

MEAM 333: Heat and Mass Transfer
Assignment 5
Due Date: 2/2/2012

Homework Guidelines:

1. All papers must be stapled (No dog eared pages!).
2. Solutions must proceed in a step-by-step fashion so that it is easy for the grader to follow and the method is well explained.
3. Handwriting should be neat and presentation should be professional.
4. Final answers for each part should be boxed or double underlined.
5. Failure to do the above will result in point deductions.

Problem 1 [Solution]:

A flat cable of resistance R carries current (I) to a hard drive. The cable is well insulated such that heat flows one-dimensionally along the cable. Resistive losses in the cable lead to a Joule heat generation rate of I^2R . The cable thickness, length, and width are t , L , and w , respectively

- a. Write an expression for the volumetric heat generation rate q''' in the cable.
- b. Given that the temperature at $x=0$ is T_1 , and the temperature at $x=L$ is T_2 , write an equation for temperature as a function of x , R , T_1 , T_2 , t , L , w , and I .
- c. If $R = 50 \Omega$, $T_1 = 300\text{K}$, $T_2 = 320\text{K}$, $t = 2 \text{ mm}$, $L = 25 \text{ cm}$, $w = 6 \text{ cm}$, and $I = 2 \text{ A}$, find the temperature in the middle of the cable.

Problem 2 [Solution]:

The wall of a drying oven is constructed by sandwiching an insulation material of thermal conductivity $k=0.05 \text{ W/mK}$ between thin metal sheets. The oven air is at $T_{\infty,i}=300^\circ\text{C}$, and the corresponding convection coefficient is $h_i = 30 \text{ W/m}^2\text{K}$. The inner wall surface absorbs a radiant flux of $q''_{rad} = 100 \text{ W/m}^2$ from hotter objects within the oven. The room air is at $T_{\infty,o}=25^\circ\text{C}$, and the overall coefficient for convection from the outer surface is $h_o=10 \text{ W/m}^2\text{K}$.

- a. Draw the thermal circuit for the wall and label all temperatures, heat rates, and thermal resistances.
- b. What insulation thickness L is required to maintain the outer wall surface at a safe-to-touch temperature of $T_o=40^\circ\text{C}$?

