**ECE 309 M.M. Yovanovich**

# Biot Number

The **Biot number** is a dimensionless group which is defined as

$$Bi = \frac{hL}{k}$$

where $h$ is the film coefficient associated with convection heat transfer through the thermal boundary, $L$ is some characteristic scale length of the solid and $k$ is the thermal conductivity of the solid. The Biot number is a positive quantity which lies in the range: $0 < Bi < \infty$.

## Derivation of Biot number for a plane wall

For steady heat conduction through a plane wall of thickness $L$ and constant thermal conductivity $k$ the temperature drop across the solid is given by

$$T_1 - T_2 = \dot{Q}\ R_{\text{solid}} = \dot{Q}\ \frac{L}{kA}$$

The temperature drop across the thermal boundary layer is given by

$$T_2 - T_f = \dot{Q}\ R_{\text{film}} = \dot{Q}\ \frac{1}{hA}$$

where $h$ is the film coefficient.

The ratio of the temperature drop across the solid to the temperature drop across the film is given by

$$\frac{\Delta T_{\text{solid}}}{\Delta T_{\text{film}}} = \frac{T_1 - T_2}{T_2 - T_f} = \frac{R_{\text{solid}}}{R_{\text{film}}} = \frac{hL}{k} = Bi$$

where the common heat transfer rate $\dot{Q}$ through the solid and the boundary layer has been cancelled.

When the Biot number is sufficiently small, eg $Bi < 0.2$, the temperature drop through the solid is small relative to the temperature drop across the film. In this case the solid can be assumed to be nearly *isothermal*.