Birzeit University
Mechanical & Mechatronics Engineering Department
Heat Transfer ME 431
Homework # 2 introduction to conduction
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2.13 A cylinder of radius ro, length L, and thermal conductivity k is immersed in a fluid of convection coefficient h and unknown temperature T∞. At a certain instant the temperature distribution in the cylinder is $T(r) = a + br^2$, where **a** and **b** are constants. Obtain expressions for the heat transfer rate at ro and the fluid temperature.

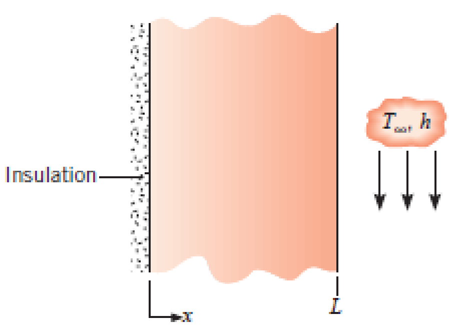
2.46 A steam pipe is wrapped with insulation of inner and outer radii ri and ro, respectively. At a particular instant the temperature distribution in the insulation is known to be of the form.

$$T(r) = C_1 \ln\left(\frac{r}{r_o}\right) + C_2$$

Are conditions steady-state or transient? How do the heat flux and heat rate vary with radius?

2.40 The steady-state temperature distribution in a one-dimensional wall of thermal conductivity k and thickness L is of the form $T = ax^3 + bx^2 + cx + d$. Derive expressions for the heat generation rate per unit volume in the wall and the heat fluxes at the two wall faces (x = 0, L).

2.57 The plane wall with constant properties and no internal heat generation shown in the figure is initially at a uniform temperature Ti. Suddenly the surface at x = L is heated by a fluid at T∞ having a convection heat transfer coefficient h. The boundary at x = 0 is perfectly insulated.



(a) Write the differential equation, and identify the boundary and initial conditions that could be used to determine the temperature as a function of position and time in the wall.
(b) On T - x coordinates, sketch the temperature distributions for the following conditions: initial condition (t = 0), steady-state condition ($t \rightarrow \infty$), and two intermediate times.
(c) On q-x t coordinates, sketch the heat flux at the locations x = 0, x = L. That is, show qualitatively how (0, t) and (L, t) vary with time.
(d) Write an expression for the total energy transferred to the wall per unit volume of the wall (J/m^3).