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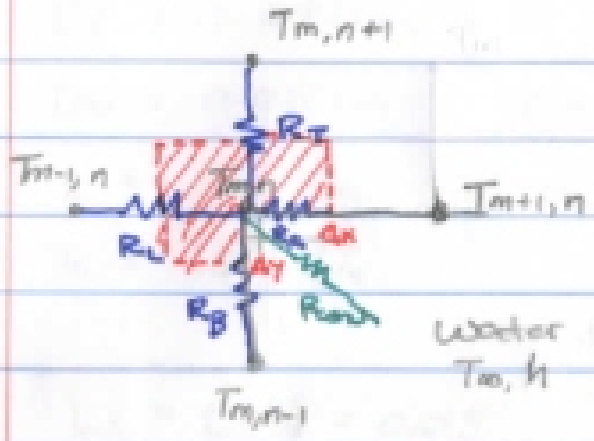
Node at an internal corner with convection — case 2

$\Delta x = \Delta y$



$$R_T = R_L = \frac{1}{k(1m)}$$

$R_R = R_B$

$$R_B = \frac{L}{kA} = \frac{\Delta y}{k\frac{\Delta x}{2}(1m)} = \frac{2}{k(1m)}$$

$$R_R = \frac{L}{kA} = \frac{\Delta x}{k\frac{\Delta y}{2}(1m)} = \frac{2}{k(1m)}$$

$$R_{conv} = \frac{1}{hA} = \frac{1}{h\Delta x(1m)}$$

$$q_T + q_L + q_B + q_R + q_{conv} = 0$$

$$\frac{T_{m,n+1} - T_{m,n}}{R_T} + \frac{T_{m-1,n} - T_{m,n}}{R_T} + \frac{T_{m,n-1} - T_{m,n}}{R_R} + \frac{T_{m+1,n} - T_{m,n}}{R_R} + \frac{T_\infty - T_{m,n}}{R_{conv}} = 0$$

$$\frac{1}{k}\left(\frac{T_{m,n+1} - T_{m,n}}{\frac{1}{k(1m)}} + \frac{T_{m-1,n} - T_{m,n}}{\frac{1}{k(1m)}} + \frac{T_{m,n-1} - T_{m,n}}{\frac{2}{k(1m)}} + \frac{T_{m+1,n} - T_{m,n}}{\frac{2}{k(1m)}} + \frac{T_\infty - T_{m,n}}{\frac{k}{h\Delta x(1m)}}\right) = 0$$

$$\left(T_{m,n+1} + T_{m-1,n} + \frac{T_{m,n-1}}{2} + \frac{T_{m+1,n}}{2} + \frac{h\Delta x}{k}T_\infty\right) + \left(-3 - \frac{h\Delta x}{k}\right)T_{m,n} = 0$$

or

(4.41) $$2\left(T_{m-1,n} + T_{m,n+1}\right) + \left(T_{m+1,n} + T_{m,n-1}\right) + \frac{2h\Delta x}{k}T_\infty - 2\left(3 + \frac{h\Delta x}{k}\right)T_{m,n} = 0$$

Part A from Practice quiz on fins

$D_i = 0.026\,m$ $\quad r_1 = .013$ $\quad r_{2c} = .026$

$D_o = 0.051\,m$ $\quad r_2 = .0255$ $\quad \frac{r_{2c}}{r_1} = 2$

$t = .001\,m$

$k = 15.1 \frac{W}{m \cdot C}$ $\quad L = r_2 - r_1 = .0125$

$L_c = L + \frac{t}{2} = 0.013$ $\quad A_p = L_c t = (.013)(.001) = 1.3 \times 10^{-5}$

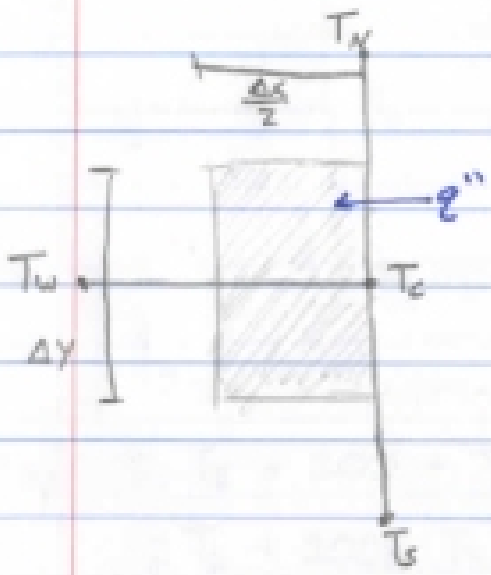
$h = 3150 \frac{W}{m^2 C}$ $\quad k = 15.1 \frac{W}{m \cdot C}$

$$L_c^{3/2}\left(\frac{h}{k A_p}\right)^{1/2} \rightarrow (.013)^{3/2}\left(\frac{3150 \frac{W}{m^2 C}}{15.1 \frac{W}{m C}\,(1.3 \times 10^{-5}\,m^2)}\right)^{1/2} = 5.94$$

still wrong!

Node at a plane surface with uniform heat flux

Case 5



$$q_N + q_W + q_S + \underbrace{q''A}_{q_E} = 0$$

$$\frac{T_N - T_C}{R_N} + \frac{T_W - T_C}{R_W} + \frac{T_S - T_C}{R_S} + q''(\Delta Y)(1m) = 0$$

$$R_N = \frac{L}{kA} = \frac{\Delta x}{k \frac{\Delta x}{2}(1m)} = \frac{2}{k(1m)}$$

$$R_W = \frac{1}{k(1m)}$$

$$R_S = \frac{2}{k(1m)}$$

$$\frac{1}{k}\left(\frac{T_N - T_C}{\frac{2}{k(1m)}} + \frac{T_W - T_C}{\frac{1}{k(1m)}} + \frac{T_S - T_C}{\frac{2}{k(1m)}} + q''(\Delta Y)(1m)\right) = 0$$

$$\left(\frac{T_N}{2} + T_W + \frac{T_S}{2} + \frac{q''(\Delta Y)}{k}\right) - 2T_C = 0$$

Do case 3 & 4 on own for homework