1. An experiment to determine the convection coefficient associated with airflow over the surface of a thick stainless steel casting involves the insertion of thermocouples into the casting at distances of x_1 and $x_2(= 2x_1)$ from the surface along a line normal to the surface. The steel has a thermal conductivity of k. If the thermocouples measure temperatures of T_1 and T_2 in the steel when the air temperature is T_∞, *obtain an expression for the convection coefficient* $\overline{h}$ given in terms of the known information. The radiation exchange is negligible.

2. Temperature distribution within a series of one-dimensional plane walls at an initial time, at steady-state and at several intermediate times are shown in Figure 1. For each case, write the appropriate form of the heat diffusion equation. Also write the equation for the initial condition and the boundary conditions that are applied at $x = 0$ and $x = L$. If volumetric generation occurs, it is uniform throughout the wall. The properties are constant.

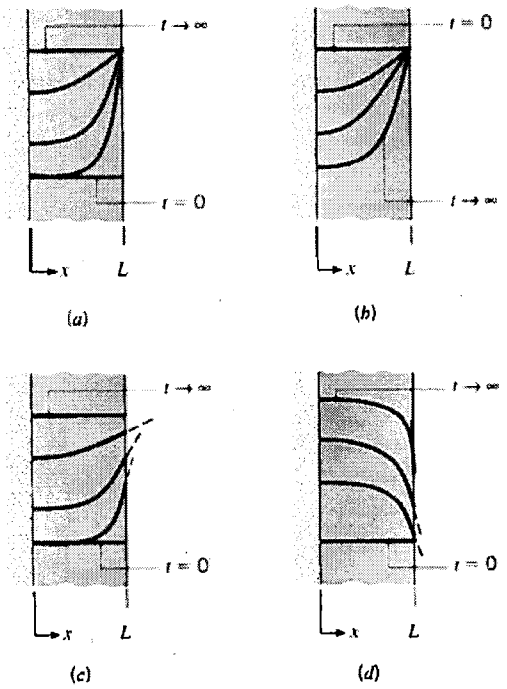

Figure 1

3. The windshield of an automobile is defogged by embedding a thin, transparent, film-type heating element between two layers of windscreen glass with thickness L and thermal conductivity k. By electrically heating this element, a uniform heat flux q_0'', in $\mathrm{W/m^2}$, may be established at the interface between layers. The windshield is subjected to convective conditions on its outer and inner surfaces characterized by $T_{\infty,o}$, $\overline{h}_o$ and $T_{\infty,i}$, $\overline{h}_i$, respectively.

   (a) Draw the thermal circuit for this heat transfer problem. Identify all thermal resistances, known temperatures and heat fluxes in the drawing.

(b) Use thermal resistances to obtain an expression for the temperature on the inner surface of the windshield.

4. We want to know the temperature distribution in the windshield in Question 3. Assuming one-dimensional, steady-state conduction heat transfer in the glass layers of the windshield,

   (a) state the heat transfer problem using the appropriate form of the heat diffusion equation and boundary conditions

   (b) apply dimensional analysis to find the pi-groups for this heat transfer problem

   (c) nondimensionalize the governing equations using the pi-groups.