15^\circ c$

$T_4 = 82.57^\circ c$

$T_5 = 80^\circ c$.

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