

10.302  
Fall 2004  
**QUIZ**  
**Tuesday, November 2, 2004**

Re-consider Problem 7.63 of I&D. (The problem is reproduced on the attached page for convenience.)

Since copper has such a high thermal conductivity ( $k_{\text{cu}} \cong 400 \text{ W/m}\cdot\text{K}$ ), a question has been raised as to whether it is really legitimate to neglect axial conduction. Accordingly, please

1. Repeat Part A, but include axial conduction.
2. Demonstrate either that axial conduction is important or that it can be neglected.
3. The problem implicitly assumes that the wire temperature is radially uniform. Demonstrate that this either is or is not true.

Additional Data

- a. For convenience, you may take  $\bar{h} = 100 \text{ W/m}^2 \cdot \text{K}$
- b. The energy balance derived in Part A of 7.63 can be expressed in several ways. One version is:

$$\frac{1}{4} \rho c_p V_e D \frac{dT}{dx} + h(T - T_\infty) + \varepsilon \sigma [T^4 - T_\infty^4] = 0$$

- c. The solution to Part B of 7.63 is

$$T - T_\infty = (T_i - T_\infty) \exp(-x/L_c)$$

$$\text{where } L_c = \frac{1}{4} \frac{\rho c_p V_e D}{h}$$