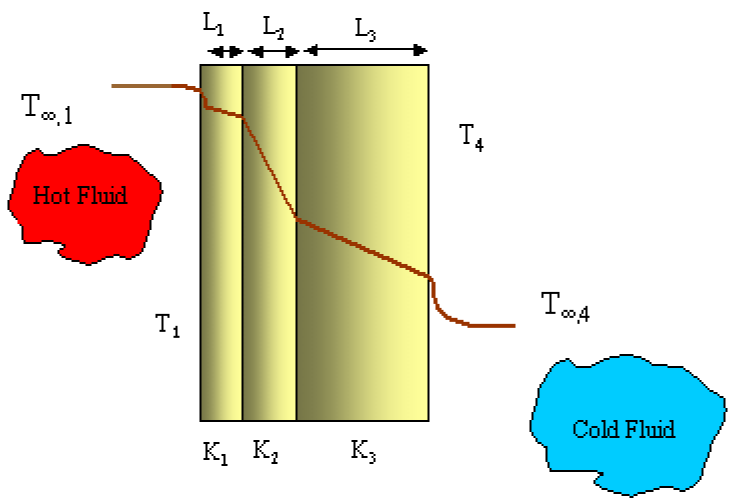
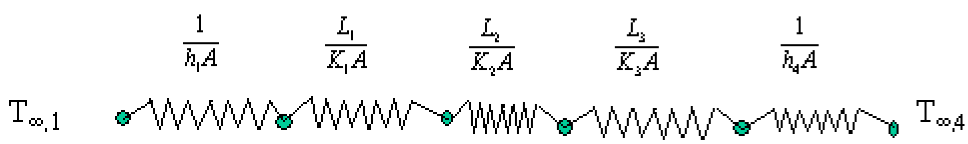
## Problem Definition

Consider A composite wall shown below:




One side of the wall is exposed to a hot fluid while the other side is facing a cold fluid. Radiation between the outer surfaces and the ambient is neglected. The problem is assumed to be one dimensional given that the temperature is uniform across each surface and the conductivity is assumed to be infinite in the vertical direction. This means that the only resistance to heat is in the x direction (from left to right). The first resistance is due to the boundary layer effect between the ambient fluid and the outer surface, 1. This resistance is characterized by the heat transfer coefficient. Then we have three wall resistances in series followed by another boundary layer resistance. We are assuming here that the contact between various layers is perfect and there are no contact resistances. In reality, however, each contact has a "contact resistance" that can be estimated using the surface characteristics as well as the pressure holding the surfaces together. Once this resistance is estimated it can be added to other resistances for calculating the total resistance.

The thermal resistances shown above are connected in series. The total thermal resistance can then be calculated as:

$$R_{total} = R_{conv,1} + R_{wall,1} + R_{wall,2} + R_{wall,3} + R_{conv,4}$$

$$R_{total} = \frac{1}{h_1 A} + \frac{L_1}{k_1 A} + \frac{L_2}{k_2 A} + \frac{L_3}{k_3 A} + \frac{1}{h_4 A}$$

The heat transfer rate through the composite slab is expressed as:

$$\dot{Q} = \frac{T_{\infty,1} - T_{\infty,4}}{R_{total}}$$

The above formula can be easily extended to slabs of n layers, each with its own properties and dimensions.